Voting Technology, Ballot Measures and Residual Votes

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Abstract

An increasing number of public policy issues are decided by ballot measures in the United States. We examine residual votes (the difference between the total ballots cast and the votes cast in a particular contest) on ballot issues and the presidential contest in 34 states that had issues on the ballot in the 2004 election. Residual vote levels for ballot issues are substantially higher and more varied than for the presidential contest. Residual votes in both types of contests are a function of ballot features, voting technology, campaign context, and demographic measures. However, some factors, especially voting machinery, have different effects on residual votes for president than on residual votes for ballot issues. A case study further indicates that full-face electronic voting machines sharply increase the number of residual votes on ballot measures. The results have implications for direct democracy and election reform in the United States.

Keywords: voting technology; ballot issues; voting; political participation; election reform

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Ballot initiatives and referendums are used to decide many public policy issues, from taxes and bonds to marriage and booze. Even election laws have been the subject of ballot propositions. Most states allow some type of process for citizens to vote on ballot issues such as constitutional amendments proposed by the state legislature, although roughly half of the states allow citizens to propose laws for citizen consideration.[1] The United States has experienced a surge in the use of ballot measures over the last thirty years (Smith, 2005, p. 407; Matsusaka, 2005, p. 159).

We are interested in the effect of voting equipment and ballot design on the degree to which voters skip over ballot issues. With the growing use of ballot propositions, an extensive literature has focused on the degree to which ballot propositions foster voter turnout (e.g., Smith, 2001; Tolbert, Grummel, and Smith, 2001). Yet few studies assess the degree to which voters weigh in on ballot measures once they have entered the voting booth. We examine residual votes on ballot measures — also known as "roll-off" (the difference between the total number of ballots cast and the number of valid votes cast for or against a ballot measure). Residual votes can be the result of undervotes (not selecting any choice on the ballot) or overvotes (selecting too many choices). The vast majority of residual votes on ballot measures are undervotes, and many are likely a result of intentional abstention. However, we demonstrate that certain types of voting technology and ballot features generate higher levels of residual votes on ballot measures. If abstention from ballot propositions is a function of voting technology and ballot design, then we might question whether election results truly reflect the will of the voters. Since a major goal of

direct democracy is to have citizens make public policy decisions, it is important to understand the sources of residual votes on ballot measures.

In addition to normative concerns, examining residual votes in direct democracy contests has policy significance in another way. A fair amount of attention has been devoted to the usability and security of voting machines in the United States.[2] In assessing the convenience and usability of voting equipment, scholars have typically examined races near the top of the ballot. Such studies have rarely examined the effects of equipment on voting in contests far down the ballot, such as initiatives or referendums. Studies of the impact of voting equipment and ballot design on ballot measure roll-off are small in number and limited to a few states (Nichols, 1998; Bowler, Donovan, and Happ, 1992; Darcy and Schneider, 1989; Magleby, 1984). As we show below, the effects of voting equipment are different for ballot measures than for presidential contests (the subject of most prior research). Voting equipment and ballot design can generate residual votes on ballot issues by drawing the voter's attention away from the ballot issues or by confusing the voter about where and how to properly cast a vote. If policymakers base voting equipment decisions on past studies, then they may unwittingly increase residual votes on down-ballot contests.

In this study, we analyze residual votes for president and for ballot propositions at the county level in the 34 states that had issues on the ballot in the 2004 general election. We find that residual vote levels for ballot issues were substantially higher and more varied than for the presidential contest. Residual votes in both types of contests were a function of ballot features, voting technology, campaign context, and demographic measures. However, some factors, especially voting machinery, have different effects on residual votes for president than on residual votes for ballot issues. A case study of the 2006 election in New Jersey provides

additional evidence that electronic voting machines with full-face ballots sharply increase the frequency of residual votes for ballot measures. These results suggest that we should not base inferences about the performance of new voting machines solely on presidential and other top-of-the-ballot contests.

What Causes Residual Votes?

A growing body of literature examines the predictors of residual votes. Theories explaining the occurrence of residual votes can be divided into three main perspectives, covering campaign context, voting equipment and ballot design, and demographic features. The first perspective is analogous to mobilization theories of participation. When the benefits of voting are high – if people are motivated by competitive races, visible campaigns, or controversial issues – people are more likely to participate (e.g., Blais, 2000; Rosenstone and Hansen, 1993). Similarly, there is evidence that some residual votes are intentional, the result of lack of interest in a contest, unappealing candidates, or little information about the race (Magleby, 1984; Bullock and Dunn, 1996; Kimball, Owens, and Keeney, 2004; Knack and Kropf, 2003a; Vanderleeuw and Utter, 1993; Wattenberg, McAllister, and Salvanto, 2000). However, contests at the top of the ballot, especially the presidential race (which tends to be competitive, with lots of campaigning and media coverage), have very low rates of intentional undervotes (Knack and Kropf, 2003b; Tomz and Van Houweling, 2003).

To our knowledge, such work has not compared ballot proposition and presidential residual votes. Consider that ballot propositions are typically at the end of a ballot, except in Washington and Virginia. Some are much less salient to voters than others. For example, in 2004 several states considered high profile measures concerning gay marriage. Others considered

more complex and low salience issues such as clarifying legislative and court powers (New Hampshire). It is not surprising that ballot propositions typically have much higher rates of residual votes than presidential contests (Magleby, 1984).

A second perspective emphasizes the mechanics of voting. One study likens voting to taking a test (Wattenberg et al., 2000). A more precise analogy to voting is completing a survey. Just as the design of a questionnaire (such as the wording of questions, and the way they are placed on a page) influences whether people answer the questions (Dillman, 2000), some residual votes are the unintentional result of faulty voting technology or confusing ballot features. In terms of voting equipment, Votomatic punch card ballots tend to produce higher rates of residual votes in top-of-the-ballot contests than other voting methods (Caltech/MIT, 2001; Bullock and Hood, 2002; Knack and Kropf, 2003a; Alvarez, Sinclair, and Wilson, 2003; Kimball et al., 2004; Buchler, Jarvis, and McNulty, 2004; Ansolabehere and Stewart, 2005). Furthermore, error prevention and correction mechanisms (such as precinct counters for optical scan ballots) tend to reduce residual votes (Nichols and Strizek, 1995; Knack and Kropf, 2003a; Kimball et al., 2004; Bullock and Hood, 2002; Tomz and Van Houweling, 2003).

In addition, recent studies focus on ballot design features that tend to produce residual votes. For example, the occasional practice of listing candidates for the same office in multiple columns or on multiple pages produces higher rates of unrecorded votes (Sinclair, Mark, Moore, Lavis, and Soldat, 2000; Jewett, 2001; Herron and Sekhon, 2003; Kimball et al., 2004). Another study identifies several ballot features associated with overvotes and undervotes in gubernatorial elections (Kimball and Kropf, 2005). From a design perspective, some ballot features are easy for voters to navigate, while others are not.

A third research perspective focuses on equal protection issues, analyzing the relationship between residual votes and demographic variables such as ethnicity or age. There is extensive evidence that residual votes are more common in precincts and counties with large populations of racial and ethnic minorities, low-income residents, less-educated citizens, or elderly voters (Walker, 1966; Vanderleeuw and Engstrom, 1987; Darcy and Schneider, 1989; Nichols and Strizek, 1995; Nichols, 1998; Herron and Sekhon, 2003; Knack and Kropf, 2003a; Tomz and Van Houweling, 2003; Sinclair and Alvarez, 2004). Some of these findings are consistent with mobilization theories of participation. For example, communities with more African American voters tend to exhibit lower rates of ballot roll-off when an African American candidate is running for office (e.g., Vanderleeuw and Utter, 1993).

