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VOTING METHODS
TWO YEARS AFTER FLORIDA

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Roughly 2 million voters -- nearly one in every 50 to cast a ballot -- failed to record a valid choice for president in the 2000 elections.

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Abstract

In the wake of the 2000 elections, several reforms have been proposed to improve election administration and reduce the number of unrecorded votes in future elections. Several counties upgraded to new voting equipment before the 2002 midterm elections, and many more are poised to follow suit in response to recent federal legislation. This paper documents changes in voting technology around the country and assesses their impact on unrecorded votes in the 2002 gubernatorial elections. The results indicate that not all "new" equipment performs the same. Touch-screen electronic voting machines and precinct-count optical scan systems significantly reduce the number of unrecorded votes in top-of-the-ballot contests. In contrast, full-face electronic voting machines and central-count optical scan systems have a much weaker impact on unrecorded votes.Voting Methods Two Years After Florida[1]

Voting Methods Two Years After Florida

As the presidential election in 2000 made clear, sometimes voters fail to cast a valid vote even in contests at the top of the ballot. Roughly 2 million voters (almost one in every 50 to cast a ballot) failed to record a valid choice for president in the 2000 elections. These unrecorded votes are the result of "undervotes" (where voters make no selection) and "overvotes" (where too many selections are recorded). In Florida, where George W. Bush defeated Al Gore by 537 votes, more than 175,000 ballots failed to record a vote for president (most were overvotes), and the disposition of those unrecorded ballots stoked a month-long election controversy.

In the wake of the 2000 elections, the phrase "we don't want another Florida to happen here" has become a common refrain for state and local election officials. Public officials have considered several election reforms to reduce the number of unrecorded votes in future elections. A common proposal is to replace older voting methods (punch cards, lever machines, and paper ballots) with newer

equipment (optical scan systems or electronic voting machines). After the 2000 elections, over 360 counties upgraded their voting technology and many more jurisdictions are poised to follow suit in response to the recently passed Help America Vote Act of 2002.

This paper documents these changes in voting technology and provides a preliminary assessment of the impact of new voting methods and other ballot features on unrecorded votes in the 2002 gubernatorial elections. It appears that not all new voting technologies reduce unrecorded votes. Precinct-count optical scan systems and newer touch-screen electronic voting machines produce significantly lower rates of unrecorded votes than central-count optical scan systems, full-face electronic machines, or other voting methods.

Waiting for the Feds to Act

Election reform has received a considerable push from the federal government in the past year. The Help American Vote Act of 2002 (HAVA) imposes several new requirements on state and local election officials. For example, the law requires each state to develop a statewide voter registration database and institute provisional voting procedures. In addition, the law requires election officials to provide access to voters with disabilities in each precinct and to adopt "second-chance" voting methods that allow voters to identify and correct mistakes.[2] The latter requirements may force many jurisdictions to replace older voting equipment. Furthermore, the law authorizes almost $4 billion to implement these requirements and improve election administration in the United States (although most of the money has not yet been appropriated). Some of the funds are specifically designated to help local governments replace punch card voting methods and lever machines. Finally, the recently passed federal appropriations for fiscal year 2003 includes roughly $1.5 billion to begin the HAVA election reform efforts.

To be sure, the recent economic downturn has lessened the appetite for election reform in many states, and the recent federal appropriation falls short of what was authorized by HAVA for fiscal year 2003. Furthermore, the money authorized by HAVA for new voting equipment (roughly $4,000 per precinct) does not come close to meeting the actual cost of new voting technologies. Nevertheless, there will be real money coming soon to make election changes, and most states are attempting to make the necessary legislative and regulatory changes to make sure they qualify for federal election reform funds. Thus, the pace of election reform and upgrading voting technology quickens.

In addition, several local governments switched to new voting equipment between the 2000 and 2002 general elections. It is worthwhile to examine the impact of these changes to inform the more sweeping changes in election administration that are likely to occur in the next few years. In particular, it is important to estimate the ability of new voting methods to reduce unrecorded votes, as compared to other ballot and election features.

