Who's Afraid of an Undervote?

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Abstract

We examine the frequency of unrecorded ("residual") votes in the 2000 presidential election, with three innovations. First, our analysis is based on a larger sample of counties than previous studies. Second, we examine several state-specific factors (ballot design, ballot access, restrictions on write-in votes) that have largely been ignored in other studies. Third, rather than rely solely on ordinary least squares regression to estimate the effects of different factors, we demonstrate the need for a generalized least squares approach that weights each county by the number of ballots cast. In general, we find that residual votes are a function of multiple factors, some of which produce intentional abstention and some of which produce voter confusion and errors (such as making too many selections). More specifically, the percentage of uncounted presidential votes is substantially lower in states that include a straight-party option on the ballot. Furthermore, the straight-party device minimizes the disparity in invalidated ballots between high-income, white counties and low-income African-American counties. We also find that unrecorded votes were more common in the majority of states that restrict write-in votes and in states that did not include Ralph Nader's name on the ballot. Votomatic punch card machines perform substantially worse than other voting methods, although Datavote punch cards perform just as well as other methods. Among newer technologies, optical scan ballots produce a slightly lower share of unrecorded presidential votes than electronic voting machines. States that want to reduce the number of unrecorded votes should consider replacing Votomatic punch cards with optical scan ballots, including a straight-party option on the ballot, and adding a "None of These Candidates" ballot line for federal and statewide contests.

Who's Afraid of an Undervote?[1]

During the controversy following the 2000 presidential election and the Florida recount, many people learned of the difficulties some voters face in casting a valid ballot. By our calculations, roughly 2 million voters failed to record a choice for president in the 2000 elections. These were the result of "undervotes" (where voters make no selection) and "overvotes" (where too many selections are recorded). By now most are aware of reports that punch card ballots generate a higher rate of uncounted ballots, or "residual votes" (Caltech/MIT Voting Technology Project 2001a) than other voting methods. Further studies indicate that the elevated rate of unrecorded votes associated with punch card ballots falls disproportionately on African-Americans and the poor (Hansen 2000; Knack and Kropf 2001; Lichtman 2001; cf. Lott 2001).

These findings provided some momentum to the election controversy and raise concerns about unequal treatment of votes in American elections, especially in light of the Supreme Court opinion in *Bush v. Gore* that used an "equal protection" argument to decide the presidential election. In an effort to avoid similar election disputes in the future, several blue-ribbon commissions, government investigators, and academic panels have proposed election reforms designed to reduce the number of voting errors that contribute to unrecorded votes (see a listing of national election reform reports in the appendix). In addition, Congress and most state legislatures are considering legal changes in voting technology and election administration.

[1] We thank Matt McLaughlin, Albert Prah, Cake, Matthew Taitt, and numerous election administrators for their assistance in completing this project.

To date, however, initial studies have overlooked other likely sources of unrecorded votes. Unrecorded votes of the type seen in the 2000 elections are a form of ballot "roll-off," on which there is a rather extensive scholarly literature. In particular, several state-level factors (such as ballot design, ballot access laws, and laws regarding write-in votes) that were not examined by other studies are important causes of unrecorded votes in the 2000 presidential election. Only after controlling for alternative causes of voter error can we properly assess the effects of voting machines and ballot design.

We examine unrecorded votes in the 2000 presidential election by comparing total ballots cast to the total votes recorded for president in 2870 counties. This represents a larger sample of counties than previous reports on the 2000 election. Our results echo other studies in finding that Votomatic punch cards produce a higher rate of unrecorded votes than other voting technologies, although the Datavote brand of punch cards does not perform any worse than other methods. In addition, electronic voting machines perform slightly worse than optical scan ballots.

We also find that the percentage of unrecorded votes in the 2000 presidential election was higher in the majority of states that restrict write-in votes and in seven states where Ralph Nader's name was not on the ballot. In addition, the frequency of unrecorded presidential votes is substantially lower in states that have a straight-party line on the ballot. Furthermore, the straight-party mechanism minimizes the racial and economic disparity in ballot roll-off by reducing the number of unrecorded votes in counties with large African-American populations and low median incomes. While most election reform proposals focus on somewhat costly proposals to upgrade voting

technology, states may also want to consider the relatively low-cost reform of adding a straight-party choice to the ballot.

In sum, unrecorded presidential votes in the 2000 election were influenced by many factors, some of which reflected intentional undervoting and some of which reflected voter confusion. Thus, some unrecorded votes were not intended for either major-party candidate, while others may have been intended for George W. Bush or Al Gore. Before describing our data and empirical analysis in more detail, the next section reviews some of the theory and evidence on the causes of ballot roll-off.

Theory and Evidence on the Causes of Ballot Roll-Off

There are several theories and empirical studies of ballot roll-off. Most studies examine roll-off in contests appearing farther down the ballot than the presidential contest. Indeed, most studies measure roll-off as the difference between the number of votes cast in the race at the top of the ballot and in down-ballot contests. Nevertheless, the literature provides a starting point for hypothesizing about the causes of unrecorded votes in the 2000 presidential election.

One common explanation of ballot roll-off is "voter fatigue." That is, voters grow weary of having to make numerous selections on a long ballot and thus refrain (or undervote) in some contests (Bullock and Dunn 1996; Bowler, Donovan, and Happ 1992). Given that the presidential contest is at or near the top of every state ballot, it is unlikely that fatigue accounts for much (if any) roll-off in presidential voting.

Another theory posits that voters simply abstain from making a selection in races that do not interest them. This is common in contests where voters have little information about the competing alternatives, often due to a lack of media coverage or a low visibility campaign (Burnham 1965; DuBois 1979; Bowler, Donovan, and Happ 1992; Magleby 1994; Mueller 1969; Pothier 1987; Stiefbold 1965; Bullock and Dunn 1996; Wattenberg et al. 2000). This may reflect a fundamental failure of political parties to mobilize competing economic classes (Burnham 1965), or it may reflect a stronger incumbency advantage and other forces that produce less competitive elections (Pothier 1987; Crain, Leavens, and Abbot 1987). This factor may account for some unrecorded votes in the 2000 presidential election. One study suggests that competitive Senate and gubernatorial races were associated with higher rates of unrecorded presidential votes (Brady et al. 2001; c.f. Knack and Kropf 2001). Other compelling statewide races may attract a small number of voters who have no interest in the presidential contest. We examine the same effects below.