Some of the research findings in this area are motivated by resource theories of participation – that groups with fewer resources, such as financial means or civic skills, are less likely to participate (Verba, Schlozman, and Brady, 1995). There is often an interaction between demographic variables and some voting methods and ballot features, suggesting that some residual ballots are unintentional. The association between socioeconomic measures and residual votes is weaker in places using equipment or ballot features that make it easier for voters to complete a valid ballot (Knack and Kropf, 2003a; Tomz and Van Houweling, 2003; Kimball et al., 2004; Buchler et al., 2004; Kimball and Kropf, 2005). By the same token, the elevated rate of residual votes associated with confusing ballots and voting technology tends to fall disproportionately on precincts and counties with high concentrations of poor, elderly, or minority voters (Darcy and Schneider, 1989; Nichols, 1998; Kimball, et al., 2004; Herron and Sekhon, 2003; Alvarez, Sinclair, and Wilson, 2003).

Residual Votes and Ballot Measures

Most of the recent studies on residual votes are based on analyses of highly salient and competitive contests at the top of the ballot (such as presidential or gubernatorial elections), where residual votes are less common. Since down-ballot contests (where most ballot measures reside) tend to receive less media scrutiny and campaign activity, ballot and equipment features may have a greater impact in those races by drawing the voter's attention away from those contests. The few studies that have examined down-ballot contests find significantly higher rates of residual votes than in top-of-the-ballot races (e.g., Magleby, 1984; Nichols and Strizek, 1995). These studies also find voting technology and ballot effects that are much larger than effects found in top-of-the-ballot contests (Darcy and Schneider, 1989; Nichols and Strizek, 1995; Nichols, 1998; Sinclair and Alvarez, 2004).

Scholars also note that residual votes tend to be higher on ballot propositions when they are placed farther down the ballot or on the back side of a paper ballot (Magleby, 1984; Bowler et al., 1992; Darcy and Schneider, 1989; Sinclair and Alvarez, 2004; Hamner and Traugott, 2004). Other studies note that residual vote rates for ballot propositions tend to be higher when lever voting machines are used (Mather, 1964; Thomas, 1968; Nichols and Strizek, 1995; Nichols, 1998). As we describe in more detail below, on ballots that display all contests at once (especially in the party column layout common in lever machines) it is a challenge to place ballot measures in an area where voters will notice them (Roth, 1998). Finally, residual votes are more common on referendums placed on the ballot by the legislature than on citizen-proposed initiatives (Mueller, 1969; Magleby, 1984; Bowler et al., 1992). Legislative proposals tend to reach the ballot with little publicity, while citizen-proposed initiatives tend to be part of a larger marketing campaign that boosts voter awareness. Overall, existing research suggests that a

number of factors may influence residual votes on ballot issues. Also, given the rapidly changing voting technology in the United States, further research is needed to examine the impact of technology and ballot features at both ends of the ballot.

Data and Methods

Since elections are administered at the county level in all but six states, our data collection includes the number of ballots cast, vote totals for president and for selected ballot propositions, type of voting technology, and demographic characteristics for each American county in the 2004 general election. In states where elections are administered by municipalities or townships, we aggregate the vote totals and voting technology data to the county level. In four states (Illinois, Missouri, Maryland, and Virginia), some cities have separate election administration authorities. These cities are treated as separate jurisdictions in this dataset. We treat Alaska as one observation since elections are administered by the Alaska state government. Adding the District of Columbia as another observation produces a total of 3,123 geographic units that cover the entire country.

There were 34 states with measures on the ballot in the 2004 general election. In these states there were 162 measures on the ballot in 2004. Residual vote rates tend to be similar for ballot measures in the same state but the figures vary substantially across states.[3] Ballot measures are usually grouped together on the ballot in the same position in each state. The measures with noticeably lower residual vote rates than other ballot measures in the state tend to be highly salient issues such as a ban on gay marriage (e.g., Amendment 1 in Georgia or Amendment 3 in Utah) or illegal immigration (Proposition 200 in Arizona).

For each state with more than one issue on the ballot, we selected for closer analysis a ballot measure that was both salient (i.e., it was the subject of substantial news coverage and organized campaigning) and competitive (a result within a 60 percent to 40 percent margin). If none of the state measures satisfied both criteria, then we picked one that was salient even if not competitive (as happened in several states with gay marriage amendments that passed easily). If multiple measures satisfied both criteria, then we picked the most salient ballot measure. See Table A1 in the appendix for the list of ballot issues and states in our dataset. These states provide a dataset of 1,999 counties for the analyses in this paper.

To measure the frequency of residual votes for ballot measures and for president in each county, we calculate the difference between the total number of ballots cast and the number of votes cast for a contest.[4] We then measure that difference in votes as a percentage of total ballots cast for the dependent variable in the analyses that follow. The distribution of residual votes across counties is somewhat skewed, with outliers at the high end. In our sample of 1,999 counties, there were 872,117 residual votes for president. Residual vote percentages for presidential contests range from 0.02% to 20.6%, with a median of 1.2%, a mean of 1.7%, and a standard deviation of 1.8%. By comparison, residual votes were much more common on ballot issues. In the same sample of counties, there were 6,790,140 residual votes for the selected ballot issues. Residual vote percentages for ballot issues range from 0.3% to 76.1%, with a median of 7.6%, a mean of 11.5%, and a standard deviation of 10.2%. Residual vote percentages tend to be much higher and more varied for ballot issues than for president. More than 95% of the counties in our sample had residual vote rates less than 5% in the presidential contest. By comparison, almost 75% of the counties had residual vote rates greater than 5% for ballot issues.

To examine various factors that may influence residual votes, we estimate two models of residual votes, one for the presidential contest and one for ballot propositions. In considering independent variables that may affect residual vote rates, we argue there are factors that may produce intentional abstention and factors that may produce unintentional residual votes.

In considering unintentional residual votes, a major focus of this paper is the unintended effects of voting technology. If voters are intentionally skipping certain contests due to a lack of interest or information, then voting technology and ballot design should have little impact on residual votes. We collected data on voting technology used in the November 2004 general election in each county, gathered from state and local election officials. Generally, five different methods of voting were used in the United States in 2004: hand-counted paper ballots, lever machines, punch card ballots, optical scan systems, and direct recording electronic (DRE) machines. With punch card ballots, voters use a tool to punch out holes in the ballot card next to their chosen candidates. Votes are then counted by a card reader machine.[5] In lever machines, all contests are listed on the face of the machine and voters pull down a lever next to their chosen candidate. Votes are counted mechanically inside the lever machine. In optical scan systems, voters mark a paper ballot with a pen or pencil and votes are counted by a scanning machine. With DREs, candidates are listed on a computer screen and voters push a button or touch the screen next to their chosen candidate. The DRE machine records and counts the votes.

[Table 1 about here]

Table 1 lists each type of voting equipment, as well as the number of counties and an estimate of the number of voters using each system in the 2004 election. Punch cards and lever

machines are being phased out and replaced by optical scan or DRE systems. Within the two newer voting equipment categories, further distinctions can be made. Optical scan systems vary depending on where ballots are counted: at a central location (like the county courthouse) or at the voting precinct. One advantage of the precinct-count optical scan systems is that they give voters a chance to discover and correct potential mistakes.[6] The central-count systems do not have such an error-correction feature.[7] Thus, we expect to find lower residual vote rates on precinct-count optical scan machines.

DRE machines can be divided into two different varieties. Older DREs (such as the Shouptronic 1242) and some new models were designed to mimic lever machines. These DREs present the entire full-faced ballot at once and typically use a push-button interface (Caltech/MIT Voting Project 2001). Most of the newer generation of DREs (such as the iVotronic and Accuvote-TS machines) typically use a touch-screen interface in which voters scroll through the offices and issues on the ballot, with only one or two contests appearing on the screen at one time. In some counties, mainly in the Northeast and in areas with heavy absentee voting, not all ballots are cast using the same technology. In those cases, we code 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, the county's voting technology is coded as a "mixed" system.

We create dummy variables for each of the different types of voting technology described above. The regression model excludes central-count optical scan as the comparison category since it was used in more counties than any other method. Since DRE voting machines and optical scan systems are replacing punch card ballots and lever machines, partly due to deficiencies in the latter systems and requirements of the Help American Vote Act of 2002, one would expect to find lower residual vote rates with the newer technologies. However, there is

reason to believe that down-ballot contests, particularly ballot measures, may be overlooked by some voters using lever machines and older generation DREs with a full-face ballot. Earlier studies found lower participation rates in ballot measures when lever machines were used as compared to paper ballots (Mather, 1964; Thomas, 1968) and punch card ballots (Asher, Schussler, and Rosenfield, 1982).

