Machine Errors and Undervotes in Florida 2006 Revisited [1]

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Abstract

The 2006 election for U.S. House district 13 in Sarasota County, Florida, attracted extensive controversy because an unusually high proportion of the ballots cast lacked a vote for that office, and the unusual number of undervotes probably changed the election outcome. Intensive technical studies based on examining software and hardware from the iVotronic touchscreen voting machines used to conduct the election fail to find mechanical flaws sufficient to explain the undervotes. Studies that examined the ballots used in Sarasota and in some other counties conclude the high undervote rate was caused by peculiar features of the ballot's format that confused many voters. I show that recorded events involving power failures, problems with the Personalized Electronic Ballots used with the machines and touchscreen calibration correlate significantly with undervote rates in several Florida counties. The relationships between machine events and undervotes are sufficiently substantial and varied to make it unreasonable to discount the likelihood that mechanical failures contributed substantially to the high numbers of undervotes.

Introduction

The controversial election for U.S. House district 13 (CD-13) in Florida in 2006 has been extensively investigated, but the basic question of what happened with the electronic voting equipment used there remains unresolved. An unusually large number of ballots cast in Sarasota County did not include a vote for that office: 18,412 of the 238,249 ballots cast cast on iVotronic touchscreen machines in the county were undervotes for that race. Some of the research regarding the high undervote rate has occurred in the context of litigation (Coffey and Herron, 2006; Stewart, 2006; Frisina et al., 2008), some has been done by independent scholars (Mebane and Dill, 2007; Ash and Lamperti, 2008), some was sponsored by the state of Florida (Yasinsac et al., 2007) and some was conducted by the federal government (Government Accountability Office, 2007, 2008). The unusually high undervote rate probably changed the election outcome (Ash and Lamperti, 2008). Teams of computer scientists examined several features of the software and hardware used to conduct the election (Yasinsac et al., 2007; Government Accountability Office, 2008) but found nothing they considered sufficient to warrant attributing the lost votes to defects in the equipment's operations. Even though the adequacy of these technical examinations has been seriously questioned (Dill and Wallach, 2007), many read the technical reports as largely exculpating the machines (Sword, 2008). Hence some argue that the high undervote rate was caused by peculiar features of the ballot's format that confused many voters (Frisina et al., 2008).

Frisina et al. (2008) in particular use data from several counties in Florida to show that the undervote rate for Attorney General was also unusually high in several counties when the choices for Attorney General, for which like CD-13 there were only two candidates running, were placed on the same screen as the Governor's race, which had many candidates. The correlation they demonstrate between the features of the ballot and the Attorney General undervote rate is clear, but the explanation entirely in terms of voter confusion is speculative. There is no direct supporting evidence about the voters' experience, although Selker (2008) reports some suggestive results based on experiments conducted using subjects from Boston, Massachusetts. Frisina et al. (2008) point out, however, that their results set the bar for any competing explanation fairly high:

"any explanation for the CD 13 undervote in Sarasota must be capable of explaining the attorney general undervote in Charlotte and Lee Counties and the lack of an attorney general undervote elsewhere (not to mention the lack of high undervotes in other races)" (Frisina et al., 2008, 31).

Recent reports examining the use and performance of touchscreen voting machines across Florida in the 2006 election open the door to meeting the standard Frisina et al. (2008) propose. Pynchon and Garber (2008) document extensive problems with the iVotronic machines that go well beyond the scope of the officially sponsored technical studies. They show that undervote rates for many races were higher in many counties where iVotronic touchscreen machines were used, regardless of the ballot format. Among the physical problems they identify with the equipment, particularly interesting is the suggestion that voting machine power failures occurred frequently, with strong adverse effects (Pynchon and Garber, 2008; Garber, 2007, 2008*a*). Garber remarks that "power supply failures were experienced by voters and poll workers as screen problems.... power problems can affect the responsiveness of the screen. In fact, one of the first symptoms of a power problem is diminished responsiveness" (Garber, 2008*a*, 9, 32).

Garber (2008*a*, 36–37) demonstrates that an error message that indicates that a voting machine had a power failure correlates strongly with high undervote rates in Charlotte county. Indeed, in that county machines in the same precinct as a machine with a power failure message also tend to exhibit high undervote rates. Garber suggests that power-related problems propagated among machines because "counties link their machines together at the polling place in what is termed a 'daisy chain.' The first machine is plugged into the wall outlet, the second is plugged into the first, the third into the second, and so on" (Garber, 2008*a*, 19).

Another possible hole in Frisina et al.'s explanation is their failure to recognize that with iVotronic touchscreen equipment, a distinctive ballot pattern is in fact a distinctive software and hardware configuration. iVotronic machines use a device called a "Personalized Electronic Ballot" (PEB) to load the candidate selection displays into the voting machine for each voter. Indeed, most interactions with the iVotronic machines involve the use of a PEB. When a ballot has a different appearance, the PEBs contain different programming. None of the technical

examinations of the equipment used in Sarasota ever examined the PEBs that were used to conduct the election. Mebane and Dill (2007) demonstrate that several PEB-related error messages correlate significantly with variations in the Sarasota CD-13 undervote rate. It is possible, then, that the adverse consequences of ballot format that Frisina et al. demonstrate should be explained at least in part as results of deficient mechanical operations connected to the PEBs.

Indeed, as I will show in the remainder of this article, both power failure problems and PEB-related problems correlate significantly with undervote rates in several Florida counties. The analysis includes data from nine Florida counties that used iVotronic touchscreen voting machines: Charlotte, Collier, Lake, Lee, Martin, Miami-Dade, Pasco, Sarasota and Sumter counties. Three of these counties (Charlotte, Lee and Sumter) used ballot formats precisely of the kind Frisina et al. (2008) flag as problematic for the Attorney General race. Ballot formats used in Miami-Dade county exhibited the key feature of having offices with differing numbers of candidate choices on the same screen. Lake and Pasco counties used ballot formats with offices arranged in two columns on each screen instead of the single-column formats used elsewhere. Ballot formats used in the remaining counties lack purportedly problematic features. The prevalence of observable problems with PEBs and power varies across the counties, and the apparent consequences for undervote rates are diverse. The magnitude of the effects varies both across counties and across offices, tending to be larger for races that have substantially larger undervote rates. The results, I suggest, breathe new life into the likelihood that high rates of undervoting in Florida in 2006 were substantially due to mechanical failures.

In an addendum I show that problems that prompted actions to calibrate the touchscreens also correlate significantly with undervote rates. The additional analysis tends to confirm Garber's (2008*a*) observation that power problems contributed to increased undervotes by diminishing screen responsiveness.