Similarly, the presence or absence of appealing candidates on the ballot influence roll-off. It is well-documented that black voters tend to roll-off at higher rates than whites (Price 1957; Walker 1966; Vanderleeuw and Engstrom 1987; Darcy and Schneider 1989; Vanderleeuw and Utter 1993; Bullock and Dunn 1996; Sheffield and Hadley 1984; Nichols and Strizek 1995; Harris and Zipp 1999; Bullock and Mishou 1999). However, the roll-off rates for black voters are smaller in contests featuring a black candidate or racially divisive issues (Vanderleeuw and Utter 1993; Harris and Zipp 1999; Vanderleeuw and Engstrom 1987; Engstrom and Caridas 1991). The candidate factor may account for some variation in unrecorded presidential votes in the 2000

election. Ralph Nader, the most popular alternative to George Bush and Al Gore, did not appear on the ballot in seven states, although previous studies have not estimated the effect of Nader's absence.

Ballot confusion is a third explanation for voter roll-off. Voters may fail to register a selection or make too many selections when they are confused by voting technology, ballot instructions, ballot design, or the choices available. For example, ballot roll-off is more common when important races are placed at the bottom of the ballot or on the back side (Darcy and Schneider 1989).

It is an axiom of politics that few voters are well-informed about full the range of candidates and issues that confront them on a ballot. Consequently, voters use an array of decision-making shortcuts to simplify the voting process (for example, Popkin 1991; Lupia and McCubbins 1998). Partisanship may be the strongest voting aid, and ballot designs that accentuate partisanship tend to produce lower ballot roll-off rates. For example, ballot roll-off increased when party-produced ballots were replaced by the Australian (secret) ballot at the end of the 19th century (Rusk 1970). In addition, roll-off is higher in states using the office block ballot design which groups candidates by office, as opposed to the party column format which groups candidates by party (Walker 1966; DuBois 1979).[2] Finally, a straight-party ballot mechanism also reduces ballot roll-off (Wattenberg et al. 2000, 240; Bullock and Mishou 1999; Kimball and Owens 2000; c.f. Knack and Kropf 1996; Wattenberg 2000, 246). The straight-party punch has the benefit of making partisanship more salient and affording the voter a very simple and almost error-free method of completing the ballot.

Several studies find that roll-off is more common when voting machines present information in a way that confuses or intimidates voters. Since the presidential election of 2000, attention has focused on the punch card machine. Several studies find that ballot roll-off in presidential elections is significantly higher in counties using punch cards as opposed to other voting technologies (Caltech/MIT Voting Technology Project 2001a, 2001b; Brady et al. 2001; United States General Accounting Office 2001b; Knack and Kropf 2001). Evidence of voter difficulties with punch card machines goes back at least ten years (Saltman 1988; Dugger 1988; Shocket et al. 1992; Roth 1998). There is some disagreement, however, in sorting out the performance of other voting technologies in presidential contests. The Caltech/MIT Voting Technology Project (2001a, 2001b) concludes that electronic voting machines perform worse than optically scanned ballots (the other relatively new voting technology in use today) and almost as poorly as punch cards.[3] In contrast, other studies find that electronic machines perform about as well as lever machines, paper ballots, and optical scan ballots (Brady et al. 2001; United States General Accounting Office 2001b; Knack and Kropf 2001).

In addition, voting technologies with the lowest residual vote rates in presidential contests do not necessarily perform as well in races appearing farther down the ballot. For example, ballot roll-off in down-ballot contests has been found to be higher in jurisdictions that use lever machines or optical scanners, which present the entire set of ballot choices at once, than in areas using paper ballots, which divide the ballot into more manageable units (Thomas 1968; Mather 1964; Darcy and Schneider 1989). Other

[2] We find little difference in residual vote rates in the 2000 presidential election between party-column and office block states. Part of the difficulty is that some counties in party-column states have switched to the office block format because they could not fit a party's candidates in a single column (Wattenberg 2000).

studies find that roll-off is less common in places using new electronic voting machines (Nichols and Strizek 1995; Nichols 1998). Newer electronic voting machines are designed to prevent overvotes and use flashing lights to alert the voter to offices where selections still remain to be made.

There is additional evidence suggesting that particular demographic groups are more prone to ballot roll-off. Some studies suggest that ballot roll-off is more common among elderly voters (Darcy and Schneider 1989; Kimball and Owens 2000; but see Nichols and Strizek 1995) low-income voters (Darcy and Schneider 1989; Nichols and Strizek 1995; Kimball and Owens 2000), and less educated voters (Nichols 1998; Nichols and Strizek 1995). In addition, numerous studies cited above indicate that ballot roll-off is more common among racial and ethnic minorities. It may be that each of these groups faces a higher degree of confusion during the voting process (due to lack of knowledge or disability). Alternatively, each of these groups may be alienated from the political process and thus less interested in many of the contests on the ballot. More recent studies indicate that race, income, education, and age help explain variation in residual vote rates in presidential elections (Brady et al. 2001; United States General Accounting Office 2001b; Knack and Kropf 2001).

Furthermore, there is evidence of an interaction between demographic characteristics and voting mechanisms in explaining ballot roll-off. The racial and socioeconomic disparities in roll-off tend to be most pronounced in jurisdictions using older voting equipment, especially punch cards (Brady et al. 2001; Knack and Kropf 2001; Nichols 1998; Minority Staff 2001a) and where there is confusion about the

[3] It appears that "precinct-count" optical scan technology that allows voters to identify and correct errors has a lower residual vote rate than "central count" optical scan methods that do not allow voters to detect

applicability of the straight-party ballot option (Darcy and Schneider 1989). This suggests that the newer optical scan ballots and electronic voting machines and a clearly marked straight-party option help reduce the difficulties that disadvantaged groups face in completing a ballot. While studies of the 2000 election have examined voting technology, we are not aware of any study that estimates the impact of the straight-party ballot device.