The lever machine and the full-face DRE list all contests (and thus all of the voter's choices) at once, which may overwhelm some voters and cause them to end the voting session prematurely. Research in psychology indicates that people become paralyzed when offered too many choices (Schwartz, 2004). For example, a study of employer-based 401(k) plans found that fewer employees participated in the plans when more investment options were offered (Iyengar, Jiang and Huberman, 2004). Thus, listing all contests at once on a screen may cause more voters to quit before they have completed the ballot. In fact, it is easy for the voter to end the voting session before considering all contests on lever machines or full-face DREs, by simply pulling the main lever (Roth, 1998) or pushing the "Vote" button that is always available to end the session (Herrnson, Niemi, Hanmer, Bederson, Conrad, and Traugott, 2007). A related problem is that many full-face ballots use a party column layout, a grid in which offices are listed in rows and candidates are listed in columns according to their party affiliation. In theory, this layout makes it easy for voters to locate all of the candidates from a particular party. However, field tests indicate that voters express less satisfaction with the party column grid (Herrnson et al., 2007). In addition, ballot measures are nonpartisan and cannot be placed easily on the party column grid. Ballot measures tend to be placed below, or to the side of the party column grid on full-face ballots, often in locations where voters are less likely to notice them.

In contrast, most new DREs tend to spoon-feed choices to voters, listing one or two contests on the computer screen at a time and then asking the voter to advance to the next screen to continue voting. Furthermore, several models of multiple screen DREs force voters to advance through every contest on the ballot before the option of ending the voting session is offered. Consistent with our suspicions, one usability study found that several voters failed to see the ballot initiatives on lever voting machines (Roth, 1998). Another study found that voters were more likely to need help using full-face DREs than with several other voting systems (Herrnson et al., 2007). Thus, we expect to find higher residual vote rates for ballot propositions on lever machines and full-face DREs than other voting methods.

We also consider other ballot design elements as a source of unintentional residual votes. One feature allows voters to cast a straight-party ballot with one mark. Kimball et al., (2004) found that the straight party punch reduces residual votes for the presidential race. However, ballot propositions are non-partisan and thus not covered by the straight-party device, even though people may believe they have completed their ballot once they use the straight party feature (Nichols, 1998, p. 110; Darcy and Schneider, 1989, p. 360; Niemi and Herrnson, 2003). Thus, we hypothesize that residual votes on ballot issues are more common in states with the straight-party option.[8] We also measure the number of contests on the ballot before the proposition in each state. Since ballot fatigue is a common source of residual votes, we expect that residual votes for ballot measures will be higher in states with more contests appearing before the measures.

Another ballot feature is the method for marking the ballot on optical scan systems. Some require voters to darken an oval, as in many standardized tests and government forms. Other optical scan systems require voters to draw a line connecting the point and tail of an arrow,

a method which does not mimic other common written tests or forms. Previous studies find higher rates of residual votes (and overvotes in particular) on ballots with the connect-the-arrow format (Bullock and Hood, 2002; Kimball and Kropf, 2005), which we expect to find in this study.

We also include two ballot features specific to the presidential contest. Nevada is the only state which includes a "None of these candidates" choice in federal and statewide candidate elections, a potentially appealing choice for voters who might otherwise abstain from the contest. In the 2004 presidential election in Nevada "None of these candidates" outpolled all third party candidates except Ralph Nader. Not surprisingly, Nevada has had one of the lowest residual vote rates in recent presidential elections (Kimball et al., 2004). In addition, states vary in the way they handle write-in votes. Only fifteen states count all write-in votes, while the remaining states either do not allow write-ins for president or only count write-in votes for declared candidates.[9] We include separate dummy variables for Nevada and for states that allow and count all write-in votes for president. We expect fewer residual votes for president in those states.

In terms of intentional residual votes, the campaign context plays a particularly important role. People are more likely to cast a vote in highly salient contests and more likely to abstain from boring contests. Some studies find that highly salient ballot measures initiatives boost voter turnout (Smith, 2001; Lacey, 2005). Measurement of salience of ballot propositions has been a topic of debate in the literature, the concept being "the awareness and concern about the propositions" (Smith, 2001, p. 701). Some measure the salience of specific ballot issues by examining the news coverage that the proposition garners (Smith, 2001; Lacey, 2005). Others measure the salience of the overall ballot proposition enterprise by counting the number of issues

on the ballot in a given state for a particular election (Tolbert et al., 2001; Tolbert and Smith, 2005).

To assess the impact of issue salience on residual votes, we opt for a measure of news coverage similar to the one used by Smith (2001) because "[t]he profit motive should lead news organizations to extensively cover important and controversial initiatives while reporting less on those perceived by citizens to be of minor relevance to their lives" (Smith, 2001, p. 701). For each state, we measure the salience of a ballot proposition by finding all articles on an issue in the state's largest newspaper from September 1 to November 9, 2004.[10] In most cases, we use the News Library database (http://www.newslibrary.com) to find articles, editorials, and letters to the editor written about the subject of the ballot proposition. Then we sum the number of words in all newspaper coverage of the ballot issue as our measure of issue salience.[11] The newspaper and search keywords for each state are listed in Table A1 in the appendix.[12] We expect residual votes on ballot issues to decrease as issue salience increases.

A second factor that may indicate whether citizens will take the time to vote on an issue is the manner in which the proposition reaches the ballot—whether a citizen proposal or a legislative-initiated proposition. Voters may have more information about citizen-initiated proposals because they require voter input in a signature gathering process before they reach the ballot (Bowler et al., 1992; Nichols, 1998, p. 106; Magleby, 1984). In contrast, legislative propositions reach the ballot without a similar sustained public campaign. Our issue salience measure provides some support for the claim that legislative proposals generate a lower public profile than other ballot measures. Ballot propositions received significantly fewer articles and words of newspaper coverage in states where the legislature put the issue on the ballot. We create a dummy variable to indicate whether or not a proposition was put on the ballot by the

legislature.[13] We expect higher rates of residual votes on propositions placed on the ballot by the legislature.

For the presidential contest, we attempt to create a similar measure of campaign salience. We create a dummy variable to identify the "battleground" states in the presidential campaign.[14] These are states where the presidential vote was close and where a vote is more likely to make a difference. In addition, the bulk of the presidential campaign, in terms of advertising, candidate visits, and staff activity, took place in the relatively small number of battleground states. The disproportionate location of presidential campaign activity likely produced greater interest in the election among voters in battleground states. As a result, we expect lower rates of residual votes for president in the battleground states.

Finally, there is a set of demographic control variables based on previous studies of residual votes, although it is not empirically clear whether the variables predict unintentional or intentional residual votes. As control variables, we include the percentage of a county's residents who are African-American, the percentage of the population who are Latino, the percentage over the age of 65, the natural log of median income and the natural log of the county's population, all obtained from the Census Bureau. Based on previous studies, we expect residual votes to be positively correlated with the size of the African-American, Latino, poor and elderly populations, and negatively correlated with median income. As for population, previous studies indicate that the smaller the county, the larger the number of residual votes (Knack and Kropf, 2003a, p. 887; Kimball et al., 2004; Brady, Buchler, Jarvis, and McNulty, 2001; Ansolabehere and Stewart, 2005). This finding may be due to election administration—larger urban counties tend to have more professional operations than smaller rural counties. Thus, we expect the natural log of the population to be negatively correlated with residual votes.