Mechanical Events and Undervotes

The foundation for my analysis is the set of vote image and event log files that report, respectively, each ballot cast and every transaction occurring on each iVotronic voting machine used by each county during the 2006 election.[1] Each vote image file contains records showing every candidate selection made on an individual ballot, including a code to indicate the voting machine, PEB and ballot style used to capture the selections. Cast ballots that contain no candidate selections are also shown. Each event log file shows many of the actions taken on each machine, including a timestamp for each transaction. Tables 1 and 2 summarize the event log file contents for the counties used in the current analysis. In the event log files, each transaction is described by a numeric code and a brief descriptive phrase. Events 20 and 21 correspond to vote casting events. For each of these events, there is a corresponding record in the vote image file. Because the vote records are supposedly included in the vote image file in a random order, to protect voter anonymity, it is not possible to match a particular set of votes to a particular event log file transaction.

*** Tables 1 and 2 about here ***

Several transaction codes in the event log files indicate events that may be relevant for studying undervote rates. A need to calibrate the terminal screen (event 02) may suggest misalignment between where vote choices display on the screen and where touching the screen activates each choice. Such misalignment can cause votes to be misrecorded or lost. Other events indicate problems with passwords or possibly inappropriate access to service menus and suggest possible security failures (events 05, 06, 07 and 31). Still other events indicate various malfunctions (events 36 and 49) or some problem with PEBs (events 18, 19, 37 and 51). The record of problems contained in the event log files is not necessarily complete. There are several documented instances in which problems with iVotronic machines caused the event log files to be corrupted. A bug diagnosed in 2004 in particular causes incomplete records in some cases where

[1] I received the files from David Dill (Sarasota), Maurice Tamman (Sumter), Kitty Garber (Charlotte, Lake, Lee, Martin, Miami-Dade, Pasco counties) and the Collier County Supervisor of Elections (Collier).

the power supplied to a machine fails (Pynchon and Garber, 2008, 44–45). Whether that bug or other problems affected the event log files available from the 2006 election is unknown.

For the current analysis I focus on two kinds of events. Event 18 ("Invalid vote PEB") flags a PEB-related error and was a focus of a study of data from Sarasota county by Mebane and Dill (2007). Event 36 ("Low battery lockout") is the event used by Garber (2008*a*) to indicate that a voting machine experienced a power failure. Because it is not possible to match particular events to particular individual vote records, nor in general to tell whether a particular vote occurred prior to an event of interest, I define variables to indicate whether a particular voting machine has an occurrence of event 18 (variable `E18`) or event 36 (`E36`).

In light of Garber's observation about voting machines being "daisy chained," with the likelihood that any consequences of power problems on one machine propagated to other machines connected to it, I also define a variable to indicate whether voting machines were in the same location as another machine that had a power failure. No data exist to show which machines were actually connected to one another in each polling place. Garber (2008*a*) used the fact of being in the same precinct to measure such connections on election day in Charlotte county. I use an alternative proxy: machines are considered to be related according to event 36 if the same PEB was ever used on both of the machines. If machine A is related to machine B by a PEB, and machine B is related to machine C by another PEB, then all three machines are considered to be part of the same PEB cluster. All machines in the same PEB cluster are considered to be at the same location. The power-location variable `E36L` is set on for all machines in a cluster whenever any machine in the cluster has an occurrence of event 36. The rationale for this measure is that machines that were used with same PEB probably were located close to one another in the polling place, and machines that were located close to one another were more likely to have been daisy chained.

Table 3 shows the distribution of the three event-measuring variables, in terms of the number and proportion of ballots cast on the affected machines in each county. Event 18 occurs much

more frequently during early voting than on election day.[2] Typically about half of the early voting ballots are on machines that have an occurrence of event 18, while on election day the frequency ranges from a low of 6.8 percent in Sumter County up to about a quarter of the ballots in Lee, Martin and Miami-Dade counties. The frequency of event 36 is relatively low on election day, ranging from 1.2 percent in Sumter County to 3.9 percent in Lake County. Taking PEB clusters into account in most counties greatly increases the number of ballots potentially affected. Sumter County remains relatively low, with 3.1 percent of ballots having a positive value for `E36L`, but the percentage for Lake County jumps to 26.6, and Miami-Dade county tops the percentages with a value of 27.4. Only four counties (Charlotte, Collier, Lake and Lee) show substantial proportions of ballots on machines or in PEB clusters with power failure indicators during early voting.

*** Table 3 about here ***

A ballot has an undervote for an office if the vote image does not include a candidate choice for the office. For offices that appear on the ballot only in specific jurisdictions, such as U.S. House elections, a nonvote is an undervote only if the vote image is for a precinct and ballot style that indicates the voter is eligible to vote for the candidates in the referent jurisdiction. I focus on votes for five statewide offices (Governor, Attorney General, Chief Financial Officer (CFO), Commissioner of Agriculture and U.S. Senate) and for seats in the U.S. House of Representatives. Table 4 shows the distribution of undervotes for these various offices across the nine counties. Undervote rates are typically lowest for Governor and U.S. Senate, and in many instances they are also low for U.S. House seats. Undervote rates are noticeably higher for Commissioner of Agriculture and CFO, and they vary quite widely for Attorney General. The three Attorney General undervote rates that are greater than 20 percent—for Charlotte, Lee and Sumter counties—are for the counties where the Attorney General race appeared on the same page with the Governor's race (Pynchon and Garber, 2008, 82). Among the U.S. House races, the CD-13 race has the second highest undervote percentage. The result for the U.S. House race with the

[2]Whether a machine was used during early voting or on election day is determined from the time stamps for the events reported for the machine. For Miami-Dade, none of the event records have a time stamp prior to election day.

highest percentage—CD-17 in Miami-Dade—is almost certainly explained by the fact that the Democratic candidate in that district did not face a major party challenger.

*** Table 4 about here ***

The standard proposed by Frisina et al. (2008) calls for effects of the invalid PEB and power failure events on the undervote rate that vary across counties, but nonetheless it is worthwhile to begin by looking at the average rate of undervoting for each combination of the events ignoring any differences among counties. Table 5 shows undervote rates for each office for combinations of the two kinds of events, separately for election day and early voting ballots but pooling across all counties. For this display the undervote counts for all U.S. House seats are treated together.