A final theory argues that ballot roll-off may be a form of protest for voters who do not find any of the candidates or parties on the ballot appealing (Kim and Koh 1972; Stiefbold 1965). Of course, a write-in vote is an alternative to roll-off for voters who want to register disapproval of the available choices on the ballot. As it turns out, however, many states either do not allow write-in votes or have a restrictive write-in provision in which only votes for candidates who have filed write-in candidacy are counted. To our knowledge, no study of the 2000 presidential election has accounted for state write-in provisions.

The main conclusion to derive from this review is that ballot roll-off is a multi-faceted phenomenon. Voters may fail to record a selection for a number of different reasons. Thus, variation in ballot roll-off (or residual votes) across jurisdictions is shaped by several factors. While county-specific factors (voting technology and demographic characteristics) have been closely examined as influences on residual votes in the 2000 presidential election, several state-specific factors (the straight-party option, Nader's access to the ballot, the number of candidates on the ballot, and write-in laws) have largely been ignored. There is good reason to believe that state factors are important. One study of the 2000 election uses dummy variables to control for state effects and finds

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errors (United States General Accounting Office 2001b; Knack and Kropf 2001).

that state-specific factors account for a much bigger share of variation in residual vote rates than voting technology and demographic variables (U.S. General Accounting Office 2001b).[4] In the next section, we describe the data and methods we use to incorporate multiple causes of residual votes in an analysis of the 2000 presidential election.

Data and Methods

Since elections are administered (and decisions about voting technology are made) at the county level in most states, we examine counties as the unit of analysis. Thus, we collected data on the number of ballots cast, the presidential vote totals, voting technology, and demographic characteristics for each county in the country. In six states (Maine, Massachusetts, Michigan, New Hampshire, Vermont, and Wisconsin), elections are administered by townships rather than counties. In these states, we aggregated the vote totals and voting technology data to the county level. In other states (Illinois, Missouri, Maryland, Virginia), some cities have separate election administration authorities. In these cases, we include such cities in our data as county equivalents and adjust the figures for the county from which they come.[5] Adding the District of Columbia as one case produces a total of 3148 geographic units that tile the entire country.[6]

[4] The GAO study does not estimate the effects of any specific state characteristics, but suggests a few factors that we test, including the straight-party option and the number of candidates.
[5] Alaska is divided into boroughs and census areas, which we treat as counties for this analysis. We aggregated precinct-level voting data from Alaska to calculate residual vote rates for each borough or census area. In Louisiana, we treat parishes as equivalent to counties.
[6] We drop Kalawao, Hawaii because it has a population of 147 and its votes are counted in another Hawaiian county.

To calculate residual vote rates for each county, we gathered data on the number of ballots cast and the number of votes cast for president. Then we simply compute the difference between the two totals to calculate the residual vote in the presidential race. In gathering vote totals data, we rely on the official canvass provided by each state in almost all cases (with the exception of some write-in votes discussed below). In most cases, we got the election data from the election administrator (usually the secretary of state's office) in each state.[7] Six states (Arkansas, Maine, Mississippi, Missouri, Pennsylvania, and Tennessee) did not have data on ballots cast at the county level. For five of these states, we contacted each county to get the data, which most (but not all) were able to provide. Maine (16 counties) is the only state missing entirely from our analysis because we would have had to contact each town for data on ballots cast (which they are not required tabulate). We are also missing data from 105 counties in Texas (all used paper ballots) and 1 county in Alabama which apparently did not record the number of ballots cast. We also contacted individual counties to correct obvious errors (as when the number of ballots cast is less than or equal to the number of presidential votes), but we were unable to fix them all. Finally, we exclude one county in Alabama with an estimated residual vote of 49% based on available data.

After dropping cases with missing data and clear errors, we have complete data on residual votes in the 2000 presidential election for 2870 "counties" (91% of the total), representing 95% of votes cast for president in the 2000 election.[8] Among the counties in

[7] For Oklahoma, we calculated residual votes by aggregating overvotes and undervotes in precinct data collected by Lublin and Voss (2001).

[8] This represents a more complete data set than other studies of residual votes in the 2000 election. Brady et al. (2001) examine 2219 counties, and GAO (2001b) includes 2455 counties. The Caltech/MIT Voting Technology Project (2001a; 2001b, 8) examines approximately 2800 counties and municipalities in multiple elections, but it appears that it misses data from fourteen states and the District of Columbia in the 2000 election (2001a, 89).

our sample, 1,844,255 residual votes were cast in the presidential contest (1.8% of ballots cast). The distribution of unrecorded presidential votes across counties is skewed, with outliers at the high end. Residual vote percentages range from .02% to 18.2%, with a median of 1.7%, a mean of 2.2%, and a standard deviation of 1.9%.

We also collected demographic data for each geographic unit in our sample. We gathered information on each county's median household income (a 1997 estimate) and population in the 2000 census, as well as the percent black, the percent Hispanic, and the percent 65 years or older from the U.S. Census Bureau's State and County QuickFacts web site (http://quickfacts.census.gov/qfd/). We also got data on the percentage of people over age 25 with a college degree (based on 1990 census data) from the 1994 County and City Data Books (http://fisher.lib.virginia.edu/ccdb/).

One of our hypotheses is that Ralph Nader's absence from the ballot in seven states (Georgia, Idaho, Indiana, North Carolina, Oklahoma, South Dakota, and Wyoming) may have increased the residual vote rate in those states.[9] Even though Nader received write-in votes in some of those states,[10] it is possible that Nader supporters intentionally abstained from the presidential contest in the states where he did not appear on the ballot.

[Table 1 about here]

Table 1 compares the residual vote rates in the 2000 presidential election for states with and without Ralph Nader on the ballot. The first column provides the mean residual vote rate averaged across all counties, in which each county is weighted equally. Some may object to calculations that weigh a county of 1,000 voters the same as a county

[9] In case one is concerned about other visible candidates, Pat Buchanan appeared on the ballot in every state except the District of Columbia.

[10] Voters in Georgia, Idaho, Indiana, and Wyoming could have cast write-in votes for Nader, while Oklahoma and South Dakota did not allow write-in votes. Finally, North Carolina did not count any write-

of 50,000 voters. Thus, the second column presents an aggregate residual vote rate calculated across all ballots cast. The aggregate residual vote rate is equivalent to a weighted mean where each county is weighted by the number of ballots cast. The evidence in Table 1 provides some preliminary evidence to support our hypothesis about ballot access. Using either calculation, the residual vote rate is at least one percentage point higher in states where Ralph Nader's name was left off the ballot.