The dependent variable is the percentage of ballots cast in each county that fail to record a valid vote for the contest (the residual vote percentage). We do not have data on overvotes and undervotes for many states, but the data we have suggest that for the presidential contest, residual votes tend to be a mix of overvotes and undervotes, but usually undervotes. For ballot measures, the residual vote totals are almost exclusively undervotes. Our data consist of counties nested within states, and some of the independent variables are measured at the county level while others are measured at the state level. Thus, the variation in residual vote rates across American counties can be separated into between-state and within-state components. We estimate a hierarchical model to take advantage of the multi-level nature of the data (Raudenbush and Bryk, 2002). The state-level variables help account for between-state variation in residual votes, while within-state variation is explained by county-level variables. Since we are mainly interested in the effects of voting technology (a county-level variable that often varies within the same state), we compare a random effects model and a fixed effects model in the multi-level analysis. The random effects model assumes that any unexplained between-state variation is not correlated with the independent variables. Thus, the random effects model depends on the state variables to correctly account for between-state differences in residual votes. In the fixed effects model, all state-specific effects are accounted by state dummy variables so that only within-state variation is left to be explained by county-level variables. The fixed effects model is important to control for state effects that we have not measured (such as differences in state laws, election administration, or political culture).[15]

Results

The results of our multi-level model estimation of residual vote percentages in the 2004 presidential election are presented in Table 2. The results of the hierarchical analysis of residual votes on ballot measures are in Table 3. The first column in each table includes estimates from the random effects model, while the second column presents the fixed effects model estimates (where the state variables are dropped out). Not surprisingly, the overall model fit is higher for the fixed effects models. However, the results indicate similar county effects in both models.[16] More generally, we find that residual votes are partly a function of voting technology and ballot features, but that some of these effects vary by contest.

First, we find some very different effects of voting equipment on residual votes for president versus ballot measures. As expected, punch cards perform significantly worse than any other type of equipment in terms of residual votes for president. Holding other factors constant, the expected residual vote rate in the presidential contest is 0.6% higher in counties using punch card ballots than in counties using centrally-counted optical scan ballots. This is a substantial effect considering that the average residual vote for president in 2004 was 1.7%. The results also indicate that residual votes on ballot propositions are more common with punch cards than with optical scan systems or touch-screen DREs.

[Table 2 about here]

However, when it comes to residual votes on ballot measures, even punch cards do not perform as badly as lever machines or full-face DREs. Lever machines stand out as a very poor voting technology at handling ballot measures. Residual vote rates on ballot propositions are a whopping 19 percentage points higher on lever machines than on central-count optical scan

systems, holding other factors constant. The average residual vote rate on ballot issues in counties using lever machines in 2004 was 33 percent, compared to the national average of 11.5 percent. Lever voting machines act as a considerable barrier to voting on ballot propositions.

Our results also indicate that full-face DREs produce significantly higher residual vote rates on ballot propositions than other voting systems (4 percent higher than central-scan systems, other factors being equal). The relatively poor performance of full-face DREs on ballot propositions is expected, since full-face DREs were designed to mimic lever machines in ballot layout. It appears that some voters simply miss ballot issues on a large full-face DRE ballot.

[Table 3 about here]

In addition, the error correction feature of precinct-count optical scanners seems to produce lower residual vote rates for president than the central-count method. This is consistent with previous studies. It is somewhat surprising, then, that precinct scan does not perform any better than central scan on ballot issues. The precinct scanners are always programmed to identify overvotes, but they are often not programmed to identify undervotes. While precinct scan systems may be more effective in presidential contests where overvotes are concentrated, they may not have an effect in contests such as ballot measures that produce undervotes almost exclusively.

Precinct-count optical scan systems and DREs are rapidly gaining market share in the United States. Based on the fixed-effects model results in Table 2, we find that precinct scan outperforms both full-face DREs ($F=11.0$, $p<.001$) and touch-screen DREs ($F=20.7$, $p<.001$) in reducing residual votes for president. On ballot measures, the difference between the effect of

precinct optical scan and touch-screen DREs is not statistically significant at conventional levels ($F=3.15$, $p=.08$).

There is evidence that other ballot design elements influence residual votes. Consistent with previous studies, we find that the connect-the-arrow ballot format produces significantly higher rates of residual votes for president and for ballot measures (although the effect on ballot measures is only marginally significant). More specifically, holding other factors constant, the residual vote rate for president was 0.5 percent higher in counties with the arrow method for completing the ballot. As expected, residual votes for president were less common in Nevada (the only state offering a "None of these candidates" choice in the presidential contest). However, the effects of rules for counting write-in votes and the straight-party option have the expected sign but fall short of statistical significance, suggesting that those features had little impact on residual votes in 2004.

We also find evidence that the campaign context influences residual votes for ballot propositions. Issue salience tends to reduce the frequency of residual votes for ballot issues. Residual votes on ballot measures were less common in states with voluminous newspaper coverage of those issues. In addition, the method of placing the proposition on the ballot has a substantial impact on residual votes. The random effects model suggests that residual vote rates were 5.5 percent higher for issues placed on the ballot by the legislature rather than by citizen petition. Furthermore, residual vote rates for measures tend to rise as more contests appear before them on the ballot, consistent with a ballot fatigue hypothesis. In the presidential contest, a state's "battleground" status does not seem to matter. The presidential contest is so salient throughout the country that residual votes are not affected by the campaign in battleground states.

Finally, demographic factors produce somewhat comparable results in both contests. Consistent with previous work, counties with more African Americans and low income voters see higher levels of residual ballots for both the presidency and ballot issues. When compared to some of the ballot and technology effects described above, these effects are rather modest. A one standard deviation increase in the percentage of African American residents (roughly 15%) is associated with a 0.1 percent increase in residual votes for president. A one standard deviation increase in the natural log of median income yields a 0.3 percent decrease in residual votes for president. Comparable increases in the percentage of African American residents and median income yield a 1.2 percent increase and a 1.3 percent decrease, respectively, in residual votes on ballot issues. Other studies suggest that the effect of county size on residual votes may be a proxy for unmeasured administrative features (Ansolabehere and Stewart, 2005). Consistent with these studies, we find that counties with a larger population tend to produce lower percentages of residual votes for the presidential contest and for ballot measures.

Case Study: The 2006 General Election in New Jersey

The huge impact of lever machines on residual votes for ballot measures is mitigated by the knowledge that lever machines will soon be replaced by other voting methods in the United States. The apparent impact of full-face DREs, however, is more disturbing because there are no plans to replace them and some states, such as New York, have laws requiring a full-face ballot. The fact that over 13 million voters in parts of 20 states voted on full-face DREs in 2004 indicates that the potential impact of these machines is neither small nor limited to a few jurisdictions. To compare full-face and multiple screen DREs further, we provide a brief case study of the 2006 general election in New Jersey. When New Jersey recently replaced its lever

voting machines, a natural experiment took place. Nineteen New Jersey counties switched to full-face DREs (with all but one of them choosing the same vender and model), while two counties switched to scrolling DREs.[17]

In the 2006 general election, there were four statewide contests on the ballot: (1) the competitive U.S. Senate race between Robert Menendez and Tom Kean, Jr; (2) a constitutional amendment to allocate part of the state's sales tax revenue to property tax relief; (3) a constitutional amendment to increase the proportion of state corporate tax revenues devoted to recreation and land conservation; and (4) a constitutional amendment to devote more of the state's gas tax revenues to the transportation system. The three amendments were part of a tax reform package passed by the state legislature. There were few other contests on New Jersey ballots in 2006 (contests for the General Assembly and municipal races in many cities).

The New Jersey case allows us to examine residual votes in a setting where other state features (such as state laws, election regulations, and statewide campaigns) are constant. Table 4 presents a direct comparison of residual vote rates for the U.S. Senate race and for the three constitutional amendments on each of the two types of electronic voting machines. The residual vote rate on each of the three constitutional amendments was roughly nine times higher on full-face DREs than on scrolling DREs. The U.S. Senate race was expensive and competitive and garnered a lot of media attention, which tends to mitigate the effects of voting equipment and ballot design on residual votes. Nevertheless, the residual vote rate in the Senate contest was still more than one percentage point higher on the full-face DREs than on the scrolling DREs. These results support the conclusion that full-face DREs produce higher residual vote rates than scrolling DREs.[18]

[Table 4 about here]

We examine the 2006 election results in New Jersey at the municipal level to uncover an interaction between voting equipment and the demographic profile of local communities. Figure 1 plots the residual vote rate for the first constitutional amendment against a poverty measure for municipalities in New Jersey with at least 50 voters. In municipalities using scrolling DREs (the triangles in Figure 1), residual vote rates are relatively low (less than 6% in each city) and unrelated to a municipality's poverty level (note that the regression line for those observations is flat). In contrast, the residual vote rate is considerably higher in municipalities using full-face DREs (the circles in Figure 1) and increases substantially as the level of poverty rises. Note how high the numbers go on the vertical axis: in some municipalities using full-face DREs more than half of the voters did not record a vote on the constitutional amendment. It again appears that full-face DREs tend to obscure ballot propositions, and the resulting increase in residual votes tends to fall disproportionately on poor communities.

