VoTeR Center

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Statistical Analysis of Post-Election Audit Data for the November 7, 2023 State Election

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Summary

This report presents an analysis of the returns from the post-election audit performed in the State of Connecticut following the November 7, 2023 municipal election. The audit involved a random selection of 5% of the precincts in which ballots were cast. In each precinct so selected, the ballots cast on election day were either hand-counted or counted with electronic assistance.[1]

A total of 47 precinct audits were submitted for analysis, comprising 679 audit records. The following precincts were exempted as a result of a town-wide recount:

- Bridgeport – Absentee Ballot Counting
- Bridgeport – District 132-2
- Bristol – Absentee Ballot Counting
- Fairfield – District 133-5
- North Canaan – District 1
- Waterbury— Absentee Ballot Counting

The specific goal of the analysis was to use statistical methods to detect instances of tabulator malfunction. The 679 precinct 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
Darien	
East Haven	4
East Haven	1 AB Central
East Haven	1s AB Central
East Haven	2 AB Central
East Haven	3 AB Central
East Haven	4 AB Central
East Haven	5s AB Central
East Haven	District 5 AB Central
Goshen	District 1
Greenwich	10 Glenville School
Guilford	
Killingly	5 BOE Building
New Britain	7 School Apartments
New Canaan	1 ABS Town Hall
New Canaan	8 Absentee Town Hall
New Canaan	9 ABS Town Hall
New Fairfield	Senior Center
Newtown	
Norwalk	A3 Kendall
Norwalk	B1 SONO
Norwich	#6 AHEPA
Pomfret	
Putnam	District 2 Municipal Complex
Southington	#4 Kennedy School
Stamford	Dolan
Stratford	Lordship School
Suffield	EDR Ballots Tab #1
Suffield	Middle School Absentee Ballots Tab #1
Suffield	Middle School Tab #1
Suffield	Middle School Tab #2
Thompson	Thompson Library
Torrington	Coe Park
Trumbull	0-5 - Frenchtown
Wallingford	1 Pond Hill
Wallingford	4 Dag Hammarskjöld
Wallingford	8 Senior Center
Wallingford	9 Park Rec
Wallingford	Absentee Ballots Town Hall
Washington	Bryan Memorial Town Hall
Waterbury	Kennedy HS 1-1
Waterbury	Carrington School 3-5
Waterbury	District 4
West Hartford	
Windsor	4 Town Hall
Wolcott	Town Hall

Table 1: Audit precincts 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**.

In the unusual situation that the total number of tabulated or hand-counted ballots was not recorded on the audit report we instead adopt the total number of votes cast in the largest single-choice race in the district under consideration. This may lead to an underestimate of the total number of cast ballots, and hence can only increase the reported discrepancy as it is treated as a percentage of cast ballots. When this method has been used for either (or both) the total number of tabulated

or hand-counted ballots, we say that discrepancies are determined by **Inferred Ballots Cast**. Note that this alternate convention is only relevant for records with nonzero discrepancy.

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.

2 Analysis Results

Of the 679 submitted records, 398 (58.62%) of the audit records exactly confirmed the tabulator count and an additional 142 (20.91%) records represented counts within the expected range for a total of 540 (79.53%) records with 0 discrepancy. The remaining 139 audit records reported a tabulator count that differed from the audit count. Of these 139 records that differed, 109 showed a discrepancy less than or equal to 1% and 30 showed a discrepancy greater than 1%. With respect to the 30 records showing a discrepancy of greater than 1%, 26 records showed a discrepancy of greater than 1.5%. We note that all of these relatively high discrepancy reports came from 2 towns, and discuss this in detail below. In fact, 25 of these records concern the same set of ballots tabulated on the same tabulator. 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. First, we remark that one audit of same day registration ballots consisted of only eight ballots. A count discrepancy of just one vote accounts for one of the discrepancies of $> 1.5\%$.
Discussions with registrars from towns with discrepancies that exceeded 1% indicated the following potentially relevant circumstances.

- One town had three audit records with discrepancy rates of 1.35%, 1.45%, and 1.04%. We remark that the 14 ballots originally counted by the tabulator but not present at the audit could plausibly account for as much as 1% of these discrepancies.
- One town encountered some procedural deviations in which ballots which were hand counted on election day due to tabulator issues were later mixed with ballots which were tabulated by machine. These audits of absentee ballots represent the remainder (25) of the records with discrepancies $> 1.5\%$ and an additional record with a discrepancy of 1.05%.

Table 2 shows the audit record categories as well as the number of audit records that fall into that category.

Category	Record count
Records within expected range	540
Records outside expected range but with $\leq 1\%$ discrepancy:	109
Records with discrepancy between 1% and 1.5% associated with procedural deviation	1
Records with discrepancy between 1% and 1.5% associated with ballots missing from audit	3
Records with discrepancy greater than 1.5% associated with low ballot count	1
Records with discrepancy greater than 1.5% associated with procedural deviation	25
Total	679

Table 2: Categorization of audit records

Max Discrepancy Rate	Ballots on Election Night	Ballots at Audit	# Records
5.85%	667	731	25
12.5%	8	8	1

Table 3: Districts with audit record(s) with discrepancy rate >= 1.5%

Further discussion of discrepancies. Of the 139 records showing a discrepancy between the audit count and the tabulator count, 109 are within 1% of the audit ballot count; the remaining records with discrepancies greater than 1% were either from an audit of an extremely low number of ballots or an audit affected by procedural factors or missing ballots. Considering these explanatory factors, we conclude that the results are within within the range of anticipated human error.

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 969 questionable marks over a population of $36,250$ ballots counted by hand and $240,982$ 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 0.4%.

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 7, 2023 municipal election. The audit involved the 5% of the precincts 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 679 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 precincts 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.