We also hypothesize that residual votes should be less common in states with a straight-party ballot option. We collected sample ballots from each state to determine which states have a straight-party device. In some cases, we contacted state election officials to clarify the position of the straight-party choice. The straight-party option is gradually disappearing from American ballots. Currently, only 15 states have a one-punch ballot device that applies to the presidential contest, down from 28 states that had the ballot option in the 1960s.[11] Three states eliminated one-punch voting within the last eight years, and several others are considering legislation to end the practice. The straight-party option is not merely a cosmetic aspect of ballot design. Before Illinois and Georgia eliminated straight-party voting, roughly one-third of all voters made a straight-party selection (Kimball and Owens 2000; Bullock and Mishou 1999).

[Table 2 about here]

If states want to reduce the number of unrecorded votes in presidential elections, they might consider adding a straight-party option to the ballot if they do not already have it. Preliminary evidence indicating that the straight-party punch reduces residual

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in votes for Nader because he failed to submit a write-in candidate declaration before the state's deadline in July (Winger 2001).

[11] North and South Carolina also have a straight-party ballot option, but it only applies to races appearing below the presidential contest. For this analysis, both states are coded as not having a straight-party device.

votes appears in Table 2. The mean residual vote rate is one percentage point higher in states without the straight-party mechanism, although the disparity is not quite as large when residual votes are calculated across all ballots.

We also hypothesize that laws regarding the treatment of write-in votes influences the number of residual votes. Voters may use the write-in option to express disapproval of the candidates listed on the ballot. We contacted each state's election office to ascertain its laws on the availability and counting of write-in votes. For some states (Indiana, Maryland, New Jersey, Washington, Wyoming) we discovered that initial election results provided by the state did not include valid write-in votes. Thus, we contacted state and county election officials in these states to get write-in totals.[12] States treat write-in votes in one of four ways. Ten states simply did not include space on the ballot for write-in votes in the 2000 presidential election, thus removing a potential way to register protest. Another 25 states allowed write-in votes but only counted write-ins cast for candidates who had filed a declaration of write-in candidacy (which hardly any candidates bother to do). Thus, some voters made write-in selections that were not counted as valid votes.[13] Another 14 states allow and count all write-in votes. Finally, we reserve a fourth category for Nevada, the only state to include a ballot line for "None

[12] As a validity check, we compared statewide residual vote rates from our data to those reported in other studies (Caltech/MIT Voting Technology Project 2001a, 89; Brady et al. 2001, 21 fn. 34). For most states, our estimates matched or were within .1% of each other. In some states, we had data that was missing from the other studies, so no comparison could be made. In the states where our estimates differed substantially (Indiana, Maryland, Nevada, and Wyoming), we calculated lower residual vote rates than reported in at least one of the comparison studies. We suspect that one or both of the other studies did not include write-in votes in their calculations of valid presidential votes for these states. Among those four states, Nader was a write-in candidate in Indiana, Maryland, and Wyoming.

[13] For example, Arizona is one of the states that only counts write-in votes for candidates who filed the required paperwork. If all write-in votes in Maricopa county, Arizona (which includes Phoenix) were counted as valid votes, the residual vote rate would have been 1.4% instead of 1.7% as our data indicate.

of These Candidates" in federal and statewide races, certainly a more conspicuous outlet for a protest vote than the write-in option.[14]

[Table 3 about here]

While the treatment of write-in votes may seem like a mundane task, it does have some bearing on residual vote rates in the 2000 presidential election. As Table 3 indicates, residual vote rates are roughly one percentage point higher in states that restrict write-in votes (by not allowing them or only counting write-in votes for qualified candidates). This suggests that some of the unrecorded votes in the 2000 presidential election would have been write-in selections rather than votes for either major-party candidate.

Finally, in order to test for the effects of voting equipment, we gathered data from each state's election office on the voting technology used in each county. Generally, five different methods of voting are used in the United States: paper ballots, lever machines, punch card machines, optical scan ballots, and direct recording electronic (DRE) machines. We also identify two different types of punch card systems. The most common punch card ballot is the Votomatic, in which a punch card is inserted behind a booklet with the ballot options and the voter uses a stylus to punch out the hole corresponding to the voter's preferred selection. A less common punch card method is the Datavote, in which offices and candidates are printed directly on the punch card and the voter punches out the hole next to one's chosen candidate. The electronic and optical scan systems are the newest technologies, seeing more widespread use as jurisdictions

[14] Over 3,000 voters in Nevada (0.5% of votes cast) chose "None of These Candidates" in the 2000 presidential election. Nevada does not have a separate line for write-in votes.

replace older methods (paper, lever, and punch card).[15] In some counties (almost entirely in states where elections are administered by townships), not all ballots were cast using the same technology. In those cases, we coded the voting technology as the equipment used by at least 75% of the voters. If no single method was used by at least 75% of the voters, we coded the county's voting technology as a "mixed" system.

[Table 4 about here]

Table 4 provides summary data on the prevalence of each type of voting technology and it's residual vote performance in our sample of counties. Punch card and optical scan systems are by far the most commonly used voting technologies. As several studies indicate, Votomatic (2.9% mean residual vote rate) and Datavote (2.8%) punch card machines produce higher mean residual vote rates than any other system. However, when residual votes are calculated as a percentage of all ballots cast, Datavote punch cards have the lowest residual vote rate of any voting method. The disparity in averages is due to the fact that few counties use the Datavote system, which allows a handful of jurisdictions with high residual vote figures to skew the mean.[16] Nevertheless, it should give pause to those who might lump Datavote and Votomatic systems together in concluding that all punch card technology is bad.

Beyond Votomatic punch cards, no large differences in residual vote rates emerge between other voting systems, although the optical scan method has a residual vote rate slightly lower than most others. While the bivariate analyses presented to this point are preliminary, it is important to note that the disparity in residual vote rates for different

[15] One can find a detailed description of each type of voting equipment in a variety of sources (Fischer 2001; Caltech/MIT Voting Technology Project 2001a, 2001b; Brady et al. 2001; U.S. General Accounting Office 2001b).

voting technologies is no greater than for the state factors (Nader's access to the ballot, the straight-party ballot device, and write-in laws) discussed above. While existing studies focus almost exclusively on voting technology, it appears that several state characteristics have a similar or greater impact on unrecorded votes than voting technology. To get a better assessment of that, the next section introduces a multivariate analysis of residual votes that simultaneously controls for various factors.

