2002 and 2004 US House Election Contests[1] Post-Election Audit Comparison:
Holt's (3, 5, 10%) Audits vs. 99% Confidence Audits
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Holt's 3, 5, 10% post-election audits treat voters and candidates unequally by providing widely varying chances of detecting inaccurate election outcomes, ranging from as low as at least a 10% chance all the way to a virtually 100% chance in different U.S. House districts.

US House Contests - Comparison of Holt's Election Audits vs. 99% Confidence Audits	2002 Election		2004 Election	
	Holt 3, 5, 10% Audits	99% Confidence Audit w/ 1% minimum	Holt 3, 5, 10% Audits	99% Confidence Audit w/ 1% minimum
min chance to detect outcome-changing miscount	10.0%	99.1%	40.7%	99.1%
average chance to detect outcome-changing miscount	97.7%	99.9%	99.2%	99.9%
est'd total #precincts audited	7,559	5,610	7,683	4,833
#contests with under 50% chance to detect outcome-changing miscount	6	-	1	-
% precincts audited nationwide	3.1%	2.3%	3.1%	2.0%
#contests Over-audited	308	-	322	-
#contests Under-audited	50	-	44	-

On the other hand, 99% confidence audits use a sample size calculated to always provide at least a 99% chance for detecting the smallest amount of miscount that could change the election outcome if such occurs, thus treating all candidates and voters equally.

Holt's 3, 5, 10% election audit amounts often audit a larger number of precincts than is necessary to provide at least a 99% chance of detecting outcome-changing miscount.
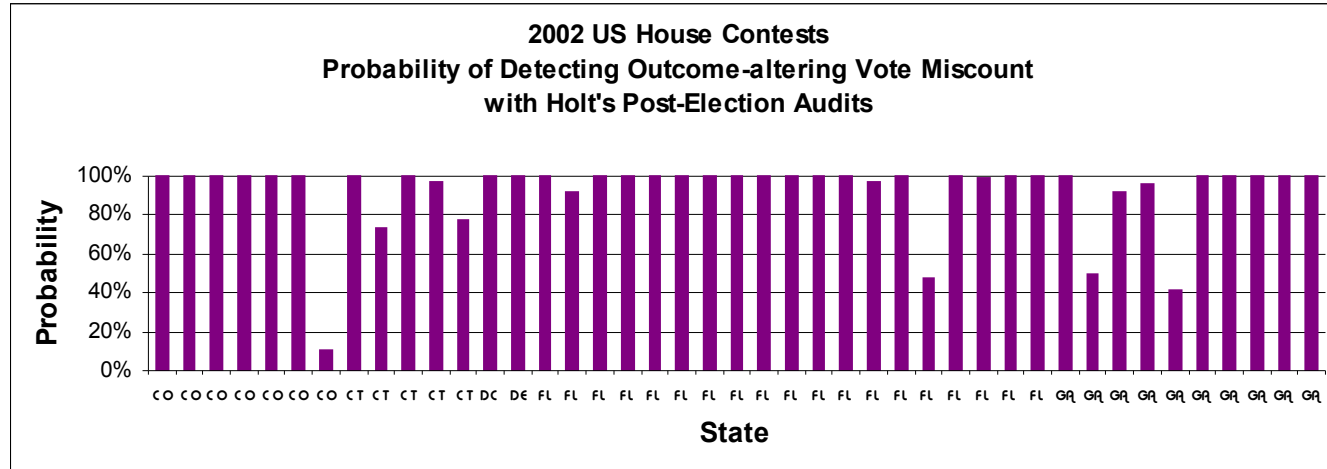
Yet, as shown in the table at left, Holt's audit amounts are sometimes insufficient, obtaining less than a 50% chance to detect incorrect election outcomes. Holt's audits use insufficient sample sizes to assure at least 99% chance for detecting outcome-changing vote miscount in approximately 50 U.S. House contests in the 2002 election and in about 44 U.S. House contests in the 2004 election.