[Figure 1 about here]

Conclusion

Most research on voting equipment and residual votes has focused on presidential contests and other races at the top of the ballot. When we examine ballot measures that usually appear near the bottom of the ballot, we find substantially higher rates of residual votes and more variation across counties and states. In addition, some ballot features and voting methods appear to influence residual votes in different ways, depending on the type of contest. In particular, voting equipment with a full-face ballot (lever machines and full-face DREs) produce sharply elevated rates of residual votes on ballot issues.

Some may wonder if any of these voting technology effects could change the outcome of an election on a ballot issue. We cannot answer this question with certainty, but we can point to a suggestive case from our sample. One of our cases is an Alabama proposition (amendment 2) to remove segregation language regarding education and voting from the state constitution. Amendment 2 narrowly failed in 2004. There were 689,450 votes in favor and 691,300 votes against, so the amendment was defeated by 1,850 votes. Out of almost 1.9 million ballots cast, over 505,000 Alabama voters failed to cast a vote on amendment 2 (a residual vote rate of roughly 27%). It is possible that the half million abstentions might have reversed the outcome if more had cast a vote on the amendment. There is a positive correlation (r=.43) between a county's residual vote rate on amendment 2 and its share of African-American residents, a somewhat surprising finding given the substance of the amendment.

As it happens, Mobile and Montgomery counties, two of the largest in the state, used full-face DRE voting machines in the 2004 general election (the rest of the state used optical scan balloting). Both counties voted in favor of the amendment, but with very high residual vote rates (39% in Mobile and 37% in Montgomery). Mobile and Montgomery counties produced over

96,000 residual votes on the constitutional amendment. If the two counties had used optical scan balloting and produced the same residual vote rate as the rest of the state, then an additional 32,144 votes would have been cast on the constitutional amendment in Mobile and Montgomery counties. Assuming the additional votes would divide in the same proportion as the recorded votes in these two counties, then 17,390 yes votes and 14,754 no votes would be added to the state totals, a margin large enough to pass the amendment with 786 votes to spare. Obviously this post-election analysis is speculative, but if Mobile and Montgomery counties used the same voting technology as all other counties in Alabama, perhaps there would have been enough votes for the amendment to pass.

There are two important implications from this study. First, policymakers are making voting equipment and ballot design decisions based on incomplete information. In particular, when one compares residual votes on down-ballot measures with those for presidency, it may be that some equipment is not as advantageous as first thought. For example, lever voting machines perform quite well in the presidential election but perform poorly on ballot propositions. Similarly, full-face DREs do not pose a problem for voting in presidential contests, but they produce significantly more residual votes on ballot measures than other types of voting equipment. Fifteen states in our study of ballot measures had at least one county using full-face DREs, and voters in those jurisdictions would appear to be at a disadvantage in ballot measure contests.

Precinct count optical scan machines appear to offer no advantage over central count machines for ballot measures. This is important in states like Oregon and Washington, which tend to have many ballot measures and use all-mail voting most or all jurisdictions (the functional equivalent of a central-count optical scan system). In this case, the choice of voting

equipment does not appear to be a source of more residual votes on ballot measures. In any case, policymakers and researchers should consider the impact of voting equipment on more than just the top-of-the-ballot contests. The results may not be the same.

Second, this work raises normative concerns about the legitimacy of elections and direct democracy in the United States. If residual votes attributed to voting equipment affect the outcome of an election, then one may question whether the election result truly reflects the will of the voters. If voting equipment tends to reduce participation most in low-income communities (as in the New Jersey case), then one may question whether the outcome is representative of the full range of interests in a state. This is becoming less of a concern in presidential elections, where voting equipment and ballot design effects are smaller and poorly performing voting equipment is being replaced. The outlook for direct democracy is not as rosy, where we find unusually high rates of abstention on ballot measures in counties using lever machines and full-face DREs. Lever machines are being replaced but full-face DREs are not likely to be replaced soon.

Abstention is a valid choice in democratic elections, and it often simply reflects a lack of interest in a particular contest. However, if abstention is an informed decision it is hard to understand why it should be heavily influenced by voting equipment. Do all voters know that the issues are on the ballot when they abstain from voting on them? We suspect that full-face ballots tend to draw attention away from ballot measures, inducing some unwitting abstention.

This study is certainly not the last word on residual votes and ballot measures, and it is not meant to undermine the entire direct democracy enterprise. Other studies note positive effects of ballot measures on voter participation, public awareness (Tolbert and Smith, 2005), and public policy (Lupia and Matsusaka, 2004). The threat of a ballot measure may influence public policy,

even if the measure is never put to a vote (Matsusaka and McCarty, 2001). But ballot measures often do come to a vote of the people, and elections would produce more legitimate results if voting technology did not act as a barrier to participation.

Appendix
Table A1
List of States and Ballot Measures Examined in 2004

State	Issue Number	Issue Topic	Newspaper	Search Strategy
Alabama	Amendment 2*	Repeal parts of Alabama Constitution	*Birmingham News*	amendment 2 or Alabama constitution
Alaska	Measure Number 2	Legalize marijuana	*Anchorage Daily News*	ballot measure 2 or legalize marijuana
Arizona	Proposition 200	Illegal immigration	*Arizona Republic*	proposition 200 or illegal immigration
Arkansas	Amendment 3	Ban gay marriage	*Arkansas Democrat-Gazette*	Amendment 3 or gay marriage
California	Proposition 71	Bond for stem cell research	*San Francisco Chronicle*	proposition 71 or stem cell research
Colorado	Amendment 37	Require more renewable energy	*Denver Post*	amendment 37 or renewable energy
Florida	Amendment 4	Gambling in Broward and Miami-Dade Counties	*Miami Herald*	amendment 4 or slot machines
Georgia	Amendment 1*	Ban gay marriage	*Atlanta Journal-Constitution*	amendment 1 or gay marriage
Hawaii	Amendment 3*	Privacy of crime victims	*Honolulu Advertiser*	amendment 3 or crime victim
Indiana	Public Question 1*	Allow General Assembly to exempt certain property from property taxes	*Indianapolis Star*	question 1 and election or property tax
Kentucky	Amendment 1*	Ban gay marriage	*Louisville Courier-Journal*	amendment 1 or gay marriage
Louisiana	Amendment 4	Support for farming and fishing industries	*New Orleans Times-Picayune*	amendment 4
Maine	Question 2	Ban bear hunting with bait, traps or dogs	*Portland Press Herald*	question 2
Michigan	State Proposal 04-1	Require state and local approval for new gambling facilities	*Detroit Free Press*	proposal 04-1 or gambling
Mississippi	Amendment 1	Ban gay marriage	*Jackson Clarion-Ledger*	amendment 1 or gay marriage
Missouri	Amendment 3	Allocation of fuel taxes	*St. Louis Post-Dispatch*	amendment 3
Montana	Initiative 147	Allow cyanide in mining	*Billings Gazette*	headline search for mining, cyanide, I-147

* Proposed by legislature (source: Initiative and Referendum Institute and the National Conference of State Legislatures).