Multivariate Analysis

To determine the impact of several factors on residual votes in the 2000 presidential election, we estimate a series of ordinary least squares regression models that include voting technology, state-specific characteristics, and demographic measures as explanatory variables. The dependent variable is the percentage of ballots cast in which no vote for president was recorded (the "residual vote rate").

In addition to the state-specific variables described above (treatment of write-in votes, the presence of Ralph Nader, and a straight-party ballot option), we account for the number of presidential candidates on the ballot in each state (which ranges from a low of 4 candidates to a high of 12). There is some evidence of a curvilinear relationship between residual votes and the number of candidates on the ballot (Knack and Kropf 2001). When there are few candidates on the ballot, the number of residual votes may be higher as disaffected voters are more likely to abstain when they find no presidential candidate to their liking. Thus, increasing the number of candidates should reduce residual votes. However, at some point including too many candidates on the ballot may

[16] Datavote technology is used almost exclusively in several small Florida counties (which had rather high

cause confusion (and more residual votes), especially if (as in Florida in 2000) it forces jurisdictions to use butterfly ballots or multiple pages to list candidates. Thus, we follow the convention established by Knack and Kropf (2001) and include the number of presidential candidates as well as a squared term in our model.[17]

Optical scan balloting is the most commonly used voting technology, and some recent studies (Caltech/MIT Voting Technology Project 2001a, 2001b; Knack and Kropf 2001) conclude that it produces lower residual vote rates than most alternatives, including its chief competitor (electronic machines). Consequently, we use optical scan as the baseline for comparison. The regression models include separate dummy variables for each voting technology (including mixed systems) except optical scan.

Our regression models also include a number of demographic variables that are correlated with residual votes. Several of these indicators measure the presence of disadvantaged groups that may feel alienated from the political process or face a disproportionate amount of difficulty during the voting process. We include the percentage of a county's population that is black (which ranges from 0% to 98% with a mean of 9% in our sample), the percentage that is Hispanic (which ranges from 1% to 98% with a mean of 6%), and the percentage 65 years of age or older (which ranges from 2% to 35% with a mean of 15%). We expect a negative relationship between residual votes and each of these three demographic variables. In addition, we include the percentage of people over age 25 that hold a college degree (which ranges from 4% to 53%, with a mean of 14%) and the natural log of median household income (which

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residual vote rates) and several larger California counties (which had relatively low residual vote rates).

[17] As in two other studies (Brady et al. 2001; Knack and Kropf 2001), we also examined the level of competition in the presidential, Senate, and gubernatorial contests in each state. However, the estimated

ranges from 9.4 to 11.3 with a mean of 10.4). Both should be positively correlated with residual votes. We calculate the log of median income because the raw data are skewed with outliers at the high end and we hypothesize that beyond some point, increased income does not increase one's familiarity with the voting process. Finally, we include the natural log of each county's population (which ranges from 6.1 to 16.1, with a mean of 10.3) because several studies find a negative relationship between population and residual votes (Brady et al. 2001; Knack and Kropf 2001; Caltech/MIT Voting Technology Project 2001b; U.S. General Accounting Office 2001b).

We use ordinary least squares (OLS) and generalized least squares (GLS) regression to estimate a multivariate model of residual votes. This allows us to present both weighted (GLS) and unweighted (OLS) coefficient estimates. Since elections are administered by county governments (which make critical decisions about voting technology) in all but a few states, one could argue that each county should be weighted the same (the OLS approach). However, the number of voters in each county varies dramatically, and most counties have small populations. Over half of the counties in our sample have populations less than 26,000. There are just 106 counties in our sample with more than 200,000 voters in the 2000 election, but these counties account for 43% of all ballots cast in the nation. Thus, an unweighted analysis is disproportionately influenced by the voting behavior of the minority of voters who reside in small counties. As seen in Florida in 2000, a high residual vote rate in the presidential election is more consequential and controversial when it occurs in a large county with tens of thousands of voters than in a small county.

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effects of these explanatory variables were not statistically significant. Their presence in the model did not alter other substantive findings, so we dropped them from the model for the sake of parsimony.

In addition, estimating OLS regression on aggregated data introduces heteroskedasticity, which produces inefficient coefficient estimates and biased standard error estimates.[18] In particular, the error variance will be inversely proportional to the number of voters in each county (Kmenta 1986, 366-373), which we confirm in our data. The solution to this problem is generalized least squares, where each county is weighted by the number of ballots cast (Kmenta 1986; Johnston and DiNardo 1997). Thus, we also present GLS regression estimates where each county is weighted by the number of ballots cast.[19] This dovetails with our presentation of weighted and unweighted mean residual vote rates in Tables 1 through 4. As a further precaution, in both cases we estimate robust standard errors, recommended by White (1980) among others, to correct for heteroskedasticity likely in data with a skewed dependent variable.[20]

[Table 5 about here]

The regression estimates in Table 5 indicate that the decision to weight counties or not influences the results for some explanatory variables.[21] In addition, we find evidence to support our hypotheses about the importance of several state ballot characteristics. Holding other factors constant, the mean (unweighted) residual vote rate is almost one percentage point lower in states with a straight-party option on the ballot, and the weighted mean is .6 percentage points lower. This is a substantial effect, given that average residual vote rates are low to begin with (recall that the unweighted mean in

[18] Voss (1996, 1164-1166) provides an example of the advantages of GLS versus OLS in election studies.
[19] Among recent studies of residual votes in presidential elections, some present unweighted regression estimates (Caltech/MIT Voting Technology Project 2001b; Knack and Kropf 2001; U.S. General Accounting Office 2001b) while others (Brady et al. 2001) weight by the number of ballots cast.
[20] To test for the effect of outliers, we also generated regression estimates after deleting 27 extreme cases (counties with residual vote rates above 10% or below .1%). The results were almost identical to ones presented in this paper.
[21] We lose one case in the multivariate analysis because the Census Bureau has no data on median household income for Skagway, Alaska.

our sample is 2.2% and the weighted mean is 1.8%). Thus, it appears that the straight-party mechanism allows some voters a way to bypass confusing features of the ballot and avoid mistakes in the presidential contest.