Theory and Evidence on Unrecorded Votes

There are two general explanations for unrecorded votes: (1) lack of voter interest in a particular contest, and (2) voter confusion. Evidence from several elections indicates that both processes help account for unrecorded votes.

One common explanation of unrecorded votes is that voters intentionally abstain from making a selection in contests that do not interest them. This may reflect a failure of political parties and organized groups to mobilize voters (Burnham 1965), or it may reflect a strong incumbency advantage and other forces that reduce competition in elections (Pothier 1987; Crain, Leavens, and Abbot 1987). The "voter fatigue" phenomenon is a common example. That is, voters grow weary of having to make numerous selections on a long ballot and thus abstain (or

undervote) in contests appearing farther down the ballot (Bullock and Dunn 1996; Bowler, Donovan, and Happ 1992).

In addition, unrecorded votes are more common in contests where voters have little information about the competing alternatives, often because of negligible media coverage or low visibility campaigns (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). Unrecorded votes seem to be more common in nonpartisan contests than in equivalent partisan races (Schaffner, Streb, and Wright 2001). Similarly, unrecorded votes are more common in contests that lack appealing candidates or controversial issues (Vanderleeuw and Utter 1993; Harris and Zipp 1999; Vanderleeuw and Engstrom 1987; Engstrom and Caridas 1991). Finally, unrecorded votes are more common in states that restrict write-in voting, thus limiting the voter's ability to register disapproval of the choices listed on the ballot (Kimball, Owens and Keeney n.d.).

Voter confusion is another potential cause of unrecorded votes. Accidental undervotes and overvotes may occur due to faulty equipment or confusing ballot designs (Knack and Kropf 2003; Kimball and Owens 2002; Darcy and Schneider 1989; Shocket *et al.* 1992; Nichols and Strizek 1995; Caltech/MIT Voting Project 2001a, 2001b). Several studies conclude that unrecorded votes are more common with Votomatic punch cards than any other type of voting equipment, probably because punch card voting involves several steps that can malfunction or cause confusion (Saltman 1988; Caltech/MIT Voting Project 2001a; Brady et al. 2001; Knack and Kropf 2002, 2003; Kimball, *et al.* 2001). In contrast, voting methods that prevent overvotes (electronic and lever machines) or allow voters to detect and correct errors (such as precinct-count optical scan systems) tend to have fewer unrecorded votes than other methods (Tomz and Van Houweling 2003; Kimball, Owens, and Keeney n.d.). As another example, when candidates for the same office are listed in multiple columns or on multiple pages of the ballot, voting errors and unrecorded votes are more common (Darcy and Schneider 1989; Wand et al. 2001; Jewett 2001; Kimball, Owens, and Keeney n.d.).

There are additional correlates of unrecorded votes that may reflect a combination of voter confusion and lack of interest. Studies indicate that ballot designs that facilitate straight-party voting (the straight-party punch and the party-column layout) reduce the number of unrecorded votes (Kimball and Owens 2002; Walker 1966). Such features minimize ballot fatigue but they also reduce the impact of voting technology and other ballot features that may confuse voters

Several demographic variables are correlated with higher levels of unrecorded votes. For example, unrecorded votes are more frequent in smaller counties than in large urban counties (Knack and Kropf n.d.; Caltech/MIT 2001b; Brady et al. 2001; Kimball, Owens, and Keeney n.d.). Since candidates have an incentive to concentrate their efforts on the heaviest concentrations of voters, little campaign activity is directed toward small rural counties in national and statewide elections. data collection includes the number of ballots cast, vote totals for specific contests, voting technology, and demographic characteristics for each American county in the 2000 and 2002 elections. In states where elections are administered by municipalities or townships, I 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 "counties" in this dataset.[3] Adding the District of Columbia as another "county" produces a total of 3148 geographic units that cover the entire country.

Voting Technology: What has Changed

Part of the data collection includes the voting technology used in each county, gathered from state and local election officials. Table 1 provides a short description of each type of voting technology and summary data on the

prevalence of each voting method in the 2000 and 2002 elections. 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.[4] Within each of these general categories, further distinctions can be made. Punch card methods are 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).