Notice in the table at left, that, according to this estimate, fewer precincts overall could be audited nationwide to achieve a greater confidence in election outcomes than under Holt's post-election audit proposal.
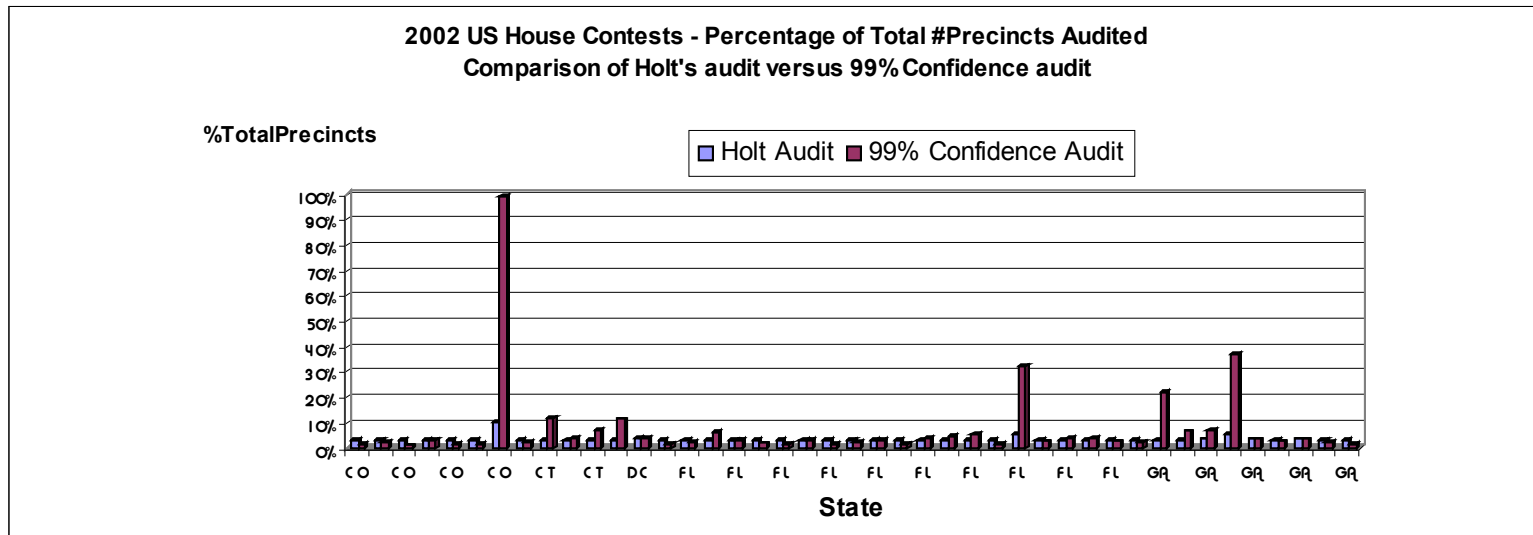
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[1] Data source is Election Data Services. Estimates for the 99% confidence audit sample sizes use Ron Rivest's first formula that estimates the audit amounts found exactly by the Dopp/Stenger method, along with Dopp's latest method for estimating the total number of minimum corrupt precincts necessary to alter election contest outcomes. The Aslam/Popa/Rivest formula cannot be used without the detailed precinct-level data for calculating precise within-precinct margin error bounds. With more work, additional tweaking could be done to increase the accuracy of these estimates. I assume that at most 40% of possible margin error occurs within any one count.

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2002 Election - US House Contests

Notice that in some U.S. House contests in Colorado, Connecticut, Florida, and Georgia, Holt's audit amount provides far less than a 95% confidence of detecting outcome-altering vote miscount in cases of vote fraud. One Colorado U.S. House contest has only 10% confidence using Holt's audit size, the Bob Beauprez versus Mike Feeley contest.