Our results also confirm that, other things equal, Nader's absence from the ballot substantially increased the residual vote rate in seven states. The impact of Nader's exclusion is similar in magnitude to the straight-party device. Not surprisingly, the states that excluded Nader have some of the most onerous petition and ballot qualification requirements for minor party candidates (Winger 2000). Thus, ballot access requirements can have an unexpected effect on residual votes.

A further examination of the minutiae of election procedures reveals that the degree to which states encourage protest votes has an effect on the frequency of unrecorded votes in presidential elections. States that count all write-in votes have a lower average residual vote rate (by .5 unweighted percentage points and .3 weighted percentage points). Since most states restrict write-in voting, this effect probably contributes quite a bit to the overall total of unrecorded votes in the 2000 presidential election.

Furthermore, the residual vote rate is substantially lower in Nevada, the only state to offer a ballot line for "None of These Candidates." After controlling for other effects, the unweighted mean residual vote rate 1.6 percentage points lower and the weighted mean is one percentage point lower in Nevada than the rest of the country. As a Nevada election official explained to us, the extra ballot line "really helps minimize the number of undervotes." States that want to minimize the controversy generated by unrecorded votes might want to follow Nevada's example.

The impact of the number of presidential candidates on the ballot depends on whether one relies on weighted or unweighted regression estimates. The unweighted regression estimates produce statistically significant results supporting the hypothesized curvilinear relationship. However, GLS regression produces weaker and statistically insignificant estimates of the effect of the number of candidates on the ballot. Thus, the number of candidates on the ballot may not have an appreciable effect on unrecorded votes in the 2000 presidential election.

Interpreting the effects of voting methods also depends on the use of OLS versus GLS. OLS regression might lead one to conclude that the oldest voting methods (paper ballots and lever machines) had lower residual vote rates than optical scan ballots, while both punch card systems and electronic voting machines had higher residual vote rates than optical scan methods. GLS estimates paint a somewhat different picture, with Votomatic punch card ballots emerging clearly as the least preferred technology in terms of unrecorded votes. Based on the GLS estimates, the average residual vote rate in counties using Votomatic machines was 1.4 percentage points higher than in counties using optical scan ballots. None of the other voting methods appears better or worse than optical scan except for electronic voting machines, with a weighted mean residual vote rate .3 percentage points higher than optical scan ballots.

Among demographic variables, the effects of racial and ethnic composition, median income, and population on a county's residual votes are statistically significant and in the expected direction. Meanwhile, the elderly share of the population and the prevalence of college graduates appear unrelated to a county's residual vote rate when controlling for other factors. The substantive effects of the race and income variables are

both quite large. According to the GLS estimates, moving from a county with no African-American residents to a county that is 50% African-American will, on average, increase the residual vote rate by one percentage point. Similarly, the mean residual vote rate in a county with a median household income of $44,500 (90th percentile in our sample) is expected to be .7 percentage points lower than a county with a median income of $24,500 (20th percentile).

It remains to be seen whether the effects of the demographic measures are the result of intentional undervoting by disaffected groups or the result of greater voter confusion and unintentional errors among disadvantaged groups. Other studies indicate that newer voting technologies designed to minimize voting errors (especially electronic machines and precinct-count optical scan methods) significantly reduce the correlation between demographic variables and residual votes. This suggests that the effects of the demographic measures reflect voter confusion rather than intentional undervoting.

The straight-party ballot option is another mechanism that may help voters avoid confusion and mistakes on other parts of the ballot. Thus, the effects of race and socioeconomic measures on residual votes may be confined to those states that do not have a straight-party option on the ballot. To test this hypothesis, we also analyze the determinants of unrecorded presidential votes separately for states that have a straight-party option and those that do not. Basically, we replicate the regression models in Table 5 except that we drop the straight-party variable. The first two columns in Table 6 provide estimates for states that use the straight-party ballot feature.[22] The last two columns provide estimates for states that do not have the straight-party option.

[22] The Datavote system is not used in any states with a straight-party device, and Nevada does not use the straight-party option. Thus, both variables are excluded from the first two columns of Table 6.

[Table 6 about here]

The regression estimates show that it is important to sort states by their use of the straight-party device. Focusing on the GLS estimates, median income and the size of the African-American population are powerful influences on the residual vote rate in states without the straight-party preference. In contrast, neither race nor income is a significant predictor of residual votes in states that have the straight-party punch on the ballot.

In addition, the effects of write-in vote restrictions and the number of candidates on the ballot are statistically significant and in the expected direction in states without the straight-party choice. However, these same measures are insignificant predictors of residual votes in states that have straight-party voting. Again, the results suggest that the straight-party device helps voters avoid mistakes that lead to unrecorded votes.

Finally, we uncover an interaction between the effects of voting technology and the straight-party ballot line. While the Votomatic punch card performs poorly in both types of states, optical scan methods perform substantially better than paper ballots and electronic machines in straight-party states. In contrast, optical scan ballots perform no better than any of the alternatives to punch cards, and even perform worse than electronic voting machines, in states without straight-party voting. This is largely due to a dramatic reduction in residual votes for optical scan ballots in states with the straight-party option, although all voting technologies except electronic machines perform better in straight-party states. The unweighted mean residual vote rate for optical scan ballots in states with straight-party voting is 1.1% (the weighted mean is 0.7%), as compared to an unweighted mean residual vote rate of 2.7% (1.6% weighted mean) in states without straight-party voting.

We do not have a good explanation for this apparent interaction between voting technology and the straight-party choice, and it merits a closer examination. Wattenberg et al. (2000) make an analogy between voting and taking a standardized test, and argue that voters abstain from contests where they feel ill-informed about the competing candidates. Optical scan ballots (where voters usually have to darken an oval by the name of their preferred candidate) most closely resemble standardized tests. Perhaps in these situations the straight-party option allows voters to make a selection in contests farther down the ballot where they may not "know the correct answer." In any case, these results indicate that as states upgrade to optical scan ballots, they might also consider including a straight-party option on the ballot.