Table 1
Voting Methods Used in 2000 and 2002

Technology	Description	Counties		% of Voters	
		2000	2002	2000	2002
Punch Card - Votomatic	Punch card is inserted behind booklet with ballot choices -- voter uses stylus to punch out holes in card. Ballots counted by card reader machine.	512	436	27%	19%
Punch Card - Datavote	Ballot choices are printed on punch card -- voter punches out hole next to chosen candidate. Ballots counted by card reader.	44	26	3%	2%
Lever Machine	Candidates listed by levers on a machine -- voter pulls down the lever next to chosen candidate. Machine records and counts votes.	406	292	16%	14%
Paper Ballot	Candidates are listed on a sheet of paper -- voter marks box next to chosen candidate. Ballots counted by hand.	331	298	1%	<1%
Older DRE (full-face)	Candidates listed on a full-face computerized screen -- voter pushes button next to chosen candidate. Machine records and counts votes.	300	320	11%	12%
Newer DRE (touch screen)	Candidates listed on a scrolling computer screen -- voter touches screen next to chosen candidate. Machine records and counts votes.	29	224	1%	11%
Optical Scan -- Central Count	Voter darkens an oval or arrow next to chosen candidate on paper ballot. Ballots are counted by computer scanner at a central location.	891	827	15%	11%
Optical Scan - Precinct Count	Voter darkens an oval or arrow next to chosen candidate on paper ballot. Ballots are scanned at the precinct, allowing voter to find and fix errors.	552	625	23%	26%
Mixed	More than one voting method used.	83	100	4%	5%

Optical scan systems and electronic machines are currently the newest voting technologies. 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 (overvotes and undervotes). The central-count systems do not have such an error-correction feature.[5] DRE machines can be divided into older and newer varieties. Older DREs (such as the Shouptronic 1242, which was designed to mimic lever machines) present the entire full-faced ballot at once and typically use a push-button interface (Caltech/MIT Voting Project 2001a). Newer DREs (such as the E-Slate and Accuvote-TS machines) typically use a touch-screen interface and allow voters to scroll through the offices and issues on the ballot (as in Votomatic punch card ballots).

Finally, in some counties, not all ballots are cast using the same technology. In those cases, I 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. Most of the counties with mixed systems are in states where elections are administered by municipalities or townships.

Several demographic variables are correlated with higher levels of unrecorded votes, including small county size, racial and ethnic minorities, low income, and high elderly population.

Roughly 14 million voters cast ballots on new voting equipment in the 2002 elections. As Table 1 shows, punch cards saw a steeper decline in usage in 2002 than lever machines (the other voting method targeted by HAVA). Over ninety counties replaced punch card balloting after the 2000 election, and the share of ballots cast on punch cards dropped from 30% in 2000 to 21% in 2002. Although over 100 counties replaced lever voting machines, most of these were small counties in Georgia, so the change did not have a dramatic impact on overall usage of lever machines in the United States.

While optical scan systems were the most commonly used voting method in recent elections, they did not see an overall increase in usage between 2000 and 2002. The percentage of ballots cast on precinct-count systems increased from 23% in 2000 to 26% in 2002 while use of central-count systems decreased. Among counties that switched to optical scan systems in 2002, 89 adopted precinct-count varieties while only 34 adopted central-count versions. In addition, central-count optical scan systems are used in more counties than the precinct-count version, but substantially more ballots are cast on the precinct-count version. Central count systems tend to be used in smaller, rural counties while precinct count systems tend to be used in more heavily populated counties.

Most of the counties that adopted new voting technology in 2002 switched to an electronic voting machine. Recent elections mark some new designs in electronic voting machines. Most of the DREs adopted after 2000 have a touch-screen interface and a scrolling format. These newer DREs saw their use rise from 1% of voters in 2000 to 11% in 2002. In contrast, almost all of the electronic machines in use before 2000 are full-face, push-button machines that tend to resemble lever machines. Among counties that upgraded to electronic voting machines before the 2002 elections, 195 adopted newer touch-screen DREs while only 23 switched to the older full-face DREs.