*** Table 5 about here ***

In the subtable showing the breakdowns among the election day ballots, in the absence of a power failure indication for the particular machine (`No E36`) or for the PEB cluster (`No E36L`), the undervote rate is always higher on machines that have an invalid vote PEB event than on machines that do not have such an event. The largest such differences are differences of one percent for Attorney General in the `No E36` case and for the CFO in the `No E36L` case. Other races in these same conditions typically show a difference of about half a percent in the undervote rate across values of `E18`, except for the Governor race where the differences are smaller. In the subtable showing the election day breakdowns in the presence of power failures (`E36` or `E36L`), the pattern of differences in the undervote rate across values of `E18` is similar except the differences are smaller. Also there is one reversal: for U.S. House with `E36`, the undervote percentage is smaller with `E18` than it is with `No E18`. An invalid vote PEB event is on average typically associated with a higher undervote rate on election day. In the subtables showing the undervote percentage breakdowns for early voting ballots, the differences with respect to `E18` do not exhibit a consistent pattern.

Focusing on the differences with respect to `E36` and `E36L` for comparable values of `E18`, among the election day ballots the undervote rate is typically greater for an office for the ballots that have `E36` or `E36L` than for ballots that have `No E36` or `No E36L`. Power failures are on

average typically associated with a higher undervote rate on election day. Again the pattern of differences among the early voting ballots is mixed.

In terms of gross averages, then, each of the two types of voting machine events is typically associated with a tendency to have a higher undervote rate, at least among election day ballots. In view of the large number of ballots being considered across all nine counties, it is perhaps not surprising that most of the differences apparent in Table 5 are statistically significant if all of the votes for each office are treated as statistically independent of one another. Nonetheless the differences across conditions in Table 5 are small as percentages of ballots cast, and of course the overall averages do not address the need to demonstrate that the differences vary across counties.

Table 6 presents the first set of results that bear on the question of diverse effects. The table shows the simple percentage difference in the undervote rate for each office in a single county when the condition measured by each of the event variables is, respectively, present versus absent. I assess the statistical significance of each difference by testing for independence between each event variable and a variable measuring whether each ballot has an undervote for the respective office. The test level is the conventional value .05, but symbols in the table also address the fact that across the whole analysis we are looking at dozens of separate tests. One symbol indicates that an association is significant even when we adjust for the number of tests being done for an event in the particular county, and one indicates significance even when we adjust for the number of tests being done in all nine counties.[3]

*** Table 6 about here ***

The results in Table 6 show undervote rate differences for Sarasota County. The substantial and significant differences occur mainly for the CD-13 race. There are significant differences for `E18` among both the election day and the early voting ballots. Oddly, the direction of the difference varies between the two election periods. The undervote rate is lower on machines with an invalid vote PEB event during early voting, but the rate is higher on such machines on election

[3]I use the Bonferroni adjustment. Letting m_j denote the number of offices being analyzed in county j and m the number summing across all nine counties, the single test level is .05, the within county test level is $.05/m_j$ and the cross-county test level is $.05/m$. Pearson chi-squared is the test statistic.

day. Also among the election day ballots the undervote percentage is higher in the presence of a power failure event. The effect is smaller for E36L than for E36, but it is large enough to give some support to the idea that the consequences of power failure propagated among nearby machines.[4]

The results for Charlotte and Sumter counties likewise show substantial differences in the undervote rate occurring largely for the office that was subject to the peculiar ballot feature. In both counties there are significant relationships between power failure events and election day Attorney General undervote rates. Table 7 shows the significant differences for Charlotte County are of comparable magnitude whether machine-specific events or PEB cluster events are considered. There are also significant power-related increases in the undervote rate for a few of the other offices, but these increases are smaller in magnitude than the increases for the Attorney General race. Table 7 shows that in Sumter County power failures are associated with significant decreases in the election day Attorney General undervote rate. In Sumter on election day there is also a significant increase in the CD-5 undervote rate associated with machine-specific power failure events. Neither county exhibits significant undervote rate differences associated with invalid vote PEB events, except for a small decline in the early voting Governor undervote rate that achieves single-test significance.

*** Table 7 about here ***

Lee County provides the principal exception to the general finding that undervote rates for the office that appeared with the peculiar ballot feature are significantly associated with invalid vote PEB or power failure events. Table 8 shows no significant differences for the Attorney General race. A significant increase in the election day Commissioner of Agriculture undervote rate is associated with invalid vote PEB events.

*** Table 8 about here ***

The results for Collier County, reported in Table 9, show no significant election day undervote rate differences. Among the early voting ballots one significant increase in undervote rates (for

[4]Table 3 shows that nine times as many ballots have a positive value for E36L as have a positive value for E36, but the percentage difference in Table 6 is not correspondingly nine times smaller.

the Governor race) is associated with invalid vote PEB events, one is associated with machine-level power failures (for the U.S. Senate race) and one is associated with PEB cluster-level power failures (for the combined U.S. House races, but principally for the CD-14 race). Frisina et al. (2008) place Collier County in contrast to Charlotte and Lee counties, because the ballot format used in Collier did not have the purportedly confusing feature of races with very different numbers of candidate choices being placed together on the same screen. Frisina et al. (2008) do not consider undervote rates in the early voting data.

*** Table 9 about here ***

The ballot format used in Martin County exhibited no remarkable features, yet Table 10 shows a significant association between machine events and undervote rates for a couple of offices. For CFO there is an early voting association with invalid vote PEB events and an election day association with machine-level power failure events. There is also a significant negative association between election day Attorney General undervotes and PEB cluster-level power failure events. Garber (2008*a*, 40) observes that the voting machines in Martin County had maintenance histories that differed in several respects from what was done in other Florida counties, and that officials in Martin County exerted special efforts to recalibrate the screens of the voting machines.

*** Table 10 about here ***

The ballot format used in Miami-Dade County differed in significant respects from the ballot format used in the other counties, featuring in particular the property of having offices with very different numbers of candidate choices together on the same screen (Herron, 2006). As Table 11 shows, the county also exhibits a large number of significant associations between election day undervote rates and machine events. Every office except CD-21 has a significant association between the undervote rate and either invalid vote PEB events or power failure events, and several offices show significant associations with both kinds of events.

