VoTeR Center

UConn Center for Voting Technology Research

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Statistical Analysis of Post-Election Audit Data for the November 5, 2024 State Election

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Summary

This report presents an analysis of the results of the post-election audit performed in the state of Connecticut after the November 5, 2024 presidential election. The audit involved a random selection of 5% of the voting locations in which ballots were cast. Since absentee and early voting ballots are tallied at the same place, this report treats both of these ballot types as the same voting location. In each voting location so selected, the ballots cast on election day were either hand-counted or counted with electronic assistance.[1]

44 voting locations were required to produce an audit report. A total of 39 reports were submitted for analysis, comprising 654 audit records.

The specific goal of the analysis was to use statistical methods to detect instances of tabulator malfunction. The 39 voting location audit results evaluated show discrepancies between tabulated and audited totals that are consistent with anticipated human error in counting or ballot handling. The analysis revealed no conclusive signs of tabulator malfunction.

[1] Auditors are allowed to use an electronic audit assistance tool, provided that they visually examine each ballot to confirm bubble interpretations.

Town	District
Berlin	Hubbard School
Bethel	Bethel Municipal Center
Branford	Mary T. Murphy School
Clinton	Clinton Town Hall
Cornwall	Cornwall Town Hall
Danbury	Park Avenue School
Darien	ABS, EV, SDR - Darien Town Hall
East Haven	Tuttle School
Ellington	Ellington High School - Gym Back
Greenwich	Greenwich High School
Greenwich	North Street School
Haddam	ABS, EV, SDR - Haddam Firehouse
Hamden	Keefe Community Center
Killingly	Killingly High School
Killingworth	Killingworth Elementary School
Lebanon	Fire Safety Complex
Ledyard	Juliet Long School
Manchester	Highland Park School
Middletown	Middletown Recreation Center
Middletown	Spencer School
Naugatuck	Andrew Avenue School
New Britain	Vance Village School
New Fairfield	New Fairfield High School
New Haven	Riverside School
Newtown	Newtown High School
North Haven	Green Acres Elementary School
Plainville	Linden Street School
Seymour	Bungay School
South Windsor	South Windsor High School
South Windsor	Timothy Edwards School
Southington	Oshana School
Stamford	Springdale School
Stamford	Star Center - Old Star of the Sea
Stonington	Board of Education Admin Building
Vernon	Vernon Center Middle School
Washington	ABS, EV, SDR - Bryan Memorial Town Hall, Main Hall
Waterbury	Chase School
Weston	Weston Middle School

Table 1: Voting locations analyzed

1 Analysis Description

1.1 Audit Records

The audit returns are presented in a result report in which auditors record information about the precinct under audit, the result of their count, and the corresponding count value from the tabulator. This analysis considers the vote totals for each candidate as a separate record. Each record consists of three items: the total votes as reported by the tabulator, the number of bubbles containing an "undisputed mark," and the number of bubbles containing a "questionable mark." An "undisputed mark" is a mark that covers the majority of the bubble and is dark enough that all auditors agree that it should have been read as a mark by a working tabulator. A "questionable mark" is a mark that is not large or dark enough to convince all of the auditors that a working tabulator would have recorded it as a mark.

1.2 Expected Vote Ranges

For each record, the undisputed hand-counted mark total and questionable hand-counted mark total are used to define an *expected tabulator total range*. The range is defined as having a minimum that is equal to the undisputed mark count and a maximum that is equal to the sum of the undisputed mark count and questionable mark count. If the total as reported by the tabulator is at least the undisputed mark count and no more than the sum of the undisputed and questionable mark counts, the tabulated results are consistent with the hand-counted results. In this case, the tabulator is considered to be functioning properly.

1.3 Discrepancies

Total Ballot Count Discrepancies. If the tabulator total falls outside of this expected range then it is considered an unexplained discrepancy. In general we measure unexplained discrepancies in different ways for different purposes. First, we define the *raw discrepancy* to be the signed distance between the tabulator count to the expected vote range: Specifically, if the tabulator count lies in the expected range, the raw discrepancy is defined to be zero; if the tabulator count is k larger than the maximum of the range, the raw discrepancy is k; if the tabulator count is k below the minimum of the range, the raw discrepancy is $-k$. The *relative discrepancy* is defined to be the raw discrepancy divided by the total number of ballots cast in the precinct under audit. Finally, we define *discrepancy* to be the absolute value of this relative discrepancy.

If the total ballot count is different from the total number of ballots counted during the audit, and the raw discrepancy value falls somewhere between zero and the ballot count difference, then the source of the discrepancy is potentially attributable to the difference in the ballot count. For this reason, it is important that auditors reconcile the tabulator ballot count and the audit ballot count. As mentioned above, we treat discrepancy as a percentage of the total number of cast ballots. However, in some circumstances, the number of ballots reported by the hand-count audit disagrees with the number of ballots reported by the tabulator. To be conservative, we evaluate relative discrepancy as a percentage of the minimum of these two quantities. (Observe that this convention can only increase the reported discrepancy in comparison with use of either of the individual numbers.) We call this method **Known Ballots Cast**.