The most dramatic changes in voting technology after 2000 took place in Florida and Georgia. Motivated by the 2000 presidential election controversy, the Florida legislature passed a reform bill requiring the replacement of punch card ballots, lever machines, and paper ballots. As a result, 43 of the state's 67 counties adopted new voting technology for the 2002 election. Counties were able to choose optical scan systems or electronic voting machines.

Twenty-eight counties in Florida upgraded to precinct-count optical scan systems and fifteen switched to electronic touch-screen voting machines.

While Florida garnered most of the media attention after the 2000 election, Georgia had a higher percentage of unrecorded votes in the 2000 presidential election than Florida. With a strong push from Secretary of State Cathy Cox, a Democratically-controlled Georgia state government adopted a uniform voting method for the entire state, requiring all 159 counties to replace existing voting methods with a touch-screen system. Voting technology upgrades in the rest of the country were more scattered, but large urban counties in several states (such as California, Colorado, Maryland, Pennsylvania and Texas) also switched to new voting methods in 2002.

How Much Does Voting Equipment Matter?

I assess the impact of new voting technology by examining unrecorded votes in the 2002 gubernatorial elections

To measure the number of unrecorded votes for governor in each county, I calculate the difference between the total number of ballots cast and the number of votes cast for governor. In most cases, election results were collected from the official canvass provided by each state. However, some states do not have data on ballots cast for every county. While I am in the process of contacting each county in these states to get data on ballots cast, there are some missing observations. I have complete data for 1,787 counties (out of 2184 counties with a governor's race in 2002), which covers slightly more than 94% of the votes cast for governor in 2002. Demographically, the counties with missing data are very similar to the counties in the sample, with the exception that missing counties tend to be smaller in population and have a higher average percentage of Hispanic residents. Among the counties in the sample, there were 1,213,525 unrecorded votes cast in gubernatorial contests (2.1% of ballots cast). The distribution of unrecorded gubernatorial votes across counties is skewed, with outliers at the high end. Residual vote percentages range from .1% to 19.8%, with a median of 1.9%, a mean of 2.3%, and a standard deviation of 1.6%.

At first glance, it appears that new voting equipment can dramatically reduce the frequency of unrecorded votes. After having two of the highest rates of unrecorded votes in the presidential election of 2000, Florida and Georgia had two of the lowest rates of unrecorded votes in the 2002 gubernatorial elections. Unrecorded votes in Florida dropped from 2.9% of ballots cast in 2000 to 0.8% in 2002. In Georgia, unrecorded votes dropped from 3.5% in 2000 to 1.0% in 2002.

Table 2 provides another preliminary assessment of voting equipment and unrecorded votes in the 2002 gubernatorial elections. As in many studies, Table 2 indicates that punch card ballots (especially Votomatics) are associated with higher rates of unrecorded votes than other voting technologies. In addition, Table 2 suggests that precinct-count optical scan systems and touch-screen DREs have noticeably lower levels of unrecorded votes than all other voting methods, while full-face DREs and central-count optical scan systems do not perform much better than paper ballots and lever machines.

The figures in Table 2 and the comparisons of Florida and Georgia are suggestive, however. Both states had very competitive contests for governor in 2002, which should increase voter interest and minimize unrecorded votes. In addition, Florida's problems in 2000 are partly attributed to decisions by election officials in eighteen counties to list the ten presidential candidates in multiple columns or on more than one page (Cauchon 2001; Jewett 2001; Kimball, Owens, and Keeney n.d.). None of the Florida ballots in 2002 had such a design flaw. Finally, there are several other factors that need to be controlled to increase confidence in the conclusion that new voting equipment reduces unrecorded votes.