Table A1 (continued)
List of States and Ballot Measures Examined in 2004

State	Issue Number	Issue Topic	Newspaper	Search Strategy
Nebraska	Measure 417	Initiative can approve new casinos	*Omaha World-Herald*	Measure 417 and casinos
Nevada	State Question 2	Require per-pupil spending to meet or exceed national average	*LV Review Journal*	Question 2 or school spending or national average
New Hampshire	Amendment Question	Clarify legislative and court powers	*Manchester Union Leader*	Constitutional Amendment Question or court practices or separation of power
New Mexico	Bond Question C*	$16.3 million bond for libraries	*Albuquerque Journal*	Bond Question C or library(ies)
North Carolina	Amendment 1*	Bonds for local development	*Charlotte Observer*	Amendment One, economic development or community development
North Dakota	Amendment 1	Ban gay marriage	*Fargo Forum*	Amendment One, Amendment 1, ban gay marriage
Ohio	Issue 1	Bay gay marriage	*Cleveland Plain Dealer*	Issue 1 or ban gay marriage
Oklahoma	State Question 707*	Local government bond payments	*The Daily Oklahoman*	SQ 707 or TIF or tax increment financing
Oregon	State Measure 35	Limit pain and suffering awards in medical malpractice suits	*The Oregonian*	Measure 35 or medical malpractice
Rhode Island	State Question 9*	$14 million bond for library at URI	*The Providence Journal*	Question 9 or bond for library
South Carolina	Amendment 1*	End requirement that alcohol be sold in mini-bottles	*The State*	Amendment 1 or Amendment One or mini-bottles
South Dakota	Amendment B*	State funding to religious schools	*Sioux Falls Argus Leader*	Amendment B or funds for religious schools
Utah	Amendment 3*	Ban gay marriage	*Deseret Morning News*	Amendment 3 or ban gay marriage
Virginia	Amendment 1*	Redistricting only every 10 years	*Norfolk Virginian Pilot*	Amendment 1 or Redistricting or Apportionment
Washington	Referendum Measure 55	Repeal law creating charter schools	*Seattle Times*	Referendum 55, repeal charter schools/ Referendum 55 or charter schools
West Virginia	Amendment 1*	$8 million bond for veterans	*The Charleston Gazette*	Amendment 1 or bonuses and death benefits or veterans
Wyoming	Amendment C*	Alternative dispute resolution before suit filed against health care provider	*Casper Star Tribune*	medical review or lawsuit or Amendment C

* Proposed by legislature (source: Initiative and Referendum Institute and the National Conference of State Legislatures).

References

Alvarez, R.M., Ansolabehere, S. & Stewart, C. III. (2005). Studying elections: data quality and pitfalls in measuring the effects of voting technologies. *Policy Studies Journal,* 33, 15-24.

Alvarez, R.M., Sinclair, D.E. & Wilson, C. (2003). Counting ballots and the 2000 election: what went wrong? In A. Crigler, M. Just, & E. McCaffery (Eds.), *Rethinking the vote: The politics and prospects of American election reform* (pp. 34-50), New York: Oxford University Press.

Ansolabehere, S. & Stewart, C. III. (2005). Residual votes attributable to technology. *Journal of Politics,* 67, 365-389.

Asher, H., Schussler, R. &Rosenfield, P. (1982, April). *The effect of voting systems on voter participation.* Paper presented at the annual meeting of the Midwest Political Science Association, Milwaukee, WI.

Blais, A. (2000). *To vote or not to vote: The merits and limits of rational choice theory.* Pittsburgh: University of Pittsburgh Press.

Bowler, S., Donovan, T. & Happ, T. (1992). Ballot propositions and information costs: direct democracy and the fatigued voter. *Western Political Quarterly,* 45, 559-568.

Brady, H.E., Buchler, J., Jarvis, M. & McNulty, J. (2001, September). Survey Research Center and Institute of Governmental Studies, University of California, Berkeley. *Counting all the votes: The performance of voting technology in the United States.* Retrieved May 24, 2005, from. http://ucdata.berkeley.edu/new_web/countingallthevotes.pdf.

Buchler, J., Jarvis, M. & McNulty, J.E. (2004). Punch card technology and the racial gap in residual votes. *Perspectives on Politics,* 2, 517-524.

Bullock, C. S., III, & Dunn, R.E. (1996). Election roll-off: A test of three explanations. *Urban Affairs Review*, 32, 71-86.

Bullock, C. S., III, & Hood, M. V., III. (2002). One person – no vote; one vote; two votes: Voting methods, ballot types, and undervote frequency in the 2000 presidential election." *Social Science Quarterly*, 83, 981-993.

Caltech/MIT Voting Technology Project. (2001, July). *Voting: What is, what could be.* Retrieved December 15, 2001, from http://www.vote.caltech.edu/Reports/index.html.

Darcy, R., and Anne Schneider. (1989). "Confusing Ballots, Roll-Off, and The Black Vote." *Western Political Quarterly* 42, 347-364.

Dillman, D. A. (2000). *Mail and internet surveys: The tailored design method*, 2nd ed. New York: John Wiley.

Hamner, M. J. & Traugott, M. (2004). The impact of voting by mail on voter behavior. *American Politics Research*, 32, 375-405.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, 46, 1251-1271.

Herrnson, P. S., Niemi, R.G., Hanmer, M.J., Bederson, B.B., Conrad, F. G. Conrad, & Traugott, M. (2007). *Voting technology: The not-so-simple act of casting a ballot*. Washington, DC: Brookings.

Herron, M. C., & Sekhon, J.S. (2003). Overvoting and representation: An examination of overvoted presidential ballots in Broward and Miami-Dade counties." *Electoral Studies*, 22, 21-47.

Iyengar, S. S., Jiang, W., & Haberman, G. (2004). How much choice is too Much? Contributions to 401(k) retirement plans. In O. Mitchell and S. Utkus (Eds.), *Pension design and*

structure: New lessons from behavior finance (pp. 83-96). New York: Oxford University Press.

Jewett, A. (2001, August). *Explaining variation in ballot invalidation among Florida counties in the 2000 election*. Paper presented at the annual meeting of the American Political Science Association, San Francisco, CA.

Kimball, D.C., & Kropf, M. (2005). Ballot design and unrecorded votes on paper-based ballots. *Public Opinion Quarterly,* 69, 508-529.

Kimball, D.C., Owens, C.T., & Keeney, K.M. (2004). Residual votes and political representation." In R.P. Watson (Ed.), *Counting Votes: Lessons from the 2000 Presidential Election in Florida* (pp. 135-150), Gainesville, FL: University Press of Florida.

Knack, S., & Kropf, M. (2003a). Voided ballots in the 1996 presidential election: A county-level analysis. *Journal of Politics*, 65, 881-897.

Knack, S., & Kropf, M. (2003b). Roll-off at the top of the ballot: intentional undervoting in American presidential elections. *Politics & Policy*, 31, 575-594.

Lacey, R.J. (2005). The electoral allure of direct democracy: The effect of initiative salience on voting, 1990-96. *State Politics and Policy Quarterly*, 5, 168-181.

Lupia, A., & Matsusaka, J.G. (2004). Direct Democracy: New Approaches to Old Questions. *Annual Review of Political Science*, 7, 463-482.

Magleby, D. (1984). *Direct legislation: Voting on ballot propositions in the United States*. Baltimore: Johns Hopkins University Press.

Mather, G. B. (1964). *Effects of the use of voting machines on total vote cast: Iowa—1920 – 1960*. Iowa City: Institute of Public Affairs, University of Iowa.

Matsusaka, J. G. (2005). The eclipse of legislatures: direct democracy in the 21st century." *Public Choice*, 124, 157-177.

Matsusaka, J. G., & McCarty, N. M. (2001). Political Resource Allocation: Benefits and Costs of Voter Initiatives. *Journal of Law, Economics, and Organization*, 17, 413-448.

Mueller, J.E. (1969). Voting on the propositions: Ballot patterns and historical trends in California. *American Political Science Review*, 63, 1197-1213.

Nichols, S.M. (1998). State referendum voting, ballot roll-off, and the effect of new electoral technology. *State and Local Government Review*, 30, 106-117.

Nichols, S.M., & Strizek, G.A. (1995). Electronic Voting Machines and Ballot Roll-Off. *American Politics Quarterly*, 23, 300-318.

Nicholson, S.P. (2005). *Voting the agenda: Candidates, elections, and ballot propositions*. Princeton: Princeton University Press.

Niemi, R.G., & Herrnson, P.S. (2003). Beyond the butterfly: The complexity of U.S. ballots. *Perspectives on Politics*, 1, 317-326.

Raudenbush, S.W., & Bryk, A.S. (2002). *Hierarchical linear models: Applications and data analysis methods*, 2nd ed. Thousand Oaks, CA: Sage.