Anticipated Human Error. We anticipate that a small amount of error will be present in a hand count. This error presumably depends on a wide variety of factors, including the complexity of the race to be audited, the operational details of the hand counting procedure, and the physical details of the ballots themselves. The study of Goggin, Byrna, and Gilbert [GBG12] observed an empirical

error rate of 1.87% (with a standard error of .678%) for Optical Scan ballots; the study adopted simple two-candidate races and averaged over several counting methods. The study also measured human miscounting of the total ballot population, observing an empirical error rate of 0.95% (with a standard error of 0.328%).

With this as a guide, we treat discrepancies of approximately 1% (or less) of the audit ballot count as consistent with errors arising from human hand counting; in particular, such error rates are not a conclusive indicator of tabulator malfunction. Historically, the majority of our observed individual discrepancies are less than 1% of the total number of cast ballots, though discrepancies tend to be higher on complicated races where voters can specify multiple candidates.

Records of Interest. We treat discrepancies exceeding 1.5% as records of special interest, and include in the report any additional information we have that may put the errors in context.

1.4 Statistical conclusions concerning the entire election

Statistical inference of significant tabulator failures. The probability of observing zero significant failures among s (independent, uniform) samples from a population of M voting locations that in fact has fM significant failures (for a value $f \in [0, 1]$) is no more than

$$(1 - f)^s. \tag{1}$$

Thus, after observation of s voting locations without significant failures, the total fraction of voting locations with significant failures is less than f with confidence $1 - (1 - f)^s$.

2 Analysis Results

For the 44 voting locations, the VoTeR Center received reports for 39. Of the 654 submitted records, 530 (81.03%) of the tabulator counts were within the range of undisputed votes and undisputed votes + questionable votes found for that record at the audit. For the records where this was not the case, 118 records (18.04%) showed a discrepancy less than or equal to 1% and 3 (0.46%) records showed a discrepancy greater than 1%. Of these 3 records, none showed a discrepancy greater than 1.5%. We note that all of the audit reports received include both the total ballot count and the total number of ballots hand-counted at the audit. Therefore, we use the Known Ballots Cast method, outlined above, to evaluate all discrepancies in the submitted audit records.

Specific remarks. Discussions with registrars from towns with discrepancies that exceeded 1% indicated the following potentially relevant circumstances.

- One town had a record that exceeded a 1% discrepancy. However, this record belonged to a *cross-endorsed candidate*. In Connecticut, candidates can be endorsed by multiple parties. If this is the case, the candidate is a *cross-endorsed candidate*. A *cross-endorsed candidate* will have a separate audit record for each party. Additionally, such a candidate will have an extra audit record, referred to here as a *no-party record*. If a voter marks multiple voting areas belonging to the *cross-endorsed candidate*, the vote will be total for the *no-party record* will be incremented instead of any of the other audit records. In the case of this town, the high discrepancy was due to a mistallying of audit records belonging to the same *cross-endorsed candidate*. That is, certain ballots were counted towards the wrong audit record, even though they were counted towards the correct candidate. When all audit records for the *cross-endorsed candidate* are merged, the discrepancy decreases from 1.03% to 0.59%. The registrars included this explanation in their submitted audit report.

- Another town had two races with the same issue described above. When the tallies for the *cross-endorsed candidate* were combined, the discrepancies decreased from 1.32% to 0.21% and 1.11% to 0.95%.

Remarks on rate of questionable marks. Considering the role played by questionable marks in the definition of discrepancy, we note the rate of questionable marks in the election. We observe 785 questionable marks over a population of 75,111 ballots counted by hand and 219,129 total cast (non-questionable) marks. The total number of questionable marks as a fraction of the total number of votes cast in the election is 0.36%.

2.1 Statistical inference concerning the election

Statistical inference of significant tabulator failures The 39 sampled voting location reports for which data are available do not indicate significant tabulator error. The missing data from these samples poses a challenge to straightforward statistical analysis of the results. If these samples are simply treated as the results of 39 independent samples, the method described above concludes that the total fraction of voting locations with significant errors is less than 7.5% with 95% confidence. Treating the missing samples as the result of an independent removal process—for example, one that discards a sample independently with fixed probability $\approx 5/44$—does not weaken these conclusions. With the most pessimistic assumptions—entertaining the possibility that the missing data is intentionally suppressed to conceal errors—no meaningful conclusions can be made.

3 Conclusion

The University of Connecticut Center for Voting Technology Research (VoTeR Center) received data gathered in the post-election audit performed in the State of Connecticut following the November 5, 2024 presidential election. The audit involved the 5% of the voting location at which ballots were cast randomly selected for audits; the audit returns were conveyed by the Office of the Secretary of the State (SotS) to the VoTeR Center. The audit data analyzed by the Center contains 654 records, where each record represents information about a given candidate: date, district, office, candidate, tabulator counted total, hand counted total of the votes considered unquestionable by the auditors, hand counted total of the votes considered questionable by the auditors, and the hand counted total, that is, the sum of undisputed and questionable votes.

While one always wishes for no discrepancies, the magnitude of the numbers for voting location participating in the audit is consistent with anticipated human error.

References

[GBG12] Stephen N. Goggin, Michael D. Byrne and Juan E. Gilbert. Post-Election Auditing: Effects of Procedure and Ballot Type on Manual Counting Accuracy, Efficiency, and Auditor Satisfaction and Confidence. Election Law Journal: Rules, Politics, and Policy. 11(1): 36–51. March, 2012.