Table 2

Unrecorded Votes in the 2002 Gubernatorial Elections by Voting Technology

Voting Technology	Unrecorded Votes in 2002
Punch Card – Votomatic	3.5%
Punch Card – Datavote	2.8%
Paper Ballot	2.2%
Lever Machine	2.2%
Mixed	1.5%
Optical Scan – Central Count	2.0%
Optical Scan – Precinct Count	1.3%
Older DRE (full-face)	2.3%
Newer DRE (touch-screen)	1.2%
Number of Counties	1796

Multivariate Analysis

To get a more reliable assessment of the impact of new voting technology, I estimate a multivariate model of unrecorded votes in the 2002 gubernatorial elections. The model includes voting technology, state-specific characteristics, and demographic measures as explanatory variables.

Optical scan balloting is the most commonly used voting technology, and some recent studies (Caltech/MIT Voting Technology Project 2001a, 2001b; Knack and Kropf n.d.) conclude that it produces lower residual vote rates than most alternatives, including electronic machines. Consequently, the regression model uses the central-count optical scan system as the baseline for comparison. The regression model includes separate dummy variables for each type of voting technology in Table 1 (including mixed systems) except centrally-counted optical scan methods.

I control for several state election features that affect unrecorded votes. Previous research suggests that unrecorded votes should be less common in states with a straight-party ballot option (Bullock and Mishou 1999; Kimball, Owens, and Keeney n.d.). In the 2002 elections, 17 states had a straight-party punch on the ballot. These states are identified by a dichotomous variable.

There is also evidence that laws regarding the treatment of write-in votes influence the number of unrecorded votes, since voters may use the write-in option to express disapproval of the candidates listed on the ballot (Kimball, Owens, and McAndrew 2001). In 2002, thirty-four states either did not include space on the ballot for write-in votes or only counted write-ins cast for candidates who had filed a declaration of write-in candidacy (a requirement few candidates fulfill). Some voters in these states made write-in selections that were not counted as valid votes. Another 15 states allow and count all write-in votes. The regression model includes a dummy variable for states that count all write-in votes for governor. I also include a dummy variable for Nevada, the only state to include a ballot line for "None of These Candidates" in federal and statewide races.[6] This is certainly a more

conspicuous outlet for a protest vote than the write-in option, so I expect unrecorded votes to be less common in Nevada.

It is also reasonable to expect that unrecorded votes are less common in competitive elections that feature vigorous two-party campaigns and high-quality candidates. I use the final governor race ratings from the Cook Political Report (Cook 2002) to code the level of competition in each governor's race. The ratings variable has four categories: "toss up" (coded as 3), "lean" (coded as 2), "likely" (coded as 1), and "solid" (coded as 0). I expect unrecorded votes to be more common in states with the least competitive campaigns for governor (those rated "solid" for one party or the other).

Finally, the regression model includes a number of demographic variables that are often correlated with unrecorded votes. I include the percentage of a county's population that is black (which ranges from 0% to 98% with a mean of 8% in our sample), the percentage that is Hispanic (which ranges from less than 1% to 84& 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%). I expect a positive relationship between residual votes and each of these three demographic variables. In addition, I 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 ranges from 9.4 to 11.3 with a mean of 10.4). Both should be negatively correlated with residual votes. Median income is logged because the raw data are skewed with outliers at the high end and I hypothesize that beyond some point, increased income does not increase one's familiarity with the voting process. Finally, I include the natural log of each county's population (which ranges from 6.1 to 16.1, with a mean of 10.4) because several studies find a negative relationship between population and unrecorded votes.[7]

The choice of a statistical model for the multivariate analysis requires some explanation. In analyzing unrecorded votes, it is common to use a least squares regression model, with the percentage of unrecorded votes serving as the dependent variable. There is some concern that least squares regression does not adequately capture the data generating process for unrecorded votes. The percentage of unrecorded votes must be between 0 and 100, and most observations clusters near 0. However, least squares regression models do not constrain the expected value to the 0-100 range.