*** Table 11 about here ***

Lake and Pasco counties differ from the other iVotronic counties because the ballot formats

used in the two counties presented choices on the voting machine screens in two columns (Herron, 2006; Garber, 2008*b*). Table 12 shows that between the two counties the associations between undervote rates and machine events differ considerably. In Lake County, undervotes for almost every office are significantly associated with one or the other type of machine event, and sometimes with both types. Only the Governor race and perhaps the race for CD-8 are exempt. In Pasco County, only two offices exhibit a significant association between undervote rates and one of the machine events: PEB cluster-level power failures are negatively associated with election day Attorney General undervotes and positively related to U.S. House undervotes. The latter association manifestly does not describe the separate congressional districts, so on the whole the evidence for substantial machine event associations with undervote rates in Pasco County should be viewed as weak. It is not the appearance of the ballots that sharply distinguishes the undervote experience in these two counties. Rather it is the association with voting machine error conditions that differs.

*** Table 12 about here ***

Conclusion

Plainly the two kinds of PEB and machine events examined here are not sufficient to explain the pattern of undervotes, neither in the CD-13 race in Sarasota County nor in the other Florida counties included here. The measured events are not always associated with high undervote rates (e.g., Lee County), and even where there are strong associations, the magnitude of the apparent effects is usually too small to fully account for a high proportion of the undervotes that occurred. In a few instances, the invalid vote PEB or power failure events are associated with declines, not increases, in the percentage of undervotes. Citing the kinds of events studied here hardly settles the question of what caused the excessive numbers of undervotes.

The point of the current exercise is not to supply an adequate explanation for the undervotes, but merely to demonstrate that the relationships between machine events and undervotes are sufficiently substantial and varied to make it unreasonable to discount the likelihood that

mechanical failures contributed substantially to the high numbers of undervotes. In three of the four cases considered by Frisina et al. (2008) and Selker (2008), where ballot format purportedly confused voters and consequently produced dramatic increases in undervoting—the CD-13 race in Sarasota County and the Attorney General race in Charlotte, Lee and Sumter counties—there are significant associations between invalid vote PEB events or power failure events and substantial variations in undervoting particularly for the offices of interest. Even if one focuses narrowly on those four races in those places, there is every reason not to rule out mechanical effects. Undervotes also appear significantly related to events for other offices in other counties. Of the nine counties examined here, only Collier and Pasco counties emerge relatively unscathed in terms of significant associations between events and election day undervotes. When early voting is included, no county escapes unblemished.

When thinking about the small magnitude of the percentage differences associated with the invalid vote PEB and power failure events, it is important to remember that the event log file entries that are the basis for measuring these conditions are at best symptoms of whatever was wrong with the PEBs, machines or polling environments where the problems occurred. There is reason to believe the event logs do not include every occurrence even of the precise kinds of flaws in focus here. Recall, for instance, the software bug diagnosed in 2004 that sometimes caused events not to be reported in cases of power failure (Pynchon and Garber, 2008, 44–45). And it is merely a hypothesis that the two kinds of events highlighted here are especially important markers for high undervotes. As we saw in Tables 1 and 2, several other kinds of events might well also indicate conditions that produce excessive undervotes. The current analysis most likely understates how much mechanical defects contributed to the problem of excessive undervotes in the 2006 election.

A definitive explanation for the undervotes requires technical examinations of the hardware, software and practices used in the election that go considerably beyond the officially sponsored reviews that have occurred. Detailed administrative and maintenance records of the kind partially collected and reviewed by Pynchon and Garber (2008) are needed to supplement the kinds of tests

described by Dill and Wallach (2007) and others. Unfortunately it is likely that we will never have a sufficient explanation for the pattern of undervotes in the 2006 election. Key equipment, such as the PEBs actually used during the election, has not been preserved. Experts have not been allowed sufficient latitude to fully test even the equipment (hardware and software) that was preserved. From some counties it is impossible to obtain the necessary kinds of administrative records, and for others to do so is infeasible.

Nonetheless, simply because a sufficient explanation is not forthcoming, there is no reason to treat a partial and incomplete explanation as if it were adequate. While it is tempting to fall back on an explanation that blames the voters—were voters confused?—there is not sufficient evidence to support doing that. While undoubtedly voter confusion prompted by unfortunate ballot formats had a hand in increasing the number of undervotes for some offices, the magnitude of this effect is unclear, and clearly that is not all of what happened.

Addendum

The conclusion that PEB and machine events contributed significantly to the occurrence of undervotes for many races across Florida in 2006 receives further support when effects associated with an additional kind of event are considered. In the event log file event 02 corresponds to "Terminal screen calibrate." Screen calibration during the election period suggests there was a problem with the screen's responsiveness before the calibration was initiated. Poor screen responsiveness might readily cause undervotes. Garber (2008*a*) linked diminishing screen responsiveness to power problems. I show that at least in an analysis that pools across counties, corresponding to the highly aggregated perspective of Table 5, occurrences of event 02 are associated with higher frequencies of undervotes. Taking these screen calibration events into account mitigates to some extent the relationship between power failure events and undervotes, hence suggesting that the link between power failures and undervotes in some way involved perceived screen responsiveness.

Table 13 shows the distribution of the now four event-measuring variables of interest, in terms

of the number and proportion of ballots cast on the affected machines in each county. The frequencies for events 18 and 36 are the same as in Table 3. Except in Miami, ballots occur in conjunction with event 02 occurs much less frequently than with event 18. Ballots occur in conjunction with event 02 sometimes more frequently than with event 36.

*** Table 13 about here ***

Table 14 shows undervote rates for each office for combinations of the three kinds of events, including the machine-specific measure `E36`, separately for election day and early voting ballots but pooling across all counties. The relationships involving event 18 and event 36 are similar to those observed in Table 5. Between pairs of columns for the same occurrences or nonoccurrences of events 36 and 02, the percentage of ballots with undervotes is in general larger with `E18` than with `No E18`. The principal exception to this pattern occurs for Attorney General in Early Voting. Among election day ballots with no event 02 (`No E02`), matching on the occurrence or nonoccurrence of event 18 finds the undervote rate typically greater for an office for the ballots that have `E36` than for ballots that have `No E36`. For election day ballots with `E02` and among early voting ballots, the relationship between event 36 and undervote rates does not exhibit a simple pattern.

*** Table 14 about here ***

Table 14 shows a strong association between undervote rates and event 02 among election day ballots. Among election day ballots, matching on the occurrence or nonoccurrence of events 18 and 36, the undervote rate is greater with `E02` than with `No E02` for every office except Attorney General. There is one exception also for Commissioner of Agriculture with `E18` and `E36`. The undervote rate is sometimes more than twice as large with `E02` than with `No E02`. Among early voting ballots the association between undervote rates and the occurrence or nonoccurrence of event 02 does not exhibit a simple pattern.

Table 15 shows that similar patterns of association occur if the power-location variable `E36L` is used instead of the machine-specific `E36`.