Rosenstone, S.J., & Hansen, J.M. (1993). *Mobilization, participation, and democracy in America*. New York: Macmillan.

Roth, S.K. (1998). Disenfranchised by design: Voting systems and the electoral process. *Information Design Journal*, 9, 1-8.

Schwartz, B. (2004). *The paradox of choice: Why more is less*. New York: HarperCollins.

Sinclair, D. E., & Alvarez, R.M. (2004). Who overvotes, who undervotes, using punchcards? Evidence from Los Angeles county. *Political Research Quarterly*, 57, 15-25.

Sinclair, R.C., Mark, M.M., Moore, S.E., Lavis, C.A., & Soldat, A.S. (2000). Psychology: An electoral butterfly effect. *Nature,* 408, 665-666.

Smith, E.R.A.N. (2005). Initiatives and referenda. In P.S. Herrnson, C.C. Campbell, M. Ezra, & S.K. Medvic (Eds.), *Guide to political campaigns in America* (pp.403-420). Washington, DC: Congressional Quarterly Press.

Smith, M.A. (2001). The contingent effects of ballot initiatives and candidate races on turnout. *American Journal of Political Science,* 45, 700-706.

Thomas, N. C. (1968). Voting machines and voter participation in four Michigan constitutional revision referenda. *Western Political Quarterly*, 21, 409-419.

Tolbert, C. J., & Smith, D.A. (2005). The educative effects of ballot initiatives on voter turnout. *American Politics Research,* 33, 283-309.

Tolbert, C.J., Grummel, J.A. & Smith, D.A. (2001). The effects of ballot initiatives on voter turnout in the American states. *American Politics Research*, 29, 625-648.

Tomz, M., & Van Houweling, R. (2003). How does voting equipment affect the racial gap in voided ballots? *American Journal of Political Science*, 47, 46-60.

Vanderleeuw, J.M., & Engstrom, R. 1987. Race, Referendums, and Roll-Off. *Journal of Politics*, 49, 1081-1092.

Vanderleeuw, J.M., & Utter, G.H. (1993). Voter roll-off and the electoral context: A test of two theses. *Social Science Quarterly*, 74, 664-673.

Verba, S., Schlozman, K.L., & Brady H. (1995). *Voice and equality: Civic voluntarism in American politics*. Cambridge, MA: Harvard University Press.

Walker, J.L. 1966. Ballot Forms and Voter Fatigue: An Analysis of the Office Block and Party Column Ballots. *Midwest Journal of Political Science*, 10, 448-464.

Wattenberg, M.P., McAllister, I., & Salvanto, A. (2000). How voting is like taking an SAT test: An analysis of American voter roll-off." *American Politics Quarterly*, 28, 234-250.

Table 1
Number of Counties and Voters Using Each Voting Method in 2004

Technology	Description	Number of Counties
Punch Card	Voter uses stylus to punch out holes in punch card. Ballots counted by card reader machine.	331 counties (15.1 million voters)
Lever Machine	Candidates listed by levers on a machine – voter pulls down the lever next to chosen candidate. Machine records and counts votes.	239 counties (14.9 million voters)
Paper Ballot	Candidates are listed on a sheet of paper – voter marks box next to chosen candidate. Ballots counted by hand.	290 counties (1.0 million voters)
Full-face DRE	Candidates listed on a full-face computerized screen – voter pushes button next to chosen candidate. Machine records and counts votes.	309 counties (13.4 million voters)
Touch-screen DRE	Candidates listed on a scrolling computer screen – voter touches screen next to chosen candidate. Machine records and counts votes.	361 counties (21.6 million voters)
Optical Scan – Central Count	Voter darkens an oval or arrow next to chosen candidate on paper ballot. Ballots counted by computer scanner at a central location.	810 counties (17.4 million voters)
Optical Scan – Precinct Count	Voter darkens an oval or arrow next to chosen candidate on paper ballot. Ballots scanned at the precinct, allowing voter to find and fix errors.	698 counties (35.8 million voters)
Mixed	More than one voting method used.	85 counties (4.5 million voters)

Table 2
Multilevel Model of Residual Votes for President in the 2004 Election

Explanatory Variable	Model 1 Random Effects		Model 2 Fixed State Effects	
County-Level Factors	Coefficient	(Std. error)	Coefficient	(Std. error)
Punch card ballot	0.56***	(0.15)	0.58***	(0.15)
Lever machine	-0.52*	(0.28)	-0.49	(0.30)
Hand-counted paper ballot	-0.10	(0.18)	-0.09	(0.18)
Full-face DRE	-0.07	(0.20)	-0.07	(0.22)
Touch-screen DRE	0.06	(0.23)	0.11	(0.23)
Optical scan precinct-count	-0.71***	(0.13)	-0.69***	(0.14)
Mixed voting system	-0.24	(0.18)	-0.27	(0.19)
Connect-the-arrow format	0.46***	(0.13)	0.47***	(0.13)
Percent Black	0.009**	(0.004)	0.008*	(0.004)
Percent Latino	0.005	(0.005)	0.005	(0.005)
Percent 65 or older	-0.005	(0.010)	-0.005	(0.010)
County population (natural log)	-0.12***	(0.03)	-0.12***	(0.03)
Median income (natural log)	-1.47***	(0.20)	-1.48***	(0.20)
State-Level Factors				
Battleground state	-0.05	(0.29)	----	
"None of These Candidates" (Nevada)	-1.37***	(0.35)	----	
Count all write-ins	-0.41	(0.31)	----	
Straight-party ballot feature	-0.32	(0.28)	----	
Constant	18.42***	(2.14)	18.17***	(2.07)
Number of Counties	1999		1999	
Number of States	34		34	
Between-state variance component	.83		.88	
Within-state variance component	1.38		1.38	
Rho (intra-state correlation)	.26		.29	
Overall R^2	.22		.43	
Within state R^2	.11		.11	
Between state R^2	.38		---	

The dependent variable is the percentage of ballots cast that failed to record a valid vote for the contest. Cell entries are coefficient estimates. Robust standard errors are in parentheses.
***p < .01, ** p<.05, * p < .1, two-tailed

Table 3
Multilevel Model of Residual Votes for Ballot Initiatives in the 2004 Election