I estimate a negative binomial regression model, using the number of unrecorded votes in each county as the dependent variable.[8] One of the statistical properties of the negative binomial model is that the expected value of the dependent variable cannot fall below zero.[9] The negative binomial is a variant of the Poisson regression model when there is "overdipsersion" in count data (Long 1997). Overdispersion means that there is more variation in the dependent variable than expected by the Poisson distribution and it can occur in count data if events are clustered in particular locations or time periods. For example, an unrecorded vote in a particular precinct or county may lead to more unrecorded votes in that same voting location (because of faulty equipment, for example). The negative binomial estimates an extra parameter (alpha) to account for overdispersion.

I use a couple of modifications to the generic negative binomial regression model. Since the number of voters in each county varies dramatically, I weight each county by the number of ballots cast. Most counties have small populations, and relatively few voters, and weighting the data gives greater credence to the large counties where most voters cast their ballots. In addition, I estimate robust standard errors to correct for heteroskedasticity likely in data with a skewed dependent variable (White 1980). Finally, the model is modified to account for the fact that the count of unrecorded votes in a county is a function of the total number of ballots cast.[10] Even with the greatest voting equipment and the most helpful poll workers, a county with 100,000 voters will have more unrecorded votes than a county with 1,000 voters.

Results

Table 3 provides the estimated coefficients of a negative binomial regression of unrecorded votes in the 2002 gubernatorial elections. The estimate for alpha is roughly ten times larger than its standard error, indicating overdispersed in the data. More importantly, the estimates show that voting methods and several state election features are associated with unrecorded votes in 2002. To begin with some of the state characteristics, unrecorded votes are significantly less common in states with a straight-party ballot option. According to the model estimates in Table 3, having a straight-party device on the ballot reduces the expected number of unrecorded votes in a county by 20 percent, holding all other variables constant.[11]

While the handling of write-in votes appears to have no effect, unrecorded votes are significantly less common in Nevada, the only state with a "None of These Candidates" ballot line in the 2002 election for governor. Based on the regression model, the "None of These Candidates" ballot feature reduces the expected number of unrecorded votes by 45 percent, even after controlling for other factors. Finally, as expected, unrecorded votes are less common in states with more competitive contests for governor. Increasing the four-category competition variable by one unit reduces the expected number of unrecorded votes in a county by 16 percent.

The estimates in Table 3 reveal substantial voting technology effects as well. Confirming other studies, Votomatic punch card balloting produces higher rates of unrecorded votes than any other voting method in the 2002 gubernatorial elections. Based on the model estimates, Votomatic punch card balloting increases the expected number of unrecorded votes by 64 percent over a county with central-count optical scan balloting. In 2002, Datavote punch cards are also associated with higher rates of unrecorded votes. The results suggest that counties replacing punch card balloting with optical scan ballots counted centrally can expect to reduce the frequency of unrecorded votes. However, the results also indicate that paper ballots and lever machines perform no worse than central-count optical scan systems.

Among "new" voting technologies, touch-screen DREs perform the best in the 2002 gubernatorial elections while full-face DREs perform the worst. Touch-screen DREs reduce the expected number of unrecorded votes by 38 percent when compared to central-count optical scan systems. A Wald test also reveals that unrecorded votes are significantly less common in counties using touch-screen DRE's than in counties using precinct-count optical scan methods.

However, older full-face DREs actually perform worse than many voting methods, including paper ballots and lever machines. Older DREs only perform better than Votomatic punch cards. Counties with older DREs have an expected number of unrecorded votes 20 percent higher than counties with central-count optical scan systems. Whether it is the interface (push-button versus touch-screen), the ballot format (full-facing versus scrolling), or something else, newer versions of electronic voting machines clearly produce lower levels of unrecorded votes than older electronic voting machines.

As expected, the results in Table 3 also indicate that precinct-count optical scan systems produce lower rates of unrecorded votes than central-count systems. The error-correction feature in precinct-count systems seems to help reduce the number of unrecorded votes.

Finally, demographic variables are not closely associated with unrecorded votes in the 2002 gubernatorial elections. Race, ethnicity, and age are the demographic variables with statistically significant effects on unrecorded votes. These effects are consistent with previous research. Unrecorded votes are more common in counties with large percentages of black, Hispanic, or elderly voters.