*** Table 15 about here ***

In view of the large counts underlying many of the percentages in Tables 14 and 15, it is not surprising that many of the percentage differences apparent in those tables reflect associations that would be judged statistically significant if one were to imagine that individual votes are cast in line with a model of independent random sampling with homogeneity across counties for each office. Such a sampling model can hardly be taken seriously, but nonetheless it is worthwhile to adopt it momentarily for heuristic reasons. It is suggestively interesting that attending to event 02 affects whether statistical tests framed in this simple setting point to significant associations between the power failure machine events and undervote rates.

To illustrate this I use statistics derived from a collection of hierarchical loglinear models (Bishop, Fienberg and Holland, 1975). I compute test statistics for the hypothesis that there is no pairwise association between undervote rates and each of the three kinds of events. Each statistic is the difference between Pearson chi-squared goodness-of-fit statistics for nested loglinear model specifications. To match the analysis reported in Table 5, one set of models omits consideration of `E02`. I report results only for models that use `E36` (results for `E36L` are similar). To describe the statistics I use integers 1, 2, 3 and 4 to refer respectively to the variables for undervote, `E18`, `E36` and `E02`. The statistics for the models that omit `E02` are the differences between chi-squared statistics for the specification with margins $\{(1,2),(1,3),(2,3)\}$ and either $\{(1,2),(2,3)\}$ or $\{(1,3),(2,3)\}$. The statistics for the models that take `E02` into account are the differences between statistics for $\{(1,2),(1,3),(1,4),(2,3,4)\}$ and either $\{(1,3),(1,4),(2,3,4)\}$, $\{(1,2),(1,4),(2,3,4)\}$ or $\{(1,2),(1,3),(2,3,4)\}$. Adopting the simple sampling model, under the null hypothesis that the less complex specification for each case is correct, each test statistic is distributed as chi-squared with one degree of freedom. With a test level of $\alpha = .05$, this implies a critical value for each statistic of 3.84 (ignoring multiple testing considerations).

To a great extent, taking `E02` into account reduces the statistics for the significance of associations between undervote rates and `E36`, but taking `E02` into account does not much change the statistics for the significance of associations between undervote rates and `E18`. In Table 16, statistics for the models that omit `E02` appear under the heading "Margins 18, 36"

while the other statistics appear under the heading "Margins 18, 36, 02." Because reliable patterns of differences in Table 14 occur mainly among election day ballots, I focus on the election day results in Table 16. The point is that the statistics for `E36` under the "Margins 18, 36, 02" heading are substantially smaller than the corresponding statistics under the "Margins 18, 36" heading. The statistics for `E18` are not very different between the two classes of models (except for Attorney General). The statistics for `E02` are all large.

*** Table 16 about here ***

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Table 1: Events Recorded in Event Log Files for Several Florida Counties in 2006

		County				
Code	Description	Charlotte	Collier	Lake	Lee	Martin
01	Terminal clear and test	512	818	956	1775	364
02	Terminal screen calibrate	14	35	219	5	78
04	Enter service menu	17	1033	1148	966	87
05	Service password fail	2	3	16	4	9
06	Enter ECA menu	0	0	14	4	27
07	ECA password fail	0	0	0	0	1
08	Date/time change	6	987	927	974	21
09	Terminal open	512	817	966	1773	365
10	Terminal close	512	817	956	1773	364
12	Audit upload	2	0	3	0	29
13	Print zero tape	125	230	135	398	69
14	Print Precinct results	8	0	2	0	2
15	Modem Precinct results	0	0	2	0	0
17	Votes recollect	1	0	0	1	0
18	Invalid vote PEB	95	166	163	448	121
19	Invalid super PEB	39	1920	115	19	30
20	Normal ballot cast	45993	70069	75292	130125	44178
21	Super ballot cast	57	91	142	392	44
22	Super ballot cancel	118	161	672	239	74
25	Open with super votes	0	0	1	0	0
26	Terminal left open	0	0	0	0	0
27	Override	900	2054	2183	1616	682
28	Override fail	6	33	31	10	11
31	Term. clear/test password fail	0	3	1	0	0
35	Modem Precinct results fail	0	0	0	0	0
36	Low battery lockout	35	57	58	87	26
37	Nonmaster PEB collection	3	10	11	2	6
49	Internal malfunction	0	0	0	0	0
50	L and A test run-Votes cleared	0	0	0	0	0
51	PEB/CF Election ID mismatch	0	0	0	2	0

Table 2: Events Recorded in Event Log Files for Several Florida Counties in 2006

		County			
Code	Description	Miami-Dade	Pasco	Sarasota	Sumter
01	Terminal clear and test	4682	1416	1503	250
02	Terminal screen calibrate	4404	9	20	4
04	Enter service menu	7387	40	70	7
05	Service password fail	120	9	2	2
06	Enter ECA menu	7	7	34	0
07	ECA password fail	2	0	0	0
08	Date/time change	5091	11	57	6
09	Terminal open	4680	1441	1503	250
10	Terminal close	4673	1408	1503	250
12	Audit upload	1	861	0	390
13	Print zero tape	1986	169	366	51
14	Print Precinct results	6	6	5	0
15	Modem Precinct results	0	4	0	0
17	Votes recollect	2	1	1	0
18	Invalid vote PEB	1377	205	308	33
19	Invalid super PEB	515	57	48	0
20	Normal ballot cast	79115	113429	119772	27399
21	Super ballot cast	875	171	184	67
22	Super ballot cancel	2700	159	225	27
25	Open with super votes	1	5	6	0
26	Terminal left open	2	0	1	0
27	Override	9276	77	21	35
28	Override fail	217	4	1	0
31	Term. clear/test password fail	39	1	0	0
35	Modem Precinct results fail	0	1	0	0
36	Low battery lockout	409	55	66	6
37	Nonmaster PEB collection	17	9	8	0
49	Internal malfunction	13	3	0	0
50	L and A test run-Votes cleared	12	0	0	0
51	PEB/CF Election ID mismatch	7	1	1	0

Table 3: Frequency of Invalid Vote PEB and Low Battery Lockout Events

Percentages

	Election day			Early Voting		
County	E18	E36	E36L	E18	E36	E36L
Charlotte	12.4	2.2	9.9	52.6	4.6	13.9
Collier	15.1	2.6	20.8	41.7	3.9	21.9
Lake	14.7	3.9	26.6	41.7	2.5	18.2
Lee	24.2	1.9	19.1	26.5	2.5	23.5
Martin	23.5	3.5	17.1	64.3	0	0
Miami	23.9	3.6	27.4	—[a]	—[a]	—[a]
Pasco	11.6	1.4	15.1	41.1	0	0
Sarasota	13.0	1.4	12.8	54.0	.1	.1
Sumter	6.8	1.2	3.1	40.7	0	0

Counts

	Election day			Early Voting		
County	E18	E36	E36L	E18	E36	E36L
Charlotte	3576	629	2864	9005	787	2374
Collier	7393	1259	10169	8823	833	4638
Lake	8649	2299	15615	6979	421	3050
Lee	26178	2044	20655	5835	545	5174
Martin	6644	987	4836	10250	0	0
Miami	66946	10132	76706	—[a]	—[a]	—[a]
Pasco	10936	1341	14240	7816	0	0
Sarasota	11578	1244	11415	16681	21	21
Sumter	830	152	379	6209	0	0

Note: Percentages and counts of ballots on a machine with the indicated event in each county. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. [a] Early voting data not available.