**2002 US House Contests
Probability of Detecting Outcome-altering Vote Miscount
with Holt's Post-Election Audits**
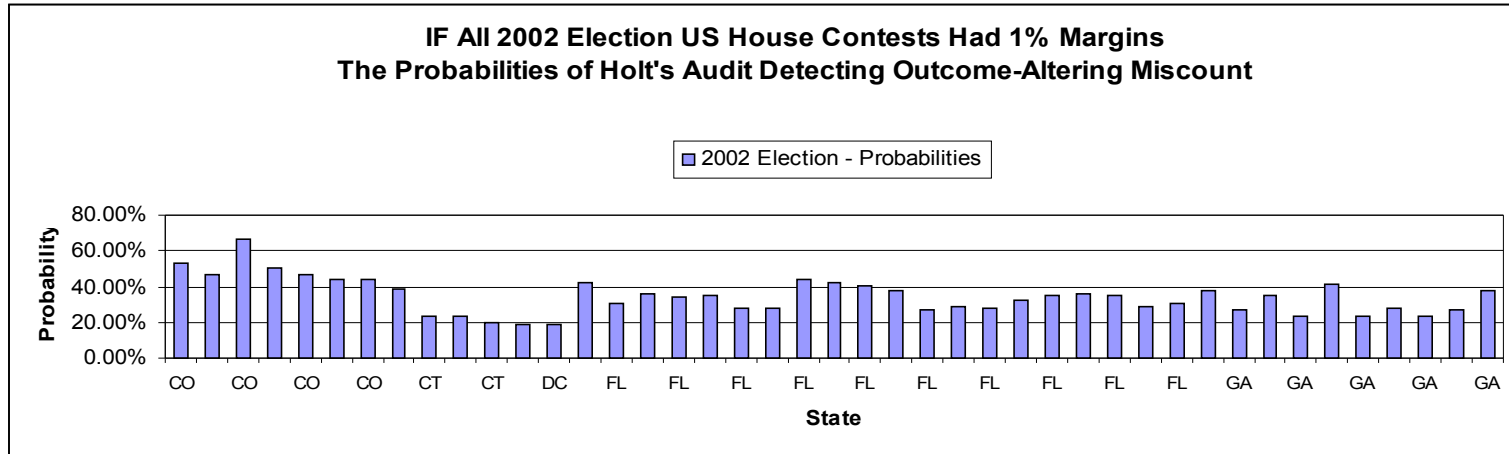
Notice that in the chart below, a 99% confidence audit automatically adjusts the sample size to initially manually count up to 100% of the reported vote counts (in one Colorado contest) whenever necessary to ensure that election outcomes are accurate.

**2002 US House Contests - Percentage of Total #Precincts Audited
Comparison of Holt's audit versus 99% Confidence audit**

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2004 Election - US House Contests

Notice that the in some U.S. House contests in Colorado, Connecticut, Florida, and Georgia, Holt's audit amount is insufficient because it gives far less than a 95% chance of detecting outcome-altering vote miscount in cases of vote fraud .

Notice that in the chart below, a 99% confidence audit automatically adjusts the sample size to initially manually count up to about 27% of precincts in one Connecticut contest, whatever is necessary to ensure that any incorrect election outcomes are accurate.
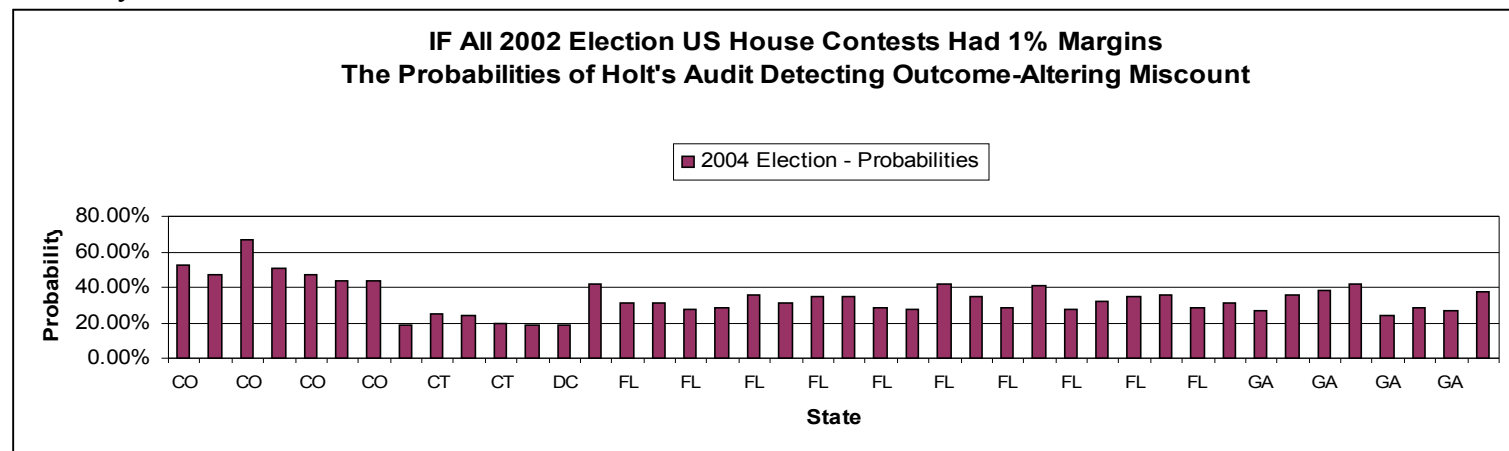