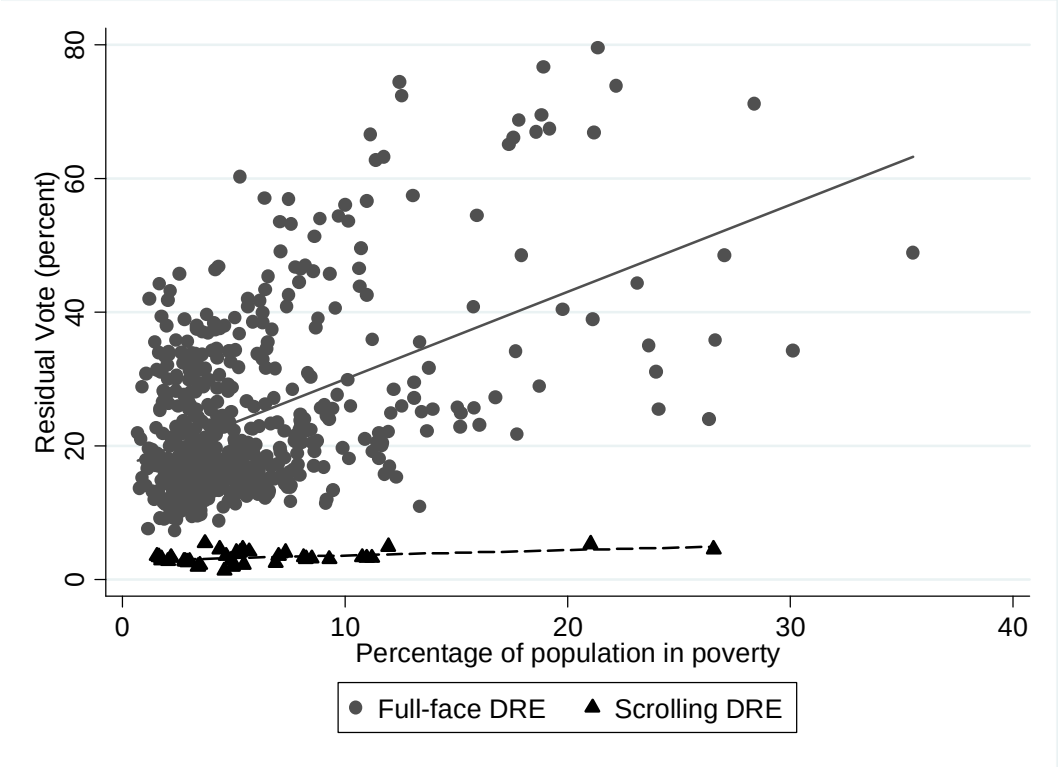
Explanatory Variable	Model 1 Random Effects		Model 2 Fixed State Effects	
County-Level Factors	Coefficient	(Std. error)	Coefficient	(Std. error)
Punch card	1.52**	(0.48)	1.55**	(0.49)
Lever machine	19.46***	(1.50)	19.41***	(1.50)
Hand-counted paper ballot	0.13	(0.50)	0.10	(0.49)
Full-face DRE	4.00***	(0.67)	4.00***	(0.69)
Touch-screen DRE	-0.75	(0.68)	-0.75	(0.71)
Optical scan precinct-count	0.35	(0.35)	0.32	(0.37)
Mixed voting system	1.85	(1.29)	1.79	(1.20)
Connect-the-arrow format	0.52	(0.37)	0.56	(0.38)
Percent Black	0.09***	(0.02)	0.08***	(0.02)
Percent Latino	0.02	(0.01)	0.02	(0.01)
Percent 65 or older	0.03	(0.03)	0.03	(0.03)
County population (natural log)	-0.25**	(0.11)	-0.27**	(0.11)
Median income (natural log)	-5.46***	(0.73)	-5.54***	(0.73)
State-Level Factors				
Ballot position of initiative	0.33*	(0.18)	----	
Issue salience (words in thousands)	-0.13***	(0.05)	----	
Legislative proposal	5.47***	(1.90)	----	
Straight-party ballot feature	2.60	(2.53)	----	
Constant	61.58***	(7.85)	68.05***	(7.33)
Number of Counties	1999		1999	
Number of States	34		34	
Between-state variance component	5.09		6.68	
Within-state variance component	4.71		4.71	
Rho (intra-state correlation)	.54		.67	
Overall R^2	.61		.79	
Within state R^2	.43		.43	
Between state R^2	.72		---	

The dependent variable is the percentage of ballots cast that failed to record a valid vote for the contest. Cell entries are coefficient estimates. Robust standard errors are in parentheses.
***p < .01, ** p<.05, * p < .1, two-tailed

Table 4
Residual Vote Rates in New Jersey Statewide Contests by Voting Equipment
2006 General Election

Contest	Residual vote rate on scrolling DREs	Residual vote rate on full-face DREs
U.S. Senate	1.4%	2.9%
Public Question 1	3.0%	28.4%
Public Question 2	3.4%	29.4%
Public Question 3	3.0%	29.8%

Figure 1
Residual Vote Rate on Question 1 in New Jersey Municipalities
2006 General Election



Biographical paragraphs

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Endnotes

[1] Ballot measures include *initiatives* placed on the ballot through a signature-gathering petition process and *referendums*, in which laws or constitutional amendments passed by the legislature are submitted for voter approval (see information provided by the Initiative and Referendum Institute at http://www.iandrinstitute.org/Quick%20Fact%20-%20What%20is%20I&R.htm, accessed 5 February 2008).

[2] A LexisNexis search of wire service stories during the 2007 calendar year with the phrases "voting equipment" or "voting machines" yielded 2,703 articles.

[3] A table listing all ballot measures and residual vote rates in 2004 by state is in an online appendix at http://www.umsl.edu/~kimballd/issue_appendix.htm. The between-state variance in residual vote rates on ballot issues in 2004 is 59.3, while the within-state variance is 9.0. The proportion of total variance in residual vote rates that is between states is .87. Due to the similarities within states we feel more confident examining just one ballot measure in each state.

[4] Official data on total ballots cast and vote totals in particular contests are available on many state web sites or from state election offices. Getting reliable counts of ballots cast is difficult in some states (Alvarez, Ansolabehere, and Stewart, 2005). Some states do not collect such data at the county level, and some do not verify the accuracy of the data, which forced us to contact county election officials in many states. We excluded 43 counties which could not provide reliable data on the total number of ballots cast, and hence the residual votes for each contest. Our turnout totals include all early, absentee, and valid provisional ballots, as well as those cast at polling places on Election Day.

[5] Punch card methods can be divided between Votomatic varieties (in which the punch card is separate from the booklet listing the offices and issues up for election) and the Datavote system (in which offices and candidates are printed directly on the punch card). Datavote ballots were used in only a handful of counties in 2004, so we lump all punch cards together, with no change in the results reported in this study.

[6] Precinct scanners are always programmed to alert voters of overvotes, but are often not programmed to identify undervotes.

[7] Some counties have precinct-count optical scan balloting but do not activate the error correction feature when scanning the ballots. These counties are coded as central-count systems.

[8] North Carolina and South Carolina have a straight-party option but it comes after the presidential contest and thus does not apply to the presidential contest. We code these two states as not having a straight-party option for the presidential election analysis, but we code both states as having a straight-party feature for the analysis of ballot measures.

[9] Write-in votes can also be problematic when calculating residual vote totals (Alvarez et al., 2005). When necessary, we contacted state or local election officials to get write-in vote totals. We counted them according to state laws. In states that allow any write-in votes for president, the write-ins are valid votes. In states that do not allow them, write-ins are residual votes. In states that only allow write-in votes for declared candidates, write-ins for undeclared candidates are residual votes.

[10] We used circulation figures reported in *Newspaper Directory* to find the largest newspaper in each state. The one exception is California, where we searched *The San Francisco Chronicle*, the state's second largest newspaper. The newspaper with the largest circulation in California, *The Los Angeles Times*, was not available in several databases for the time period we needed.

[11] Some of the largest circulation newspapers were not available on News Library, so we used either Lexis/Nexis or the archive of the paper itself. We used Lexis/Nexis for *The Omaha World-Herald* (Nebraska) and *The Arkansas Democrat-Gazette* (Arkansas). We used the newspaper archives located on the paper's website for *The Fargo Forum* (North Dakota), *The Casper Star Tribune* (Wyoming), *The Billings Gazette* (Montana) and the *Providence Journal* (Rhode Island).

[12] Another possible measure of issue salience would be the amount of money spent by proponents and opponents of the ballot measure. Using data provided by The Institute on Money in State Politics (http://www.followthemoney.org), we analyze how much money was spent for and against each issue. Unfortunately, these data are not available for all of our states (no spending data are available for Indiana, Louisiana, New Mexico, Rhode Island, Virginia or West Virginia), so we chose not to use that measure. However, for the states with campaign spending data, the total amount spent correlates with our media coverage measures.

[13] In order to ascertain whether a measure was initiated by petition or was placed on the ballot by the legislature, we consulted the Initiative and Referendum Institute's newsletter Ballotwatch (http://www.iandrinstitute.org/BW%202004-0%20(List).pdf) and the National Conference of State Legislatures list of statewide ballot issues (http://www.ncsl.org/programs/legismgt/stateVote/measures.lst.htm).

[14] In our sample, battleground states are Colorado, Florida, Maine, Michigan, Nevada, New Hampshire, New Mexico, Ohio, and Oregon. The other four battleground states (Iowa, Minnesota, Pennsylvania, and Wisconsin) did not have any ballot propositions in 2004.

[15] We use the xtreg command in version 9 of Stata to estimate both models.

[16] A Hausman (1978) specification test finds no significant difference in the county coefficient estimates across the two models in Tables 2 and 3.

[17] Fifteen of the twenty-one counties purchased new voting equipment after the 2000 election. The other six switched before 2000.

[18] We have posted an image of the full-face DRE ballot from one of New Jersey's counties in the 2006 election in an online appendix at http://www.umsl.edu/~kimballd/issue_appendix.htm.