Table 4: Undervote Percentages by Office

	County								
Office	Charlotte	Collier	Lake	Lee	Martin	Miami	Pasco	Sarasota	Sumter
Atty Genl	24.7	3.5	3.8	20.7	3.3	9.6	4.9	4.7	23.9
Comm Agric	5.7	7.5	4.9	5.8	8.0	8.0	5.5	5.3	6.3
CFO	3.7	6.6	5.4	3.4	7.7	9.5	3.8	4.5	3.7
Governor	.8	.7	1.0	.7	.8	1.5	.8	1.4	.9
US House	1.8	2.0	5.9	1.4	1.1	9.5	5.2	14.9	2.5
US House 5	—[a]	—[a]	7.2	—[a]	—[a]	—[a]	6.0	—[a]	2.5
US House 6	—[a]	—[a]	7.8	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
US House 8	—[a]	—[a]	2.8	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
US House 9	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]	4.3	—[a]	—[a]
US House 13	2.4	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]	14.9	—[a]
US House 14	2.1	1.9	—[a]	1.4	—[a]	—[a]	—[a]	—[a]	—[a]
US House 16	1.5	—[a]	—[a]	—[a]	1.1	—[a]	—[a]	—[a]	—[a]
US House 17	—[a]	—[a]	—[a]	—[a]	—[a]	16.4	—[a]	—[a]	—[a]
US House 18	—[a]	—[a]	—[a]	—[a]	—[a]	5.7	—[a]	—[a]	—[a]
US House 21	—[a]	—[a]	—[a]	—[a]	—[a]	8.5	—[a]	—[a]	—[a]
US House 25	—[a]	2.7	—[a]	—[a]	—[a]	7.8	—[a]	—[a]	—[a]
US Senate	1.2	1.4	1.2	1.2	1.2	4.7	1.6	1.2	1.3

Note: Undervotes as percentage of all ballots cast. Results for "US House" with a district include only ballots in the referent district. "US House" with no district combines all districts for each county. [a] Office not included in county.

Table 5: Undervote Percentages by Occurrence of Machine Events

	No E36				No E36L			
	Election Day		Early Voting		Election Day		Early Voting	
Office	No E18	E18	No E18	E18	No E18	E18	No E18	E18
Atty Genl	9.7	10.7	10.3	9.7	9.8	10.7	10.1	9.5
Comm Agric	6.6	7.1	5.4	5.4	6.5	7.0	5.4	5.4
CFO	6.3	7.2	4.4	4.3	6.1	7.1	4.3	4.3
Governor	1.1	1.3	.8	1.0	1.1	1.2	.8	1.0
US House	6.7	7.3	6.3	7.4	6.7	7.2	6.9	8.1
US Senate	2.5	3.0	1.0	.9	2.4	2.8	1.0	.9

	E36				E36L			
	Election Day		Early Voting		Election Day		Early Voting	
Office	No E18	E18	No E18	E18	No E18	E18	No E18	E18
Atty Genl	9.8	10.3	14.7	2.1	9.2	10.7	12.2	11.1
Comm Agric	7.5	7.6	5.7	6.9	6.9	7.5	5.5	5.7
CFO	7.3	9.0	4.2	6.5	6.9	7.9	4.6	4.5
Governor	1.4	1.5	.7	.8	1.1	1.3	.6	.8
US House	7.6	7.2	2.1	1.9	7.0	7.6	2.1	1.9
US Senate	3.3	3.6	1.2	1.9	3.0	3.6	1.1	1.1

Note: Undervote percentages with and without the indicated type of event, pooling data from all nine counties. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. "US House" includes all districts in all counties.

Table 6: Undervote Percentage Differences by Occurrence of Machine Events I

	Sarasota					
	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	.2	.5	.1	$-.2$	.3	.3
Comm Agric	.3	$-.2$	.0	$-.2$	4.6	4.6
CFO	.3	$-.5$	.2	$-.4$	-4.0	-4.0
Governor	.0	.3	$.3^{*}$	.1	3.4	3.4
US House 13	$.9^{*}$	2.3^{*}	$.8^{*}$	$-2.4^{\ddagger}$	-12.9	-12.9
US Senate	.0	.2	.0	$-.1$	$-.9$	$-.9$

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *, ‡: Two-way association significant at level .05; at level .05 adjusting for tests across all counties.

Table 7: Undervote Percentage Differences by Occurrence of Machine Events II

Charlotte

	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	$-.1$	$5.6^{\dagger}$	$4.6^{\ddagger}$	.3	-1.8	$-.8$
Comm Agric	$-.7$	2.5^{*}	$1.8^{\ddagger}$	.4	.7	.0
CFO	.1	.0	1.0^{*}	.3	$-.5$	$-.8^{*}$
Governor	$-.2$	.4	.4	.2	$-.4$	$-.2$
US House	.2	.6	$.7^{*}$	$-.1$	.5	.6
US House 13	.5	.9	1.1	$-.6$	.4	.1
US House 14	-1.1	—[b]	—[b]	.0	$-.4$	$-.2$
US House 16	.2	.5	.5	.2	-1.4	-1.4
US Senate	$-.2$	1.4^{*}	.4	.0	$-.5$	$-.3$

Sumter

	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	$-.9$	-6.6^{*}	-5.5^{*}	$-.3$	—[b]	—[b]
Comm Agric	.0	.9	-1.3	.4	—[b]	—[b]
CFO	$-.2$	-1.3	$-.5$	$-.1$	—[b]	—[b]
Governor	$-.1$	.4	.1	$-.3^{*}$	—[b]	—[b]
US House 5	$-.8$	3.2^{*}	.4	.0	—[b]	—[b]
US Senate	$-.2$	$-.1$	$-.3$	$-.2$	—[b]	—[b]

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *, †, ‡: Two-way association significant at level .05; at level .05 adjusting for all tests in this county; at level .05 adjusting for tests across all counties. Results for "US House" with a district include only ballots in the referent district. "US House" with no district combines all districts for each county. [b] No events.