Table 3

Multivariate Analysis of Unrecorded Votes in the 2002 Gubernatorial Elections

Explanatory Variable	Coefficient	Robust Standard Error
State Variables		
Straight-Party Ballot Option	-.22***	.06
Level of Competition	-.17***	.03
State Counts all Write-In Votes	.05	.06
"None of These Candidates" (Nevada)	-.60***	.09
Voting Technology		
Votomatic Punch Card	.46***	.08
Datavote Punch Card	.22	.15
Paper Ballot	.01	.10
Lever Machine	-.01	.08
Older Electronic Machine (push-button)	.17*	.09
Newer Electronic Machine (touch-screen)	-.50***	.11
Optical Scan – Precinct Count	-.29**	.09
Mixed	-.11	.11
Demographic Controls		
Percent Black	.003*	.001
Percent Hispanic	.013***	.003
Percent 65 or older	.022**	.007
Median household income (natural log)	-.10	.15
Percent with a college degree	-.005	.004
Population in 2000 (natural log)	-.04	.02
Constant	-2.42	1.56
Alpha		
	.21***	.02
Number of Cases	1796	
Model Chi-Square	741.2***	

The dependent variable is the number of ballots cast that failed to record a valid vote for governor. Cell entries are negative binomial regression coefficients and robust standard errors.

Observations (counties) are weighted by the number of ballots cast in the 2002 election.

Central-count optical scan systems are the comparison category for voting technology.

*** p < .001, ** p < .01, * p < .1, two-tailed

The results suggest that counties looking to upgrade voting technology may want to distinguish between varieties of optical scan systems and electronic voting machines. Touch-screen DREs and precinct-count optical scan methods may reduce unrecorded votes more than full-face DREs and central-count optical scan systems.

A final analysis examines the change in unrecorded vote rates from the 2000 presidential election to the 2002 gubernatorial election in each county. This will help determine whether upgrading to new voting technology significantly reduced unrecorded votes, after controlling for some other relevant factors. The dependent variable is the percentage of unrecorded ballots in the 2002 gubernatorial election minus the percentage of unrecorded ballots in the 2000 presidential election. Positive values indicate that unrecorded votes increased in 2002, while negative values indicate that unrecorded vote rates decreased. On average, unrecorded vote rates did not change dramatically from 2000 to 2002, but there was quite a bit of variation. More than one quarter of the counties in the sample saw unrecorded vote rates increase more than 1 percent from 2000 to 2002. Similarly, more than one quarter of the counties saw unrecorded vote rates drop more than .5 percent in 2002.

I estimate a linear regression model with four explanatory variables to account for changes in unrecorded vote rates. Two voting technology variables are created to estimate the effect of new equipment. One dichotomous variable identifies counties that upgraded to touch-screen DREs or precinct-count optical scan systems (the two methods that performed the best in previous analyses). A second dummy variable identifies counties that upgraded to full-face DREs or central-count optical scan methods in 2002. The separate variables will test whether there is a difference in their ability to reduce unrecorded vote rates observed in previous elections.

The regression model includes two control variables. One is a dummy variable identifying nineteen counties known to have listed presidential candidates in more than one column in 2000 (18 counties in Florida and one in Louisiana). The multiple-column layout caused unusually high levels of overvotes in the 2000 presidential contest (Wand et al. 2001; Jewett 2001; Kimball, Owens, and Keeney n.d.). Since each county corrected the ballot design flaw in 2002, I expect unrecorded vote rates to drop substantially in these counties. Finally, I include the competition rating variable used in Table 3 as a control. I expect that unrecorded vote rates may increase in states holding relatively uncompetitive gubernatorial elections in 2002.

The results are presented in Table 4, and they generally support expectations. On average, unrecorded vote rates dropped 4.7 percent in counties that had listed presidential candidates in multiple columns in 2000. This is a very large change and is seen in each of the affected counties. For example, the unrecorded vote rate in Duval County, Florida dropped from 9.1% in 2000 to 0.5% in 2002.