This study only examines the impact of the straight-party mechanism in a cross-sectional analysis. Those skeptical of the reported effects might argue that the states which happen to have straight-party voting possess other unmeasured qualities (efficient election administrators, excellent voter education efforts, or high levels of civic duty among citizens) that might account for the rather large reduction in residual votes that we attribute to the straight-party option. There are two reasons not to be skeptical of the effect we ascribe to straight-party voting.

First, although we do not have data to address this issue definitively, with a few exceptions the states with straight-party voting (Alabama, Iowa, Indiana, Kentucky, Michigan, Missouri, New Hampshire, New Mexico, Oklahoma, Pennsylvania, Rhode Island, Texas, Utah, Wisconsin, and West Virginia) are not the states one would expect to see at the top of a list of "good government" indicators. Second, with many jurisdictions upgrading to optical scan ballots for the 2000 election (and with an extremely

competitive presidential contest), one would expect the residual vote rate to drop from 1996 to 2000. Indeed, that is what one finds in almost every state, with one glaring exception. The percentage of unrecorded presidential votes in Illinois increased from 2.4% in 1996 to 3.9% in 2000 (the highest rate in the country). Not coincidentally, Illinois eliminated the straight-party punch after the 1996 election.[23] This provides some circumstantial evidence that the straight-party option helps reduce unrecorded votes.

The 2000 Election Controversy and its Aftermath

Several factors account for the roughly two million unrecorded votes in the 2000 presidential election. There is some evidence to defuse the controversy surrounding the 2000 presidential election and there is evidence to inflame the controversy. On the one hand, the effects of Nader's absence from the ballot, restrictive write-in laws, and Nevada's "None of These Candidates" option strongly suggest that some residual votes were intentional undervotes (abstention). Thus, some residual votes were not intended for either major-party candidate and have no bearing on the election controversy between George Bush and Al Gore.

On the other hand, the strong effects we attribute to straight-party voting (its ability to reduce residual votes and minimize the racial and economic differences in roll-off rates) and voting technology (especially Votomatic punch cards) suggest that many unrecorded votes resulted from voter confusion. Many of the votes lost because of these

[23] South Dakota also dropped straight-party voting after the 1996 election and saw its residual vote rate increase barely in 2000 (from 1.7% to 1.8%). Finally, South and North Carolina tied for the second highest rate of unrecorded presidential votes in the 2000 election. Both states have straight-party options on the ballot that do not apply to the presidential race. This could create confusion for voters who think they have made a choice in the presidential contest when they make a straight-party selection.

factors were probably intended for Bush or Gore, who received about 95% of the valid votes. In at least six states (Florida, Iowa, New Hampshire, New Mexico, Oregon, and Wisconsin), the number of unrecorded votes was larger than the vote margin between Bush and Gore. It is at least theoretically possible that the winner could have been different in some of these states if unrecorded votes had been cast properly and counted as intended.

On the positive side, our results suggest a few things states and counties can do to reduce the number of unrecorded presidential votes in future elections. To achieve the greatest impact, election officials should consider replacing Votomatic punch card machines with optical scan ballots, and include straight-party and "None of the Above" options on the ballot. Other measures that would have a lesser impact include changing election laws so that all write-in votes are counted and a minor party candidate with a national following like Ralph Nader can qualify for a position on the ballot.

We end with a cautionary note for states and counties that are considering costly efforts to buy new voting machinery. We find that new technology (optical scan and electronic machines) at best performs only slightly better than older voting methods, with the exception of Votomatic punch card machines. In addition, a detailed study of Florida precincts in the 2000 election finds that confusing ballot designs (where presidential candidates were listed on more than one page), rather than punch card machines, accounted for most of the unrecorded presidential votes (Cauchon 2001).[24] Thus, jurisdictions using paper ballots, lever machines, or Datavote punch cards may not need to upgrade to newer voting technology. Instead, less costly solutions, such as simpler ballot designs and other minor additions to the ballot (especially the straight party and

"None of These Candidates" options) may do as much or more to reduce the frequency of unrecorded votes than a change in voting technology. Finally, if states want to improve efforts to understand the causes of unrecorded votes, they should consider requiring election administrators to uniformly record and report the number of ballots cast, as well as the number of overvotes and undervotes, in each precinct.

[24] Nine of the 25 punch card counties in Florida use Datavote technology.

Appendix: Catalog of Recent Election Reform Studies

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Table 1
Residual Vote in the 2000 Presidential Election by Nader's Presence

Ralph Nader on Ballot?	Mean Residual Vote	Aggregate Residual Vote
Nader on the Ballot (43 states, 2321 counties, 90% of ballots)	2.0% (1.7%)	1.7%
Nader Not on the Ballot (7 states, 549 counties, 10% of ballots)	3.1% (2.1%)	3.0%

"Mean Residual Vote" is the average across all counties in the category (standard deviation in parentheses). "Aggregate Residual Vote" is the residual voting rate calculated across all ballots cast (equivalent to a weighted mean where each county is weighted by the number of ballots cast).

Table 2
Residual Vote in the 2000 Presidential Election by Ballot Format

Ballot Format	Mean Residual Vote	Aggregate Residual Vote
Straight-Party Punch (15 states, 1008 counties, 28% of ballots)	1.6% (1.3%)	1.4%
No Straight Party Punch (35 states, 1862 counties, 72% of ballots)	2.6% (2.0%)	2.0%

"Mean Residual Vote" is the average across all counties in the category (standard deviation in parentheses). "Aggregate Residual Vote" is the residual voting rate calculated across all ballots cast (equivalent to a weighted mean where each county is weighted by the number of ballots cast).

Table 3
Residual Vote in the 2000 Presidential Election by Write-In Laws

Status of Write-In Votes	Mean Residual Vote	Aggregate Residual Vote
Write-Ins Not Allowed (10 states, 530 counties, 9% of ballots)	2.5% (2.3%)	1.9%
Write-Ins Counted Only for Declared Candidates (25 states, 1687 counties, 67% of ballots)	2.4% (1.8%)	2.0%
All Write-Ins Counted (14 states, 636 counties, 23% of ballots)	1.6% (1.3%)	1.1%
"None of These Candidates" Ballot Option (Nevada only, 17 counties, 1% of ballots)	0.9% (0.4%)	0.6%

"Mean Residual Vote" is the average across all counties in the category (standard deviation in parentheses). "Aggregate Residual Vote" is the residual voting rate calculated across all ballots cast (equivalent to a weighted mean where each county is weighted by the number of ballots cast).