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Holt's Audits Treat US House Candidates Unequally Even If All Winning Margins Are Equal

Even if the margins for candidates were the same in all US House contests, the Holt audit would treat candidates and voters of different districts unequally. The two charts below show that even if all U.S. House contests were won with the same 1% margin between the winner and the runner-up, Holt's 5% fixed rate audit would provide widely diverse chance of detecting outcome-changing levels of vote miscount from about 19% to 67%. Nationwide, the differences would be even greater, ranging from about 19% to virtually 100%. The same result – unequal treatment of candidates and voters in different districts by Holt's audits, even with the same exact margins, holds true no matter what the margin is.

Notice by comparing the charts for 2002 and 2004 House elections, that within any state, the Holt's audit chances remain somewhat constant from year to year for contests with the same margins because the total number of precincts in a contest is roughly the same. Chart title below has error – should say "*2004* Election".

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Holt's Audits Allocate Resources to House Districts Unequally

Assuming that the amount of resources allocated for audits is roughly proportional to the number of precincts manually audited per US House contest, if all election contests had the same winning margins, then Holt's audit allocates resources unequally to U.S. House Districts. On the other hand, 99% confidence audits allocate resources more equally to all U.S. House districts whenever contests have the same margins.

Nationwide *if* all margins between candidates were approximately 11.5% the Holt audit and the 99% confidence audit would audit roughly an equal number of precincts in total nationwide (about 7,435 precincts for the Holt audit and 7,313 for the 99% confidence audit). However, using a 99% confidence audit, each U.S. House contest would be provided funds to audit roughly 17 or 18 randomly selected precincts, but under a Holt audit each House district would receive unequal funding to audit from as few as 4 precincts in Connecticut, up to roughly 112 precincts in New York State. This inequality could be overcome by requiring the number of ballots cast per precinct to be uniform nationwide, but that would not solve the problem of inequitable chances for the Holt audit to detect outcome-changing vote miscount.

So we see that Holt's audit not only treats voters and candidates unequally by providing widely varying chances to detect levels of vote miscount that could alter election outcomes, Holt's audit also treats states unequally by providing widely unequal funding for checking the accuracy of election outcomes in different US House districts. The same inequalities hold true for US Senate contests.

99% confidence audits, on the other hand, provide virtual equality to voters, candidates, and states as far as funding for each districts' audits when margins are equal and with respect to providing equal assurances that election outcomes are accurately decided by voters.

CAVEAT: Since 99% confidence audits in general require auditing fewer precincts than Holt's audit in wide-margin contests and more precincts in closer contests, states that have closer election contests than other states, would receive more resources in 99% confidence audits.

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Conclusion

The U.S. Congress could require more effective and more efficient post-election audits in federal election contests than the fixed rate or tiered fixed rate audits that Congress is considering now. Calculating post-election audit sample sizes by using the method of 99% confidence audits treats voters, candidates, and congressional districts more equally, achieves an overall higher confidence in the accuracy of election outcomes, and also may conserve federal funding as compared to the method proposed by Representative Rush Holt's (3, 5, 10% Audits).

Comparison **Holt vs. Confidence Audits**	**Holt's 3, 5, 10% Post-Election Audits**	**99% Confidence Post-Election Audits**
Assurance to Voters and Candidates	Unequal treatment of Voters and Candidates, providing anywhere from a 1 in 10 chance to a 100% chance to detect outcome-changing vote miscount in different US House districts.	Equal treatment of voters and candidates, providing at least a 99 in 100 chance of detecting the smallest amount of outcome-changing vote miscount.
Costs to States for Each US House District	Unequal costs for each US House district, even when margins are equal in different districts.	More equal cost for each U.S. House district for election contests with equal margins.[2]
Administrative Planning Considerations	Simple to calculate from the unofficial reported election contest margin%	Can be estimated fairly accurately by taking the maximum of 1% of the total #precincts p and the quantity $p\left(1-0.01^{\frac{0.4(b+w-r)}{p(w-r)}}\right)$ and at most all p precincts.[3]