Table 8: Undervote Percentage Differences by Occurrence of Machine Events III

	Lee					
	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	.4	−.6	−.4	.9	1.0	.4
Comm Agric	.5†	−.3	.1	.3	−.2	−.3
CFO	.2	.0	−.2	.0	.7	.2
Governor	.1	.2	−.1	.1	.2	.0
US House 14	.1	.4	−.1	−.2	−.9*	.1
US Senate	.1	−.1	.0	−.1	−.4	−.2

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *, †: Two-way association significant at level .05; at level .05 adjusting for all tests in this county.

Table 9: Undervote Percentage Differences by Occurrence of Machine Events IV

	Collier					
	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	−.1	.0	.0	.1	−.4	.3
Comm Agric	.0	−.1	−.3	.6	.0	.0
CFO	−.2	−.4	−.2	.1	.6	.8
Governor	−.1	.2	.0	.2*	−.1	.0
US House	.0	.3	−.1	.1	.4	.5*
US House 14	.1	.5	.0	.1	.4	.5
US House 25	−.3	−.3	−.4	.4	.0	.0
US Senate	.2	.1	.2	.2	1.1*	.1

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *: Two-way association significant at level .05. Results for "US House" with a district include only ballots in the referent district. "US House" with no district combines all districts for each county.

Table 10: Undervote Percentage Differences by Occurrence of Machine Events V

	Martin					
	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	$-.1$	$-.7$	$-.6^{*}$	.2	—[b]	—[b]
Comm Agric	.3	1.3	$-.1$	.5	—[b]	—[b]
CFO	.6	1.9^{*}	.1	$1.0^{\dagger}$	—[b]	—[b]
Governor	.0	$-.3$	$-.1$	.2	—[b]	—[b]
US House 16	.1	.5	$-.1$	.2	—[b]	—[b]
US Senate	.2	.6	.2	.2	—[b]	—[b]

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *, †: Two-way association significant at level .05; at level .05 adjusting for all tests in this county. [b] No events.

Table 11: Undervote Percentage Differences by Occurrence of Machine Events VI

	Miami-Dade					
	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	$.3^{*}$	$.7^{\dagger}$	$-.1$	—[a]	—[a]	—[a]
Comm Agric	.1	$.7^{*}$	.2	—[a]	—[a]	—[a]
CFO	$.6^{\ddagger}$	.4	$-.1$	—[a]	—[a]	—[a]
Governor	$.2^{\ddagger}$	.2	.0	—[a]	—[a]	—[a]
US House	$.8^{\ddagger}$	$-.1$	$-.3^{\dagger}$	—[a]	—[a]	—[a]
US House 17	$-.3$	$-.2$	$1.0^{\dagger}$	—[a]	—[a]	—[a]
US House 18	$.6^{*}$	1.1^{*}	$-.1$	—[a]	—[a]	—[a]
US House 21	$-.1$	$-.6$	$-.4$	—[a]	—[a]	—[a]
US House 25	.4	$-.5$	$-.9^{\ddagger}$	—[a]	—[a]	—[a]
US Senate	.1	.3	$.2^{*}$	—[a]	—[a]	—[a]

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *, †, ‡: Two-way association significant at level .05; at level .05 adjusting for all tests in this county; at level .05 adjusting for tests across all counties. Results for "US House" with a district include only ballots in the referent district. "US House" with no district combines all districts for each county. [a] Early voting data not available.

Table 12: Undervote Percentage Differences by Occurrence of Machine Events VII

Lake

	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	.3	.7	$-.1$	.0	.1	$-.7^{*}$
Comm Agric	.5	1.2^{*}	.2	$-.2$	$-.5$	$-.4$
CFO	.2	1.2^{*}	.1	$-.3$	$-.6$	$-.5$
Governor	.2	.2	.0	$-.1$	.5	.2
US House	$.7^{*}$	1.5^{*}	$.7^{\dagger}$	$-.4$	-1.1	$-2.2^{\ddagger}$
US House 5	.5	1.1	$-.9^{*}$	.5	$-.2$	.8
US House 6	$-.1$	1.3	1.6^{*}	-1.3	-6.9	-3.9
US House 8	.0	1.4	.6	$-.6$	1.0	.0
US Senate	.1	$.7^{\dagger}$	$-.1$	$-.3^{*}$	.9	$.5^{*}$

Pasco

	Election Day			Early Voting		
Office	E18	E36	E36L	E18	E36	E36L
Atty Genl	.1	$-.4$	$-.4^{*}$	.1	—[b]	—[b]
Comm Agric	.1	$-.1$	.0	.1	—[b]	—[b]
CFO	.1	$-.8$	$-.2$	$-.3$	—[b]	—[b]
Governor	.1	.2	.0	.0	—[b]	—[b]
US House	.4	.6	$.5^{*}$	.3	—[b]	—[b]
US House 5	.5	.3	.1	.6	—[b]	—[b]
US House 9	$-.1$	-1.3	$-.6$	$-.1$	—[b]	—[b]
US Senate	.0	$-.2$	.0	$-.1$	—[b]	—[b]

Note: Differences between undervote percentages with and without the indicated type of event. E18 and E36: events 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. *, †, ‡: Two-way association significant at level .05; at level .05 adjusting for all tests in this county; at level .05 adjusting for tests across all counties. Results for "US House" with a district include only ballots in the referent district. "US House" with no district combines all districts for each county.