Table 4
Residual Vote in the 2000 Presidential Election by Voting Technology

Ballot Format	Mean Residual Vote	Aggregate Residual Vote
Punch Card – Votomatic (502 counties, 28% of ballots)	2.9% (1.5%)	2.8%
Punch Card – Datavote (43 counties, 3% of ballots)	2.8% (2.6%)	1.2%
Lever Machine (370 counties, 15% of ballots)	2.2% (2.0%)	1.7%
Paper Ballot (260 counties, 1% of ballots)	2.1% (1.5%)	1.6%
Optical Scan (1303 counties, 34% of ballots)	2.0% (2.0%)	1.3%
Electronic (DRE) (310 counties, 11% of ballots)	2.4% (1.7%)	1.7%
Mixed (82 counties, 7% of ballots)	1.3% (0.8%)	1.1%

"Mean Residual Vote" is the average across all counties in the category (standard deviation in parentheses). "Aggregate Residual Vote" is the residual voting rate calculated across all ballots cast (equivalent to a weighted mean where each county is weighted by the number of ballots cast).

Table 5
Multivariate Analysis of Residual Vote in the 2000 Presidential Election

Explanatory Variable	OLS Coefficient	GLS coefficient
State Variables		
Straight-Party Ballot Option	-.90***	-.62***
	(.07)	(.15)
Nader not on Ballot	.57***	1.02**
	(.13)	(.38)
Count all Write-In Votes	-.51***	-.31**
	(.08)	(.10)
"None of These Candidates" (Nevada)	-1.56***	-.96***
	(.13)	(.16)
Number of Presidential Candidates	-.55**	-.32
	(.20)	(.36)
Presidential Candidates Squared	.04**	.02
	(.01)	(.02)
Voting Technology		
Votomatic Punch Card	1.01***	1.40***
	(.07)	(.15)
Datavote Punch Card	.55*	.04
	(.32)	(.19)
Paper Ballot	-.25*	.26*
	(.11)	(.15)
Lever Machine	-.40**	.31
	(.12)	(.23)
Electronic Machine (DRE)	.49***	.31*
	(.11)	(.13)
Mixed	.15	.34*
	(.11)	(.16)
Demographic Controls		
Percent Black	.036***	.024***
	(.004)	(.006)
Percent Hispanic	.011**	.016**
	(.003)	(.006)
Percent 65 or older	.007	.026
	(.008)	(.021)
Median household income (natural log)	-.88***	-1.21***
	(.18)	(.30)
Percent with a college degree	-.033***	-.001
	(.005)	(.009)
Population in 2000 (natural log)	-.19***	-.11*
	(.03)	(.06)
Constant	15.06***	15.95***
	(2.00)	(3.32)
Number of Cases	2869	2869
R^2	.32	
Root MSE	1.54	

Dependent variable is the percentage of ballots cast that were not counted in the presidential contest. Cell entries are regression coefficients (robust standard errors in parentheses). For GLS estimates, each county is weighted by the number of ballots cast in the 2000 election.
*** p < .001, ** p < .01, * p < .1, two-tailed

Table 6
Multivariate Analysis of Residual Vote in the 2000 Presidential Election

	Straight-Party Option		No Straight-Party Option	
Explanatory Variable	OLS Coefficient	GLS Coefficient	OLS Coefficient	GLS coefficient
State Variables				
Nader not on Ballot	.76**	1.35	-.02	.04
	(.29)	(.83)	(.16)	(.53)
Count all Write-In Votes	-.59***	-.10	-.31***	-.36**
	(.14)	(.22)	(.08)	(.13)
"None of These	----	----	-1.38***	-.66**
Candidates" (Nevada)			(.16)	(.21)
Number of Presidential	.31	.29	-1.50***	-1.36*
Candidates	(.35)	(.43)	(.26)	(.53)
Presidential Candidates	-.01	-.01	.10***	.08*
Squared	(.02)	(.03)	(.02)	(.03)
Voting Technology				
Votomatic Punch Card	1.28***	1.40***	.72***	1.27***
	(.09)	(.13)	(.09)	(.18)
Datavote Punch Card	----	----	.34	-.17
			(.34)	(.23)
Paper Ballot	.68***	.64***	-.66***	-.08
	(.11)	(.16)	(.14)	(.23)
Lever Machine	.63	1.39	-.98***	.06
	(.41)	(1.07)	(.13)	(.16)
Electronic Machine	1.37***	1.57***	-.77***	-.28*
(DRE)	(.13)	(.23)	(.15)	(.16)
Mixed	.45**	.67**	-.17	.33
	(.13)	(.24)	(.15)	(.23)
Demographic Controls				
Percent Black	.009*	.007	.044***	.036***
	(.004)	(.005)	(.005)	(.009)
Percent Hispanic	.017***	.017**	.015**	.022**
	(.004)	(.006)	(.005)	(.008)
Percent 65 or older	-.003	.005	.024*	.032
	(.014)	(.022)	(.009)	(.025)
Median household	-.47*	-.49	-1.36***	-1.33**
income (natural log)	(.25)	(.34)	(.23)	(.42)
Percent with a college	-.020**	-.003	-.026***	.001
degree	(.007)	(.011)	(.006)	(.012)
Population in 2000	-.08*	-.13*	-.19***	-.13*
(natural log)	(.05)	(.05)	(.03)	(.07)
Constant	5.20	5.72	23.86***	21.62***
	(3.32)	(4.21)	(2.57)	(4.91)
Number of Cases	1008	1008	1861	1861
R^2	.31		.38	
Root MSE	1.12		1.59	

Dependent variable is the percentage of ballots cast that were not counted in the presidential contest. Cell entries are regression coefficients (robust standard errors in parentheses). For GLS estimates, each county is weighted by the number of ballots cast in the 2000 election.
*** p < .001, ** p < .01, * p < .1, two-tailed