In addition, the level of competition in the 2002 gubernatorial elections is associated with changes in unrecorded vote rates. On average, unrecorded vote rates increased substantially in states with uncompetitive contests for governor in 2002, but rates changed little in states that had very competitive races for governor. For example, in Connecticut, unrecorded votes jumped from 1.0% in 2000 to 2.0% in 2002, when incumbent John Rowland cruised to reelection.

Most importantly, the results in Table 4 suggest that upgrading to touch-screen DREs or precinct-count optical scan systems significantly reduces unrecorded vote rates, while upgrading to full-face DREs or central-count optical scan methods has no impact on unrecorded votes. Counties that switched to touch-screen DREs or precinct-count systems in 2002 saw unrecorded vote rates drop almost 2 percent on average. In contrast, counties that switched to full-face DREs or central-count optical scan systems in 2002 saw, on average, no change in unrecorded votes.

Table 4
Multivariate Analysis of Change in Unrecorded Vote Rates from 2000 to 2002

Independent Variable	GLS Coefficient
Candidates Listed in Multiple Columns in 2000	-4.65*** (.92)
New Voting Technology (touch-screen or preceinct count)	-1.90*** (.23)
New Voting Technology (full-face DRE or central count)	.28 (.30)
Level of Competition in 2002 Gubernatorial Contest	-.34*** (.05)
Constant	1.28*** (.15)
Number of Cases	1722
Standard Error	1.43
R^2	.37

The dependent variable is the change in unrecorded vote rates (2002 unrecorded vote rate minus 2000 unrecorded vote rate). Cell entries are regression coefficients with robust Huber/White standard errors in parentheses. Each county is weighted by the number of ballots cast in the 2002 general election.

***$p < .01$, two-tailed test

**$p < .05$, two-tailed test

*$p < .1$, two tailed t test

Conclusion

Several counties installed new voting equipment after the 2000 elections, and many more are preparing to do so in the near future. The evidence in this paper suggests that touch-screen DREs and precinct-count optical scan balloting will significantly reduce the number of unrecorded votes in future elections. In contrast, full-face DREs and central-count optical scan systems may produce little or no reduction in unrecorded votes if they replace paper ballots or lever machines. Election officials purchasing new voting equipment should pay close attention to what they are buying.

Finally, while voting technology clearly deserves notice as election reforms move forward, other ballot features also merit consideration for those interested in reducing the frequency of unrecorded votes. The straight-party option and Nevada's "None of These Candidates" ballot line significantly reduce unrecorded votes. There may be other ballot design elements (such as the multiple column layout) that increase or decrease voter confusion and thus deserve closer scrutiny.

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(Footnotes)

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[2] HAVA allows states to avoid the "second chance" requirement by adopting voter education programs to help reduce voting errors.

[3] Elections in Alaska are administered by the state. Alaska's boroughs are treated as counties for this analysis.

[4] 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).

[5] 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.

[6] In the 2002 Nevada gubernatorial election, "None of These Candidates" received 23,674 votes, almost as many as the combined totals of all four third-party candidates.

[7] Data on each county's median household income (a 1997 estimate) come from the U.S. Census Bureau's State and County QuickFacts web site (http://quickfacts.census.gov/qfd/). Data on each county's population, as well as the percent black, the percent Hispanic, and the percent 65 years or older (based on the 2000 census) come from the U.S. Census Bureau's State and County QuickFacts web site (http://quickfacts.census.gov/qfd/). Finally, data on the percentage of people over age 25 with a college degree (based on 1990 census data) come from the 1994 County and City Data Books (http://fisher.lib.virginia.edu/ccdb/).

[8] Bullock and Hood (2002) estimate a negative binomial model to examine unrecorded votes.

[9] Some studies use a grouped logit equation to model unrecorded votes (Wand et al. 2001; Herron and Sekhon 2002).

[10] I use the nbreg command in Stata 7 to estimate the model. The total number of ballots cast is specified with the "exposure" option. Long and Freeze (2001, 241-250) describe the negative binomial model and the exposure concept.

[11] I use the "listcoef" suite of commands developed for Stata by Long and Freeze (2001) to calculate the percent changes reported in this section.