Caveats: This comparison is general, giving a broad view. Assuming that random selections of precincts are made from the entire population of precincts in any U.S. House contest, because the data I used for these estimates does not include the county-level data for each U.S. House district, the estimates for the total number of precincts audited does not account for the requirement that at least one precinct or auditable vote count shall be audited from each separate election jurisdiction in which a U.S. House contest occurs.   Consequently the total number of precincts that need to be audited nationwide for both proposals may be under-estimated, with the number of precincts audited for a 99% confidence audit relatively more under-estimated than the number for Holt's audit. Therefore the total number of precincts audited for the

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[2] There will still be some differences in costs in different districts with the same margins due to the variation in the margin error bounds in each reported precinct or other auditable vote miscount, and other factors. However resource allocation and cost differences for contests with the same reported margins will be less with 99% confidence audits than with Holt's current 3, 5, 10% audit sample size proposal. States that experience a greater number of close margin contests will receive more funding and resources for audits under both plans, but perhaps comparatively more under the 99% confidence audits.

[3] This can be entered in a spreadsheet by using the formula =CEILING(MAX(MIN(p-p*(0.01)^((0.4/p)*(1+b/(w-r))),p),0.01*p),1) or similar formula. This assumes a 1% minimum audit rate. Note that using this formula would be an improvement over 3, 5, 10% audits. Using 0.4 assumes that up to 40% of possible margin error could occur (this more conservatively could be 0.50), 0.01 assumes 99% desired confidence (0.05 would be 95% confidence), b is the #ballots cast, w is the #votes for the winner, r is the #votes for the runnerup, and p is the total number of precincts or other auditable vote counts. Alternatively, a simple-to-use open-source program could be made available to election officials and auditors to calculate exact 99% confidence audit amounts by simply inputting initial auditable reported vote counts.

Holt audit and the 99% confidence audit with a 1% minimum may be somewhat closer to equal overall than is shown here. However, even if the total number of precincts audited nationwide under both audit plans were equal, it would not change the unequal treatment of voters, candidates, and congressional districts under Holt's audit proposal compared with the more equitable 99% confidence audit.

Definitions:

"*Election outcomes*" – the winners or losers of an election contest or ballot contest

"*Outcome-changing vote miscount*" – Sufficient vote miscount to change the election outcome.

"*99% Confidence Post-Election Audits*" – Post-election manual audits of secured voter-verified paper ballots that use a sample size that is calculated to always provide at most a 1% chance that any incorrect election outcomes escape detection. The calculations are based upon the upper limit for possible margin error within each precinct or other auditable vote count.

"*Holt's 3, 5, 10% Post-Election Audits*" – A fixed rate tiered audit where the sample size is 3% of the total number of precincts in the election contest if the margin between the winner and runnerup is 2% or greater, the sample size is 5% of the total number of precincts if the margin is between 1% and 2 %, and the sample size is 10% of the total number of precincts if the margin is less than 1%.

"*Margin*" – The difference in reported votes between the winning candidate and the runner-up. If stated as a percentage, the margin is the difference in reported votes between the winning candidate and the runner-up divided by the total number of ballots cast in the election contest.

Partial Reference List

Comparison of Proposed Federal Election Audits
http://electionmathematics.org//ucvAnalysis/US/paper-audits/ComparisonFederalElectionAuditProposals.pdf

Federal Election Audit Costs
http://electionmathematics.org//ucvAnalysis/US/paper-audits/FederalAuditCosts.pdf

Post-Election Vote Count Audits -- Probability Proportional to Margin Error Bound (PPMEB) Method - How to determine initial audit sample size, make random selections, and perform discrepancy analysis to achieve any desired confidence (say 95% or greater) that any incorrect unofficial election outcome would be corrected before certification.
http://electionmathematics.org//ucvAnalysis/US/paper-audits/VoteCountAudits-PPMEB.pdf

History of Confidence Election Auditing Development (1975 to 2008) & Overview of Election Auditing Fundamentals
http://electionmathematics.org//ucvAnalysis/US/paper-audits/History-of-Election-Auditing-Development.pdf

Fool Me Once: Checking Vote Count Integrity
http://electionmathematics.org//ucvAnalysis/US/paper-audits/TierElectionAuditEval.pdf

How Big Should an Election Audit Be? Fixed Rate Audits Do Not Work For Elections
http://electionmathematics.org//ucvAnalysis/US/paper-audits/ElectionAuditEstimator.pdf

The method used to estimate election audit sample sizes and probabilities in this paper employs the latest most accurate formulas for margin error bounds.

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