Table 13: Frequency of Invalid Vote PEB, Low Battery Lockout and Terminal Screen Calibrate Events

Percentages

	Election day				Early Voting			
County	E18	E36	E36L	E02	E18	E36	E36L	E02
Charlotte	12.4	2.2	9.9	.9	52.6	4.6	13.9	11.2
Collier	15.1	2.6	20.8	4.0	41.7	3.9	21.9	1.4
Lake	14.7	3.9	26.6	5.4	41.7	2.5	18.2	16.0
Lee	24.2	1.9	19.1	.2	26.5	2.5	23.5	.2
Martin	23.5	3.5	17.1	9.4	64.3	0	0	9.7
Miami	23.9	3.6	27.4	72.9	—[a]	—[a]	—[a]	—[a]
Pasco	11.6	1.4	15.1	.3	41.1	0	0	0
Sarasota	13.0	1.4	12.8	.8	54.0	.1	.1	4.5
Sumter	6.8	1.2	3.1	0	40.7	0	0	0

Counts

	Election day				Early Voting			
County	E18	E36	E36L	E02	E18	E36	E36L	E02
Charlotte	3576	629	2864	261	9005	787	2374	1920
Collier	7393	1259	10169	1939	8823	833	4638	287
Lake	8649	2299	15615	3175	6979	421	3050	2679
Lee	26178	2044	20655	163	5835	545	5174	33
Martin	6644	987	4836	2650	10250	0	0	1541
Miami	66946	10132	76706	203630	—[a]	—[a]	—[a]	—[a]
Pasco	10936	1341	14240	329	7816	0	0	0
Sarasota	11578	1244	11415	705	16681	21	21	1380
Sumter	830	152	379	0	6209	0	0	0

Note: Percentages and counts of ballots on a machine with the indicated event in each county. E18, E36 and E02: events 18, 36 and 02 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. [a] Early voting data not available.

Table 14: Undervote Percentages by Occurrence of Machine Events II

Election Day

	No E02				E02			
	No E36		E36		No E36		E36	
Office	No E18	E18	No E18	E18	No E18	E18	No E18	E18
Atty Genl	9.8	11.3	10.0	10.4	9.3	9.7	9.6	10.1
Comm Agric	6.1	6.5	6.9	7.8	7.8	8.0	8.5	7.4
CFO	5.2	5.7	6.3	8.3	9.2	9.9	8.9	9.8
Governor	1.0	1.1	1.3	1.4	1.4	1.6	1.5	1.6
US House	6.0	6.0	7.1	5.6	8.8	9.8	8.3	9.2
US Senate	1.8	2.1	2.5	2.7	4.5	4.6	4.6	4.5

Early Voting

	No E02				E02			
	No E36		E36		No E36		E36	
Office	No E18	E18	No E18	E18	No E18	E18	No E18	E18
Atty Genl	10.5	9.6	13.0	2.1	9.8	3.5	21.4	—[a]
Comm Agric	5.7	6.0	5.3	6.9	5.9	6.4	7.1	—[a]
CFO	4.3	4.7	4.4	6.5	5.2	6.5	3.7	—[a]
Governor	.8	.9	.5	.8	.9	.9	1.1	—[a]
US House	5.3	5.9	1.9	1.9	5.8	5.9	2.5	—[a]
US Senate	1.0	1.0	1.2	1.9	1.6	1.0	.9	—[a]

Note: Undervote percentages with and without the indicated type of event, pooling data from all nine counties. E02, E18 and E36: events 02, 18 and 36 on the ballot's machine. "US House" includes all districts in all counties. [a] No events.

Table 15: Undervote Percentages by Occurrence of Machine Events III

Election Day

	No E02				E02			
	No E36L		E36L		No E36L		E36L	
Office	No E18	E18	No E18	E18	No E18	E18	No E18	E18
Atty Genl	9.9	11.2	9.3	11.5	9.5	9.7	9.0	9.6
Comm Agric	6.1	6.5	6.4	6.9	7.9	7.9	7.8	8.3
CFO	5.1	5.6	5.7	6.5	9.4	9.9	8.8	9.8
Governor	1.0	1.1	1.1	1.1	1.4	1.6	1.3	1.6
US House	6.0	5.9	6.1	6.2	8.9	9.8	8.6	9.7
US Senate	1.8	2.0	2.1	2.5	4.5	4.5	4.5	5.0

Early Voting

	No E02				E02			
	No E36L		E36L		No E36L		E36L	
Office	No E18	E18	No E18	E18	No E18	E18	No E18	E18
Atty Genl	10.4	9.4	12.5	11.1	10.8	3.5	9.9	—[a]
Comm Agric	5.7	6.0	5.6	5.7	6.2	6.4	5.0	—[a]
CFO	4.3	4.7	4.6	4.5	5.3	6.5	4.1	—[a]
Governor	.8	.9	.5	.8	.9	.9	1.1	—[a]
US House	5.6	6.2	1.9	1.9	5.9	5.9	3.3	—[a]
US Senate	1.0	1.0	1.0	1.1	1.6	1.0	1.6	—[a]

Note: Undervote percentages with and without the indicated type of event, pooling data from all nine counties. E02, E18 and E36: events 02, 18 and 36 on the ballot's machine. E36L: event 36 on a machine in the ballot's PEB cluster. "US House" includes all districts in all counties. [a] No events.

Table 16: Tests of Relationship between Occurrence of Machine Events and Undervote Percentages

	Election Day				
	Margins 18, 36		Margins 18, 36, 02		
Office	E18	E36	E18	E36	E02
Atty Genl	.1	138.5	154.4	.4	84.9
Comm Agric	24.5	45.7	23.2	14.8	644.7
CFO	40.7	163.4	65.3	13.9	3698.9
Governor	11.0	24.1	14.7	7.3	191.2
US House	12.7	41.3	10.6	2.5	1903.9
US Senate	38.1	87.3	20.6	11.9	3760.9
	Early Voting				
	Margins 18, 36		Margins 18, 36, 02		
Office	E18	E36	E18	E36	E02
Atty Genl	12.2	15.1	70.5	13.1	21.8
Comm Agric	1.2	.2	9.8	.1	1.5
CFO	.5	.1	16.9	.1	19.7
Governor	.6	10.8	5.6	.5	1.7
US House	112.0	43.8	22.9	74.4	1.8
US Senate	2.2	1.5	1.3	1.0	9.3

Note: Chi-squared statistics (1 df) based on log-linear models for the hypothesis of no two-way relationship between the indicated event and an undervote for each office. Using integers 1, 2, 3 and 4 to refer respectively to the variables for undervote, `E18`, `E36` and `E02`, the statistics for the "Margins 18, 36" models are the differences between Pearson chi-squared goodness-of-fit statistics for the specification with margins $\{(1,2),(1,3),(2,3)\}$ and either $\{(1,2),(2,3)\}$ or $\{(1,3),(2,3)\}$, and the statistics for the "Margins 18, 36, 02" models are the differences between statistics for $\{(1,2),(1,3),(1,4),(2,3,4)\}$ and either $\{(1,3),(1,4),(2,3,4)\}$, $\{(1,2),(1,4),(2,3,4)\}$ or $\{(1,2),(1,3),(2,3,4)\}$.