More Clarification and Exploration

Thursday, August 15, 2019

Trade-off

(old news)

- Audits using Wald's sequential probability ratio test (such as the Bayesian RLA and the BRAVO audit) offer *flexibility* in choosing when to make decisions, since they permit the auditor to make a decision after each ballot.

- If audits are conducted ballot-by-ballot until the risk limit was satisfied, Wald-based audits are most efficient.

- Making decisions more frequently, unsurprisingly, helps the efficiency of the audit (if efficiency is defined by number of ballots examined).

- But we see that auditors often do not make a decision at each ballot, and so the assumption of ballot-by-ballot drawing may be overly conservative (and so results in "wasted risk").

Trade-off

(old news)

- If we do not permit auditors to make a ballot-by-ballot decision and instead box them into a fixed, prespecified round schedule, we may actually "use up" all of the risk limit. (This is the motivation for the convolution approach.)

- So Wald-based audits offer flexibility and are most efficient (*if* audits are conducted ballot-by-ballot), and the convolution approach appears to offer greater efficiency (*if* the audit would have been conducted in rounds anyway).

3 “Areas” of Wasted Risk

- If a round-by-round audit is conducted using a Wald-based approach, there are 3 areas of “wasted” risk. (For a round schedule of [200, 400, …, 3200] we show the areas of wasted risk.)

- Before the first decision is made [~15, 16, 17, …, 199]

- In between successive decisions [201, 202, …, 399, 401, …]

- After the last decision is made [3201, 3202, …, ~100000]

So Far…

- So far we've been focusing on all three areas in producing round schedules for the convolution approach.

- But what if the auditor wants to retain some of the flexibility of the Wald-based approaches?

- Focus only on the first and third areas!

Why focus on first and third areas?

- For example, it is common to have a fairly large initial sample size (e.g., the average number of ballots examined). If the average number of ballots examined is 608, all values up to and including 607 are in the first area of wasted risk.

- On the other end, we know auditors will stop auditing at a certain point (say, 5% of ballots) and just proceed to a full hand count because it’s less time consuming.

- By focusing only on the first and third areas, and not on the wasted risk of the second area: we can give flexibility to auditors where it matters most: in-between the rounds.

A Flexible Round Schedule

- What would the performance of a round schedule such as [200, 201, 202, …, 3199, 3200] look like in the convolution approach?

Results

- If N = 100,000, and the auditor will draw an initial sample of 200 and proceed to a FHC after 3200 (another way of saying the round schedule is 200, 201, …, 3199, 3200), for a risk limit of 5% and a true margin of 10% we have:
    - BRAVO-like (traditional RLA, β = 0) audit w/o replacement examines on average **849** ballots, if it is made round-by-round.
    - Convolution approach (uniform risk schedule) examines on average **752** ballots.
- Again we emphasize that if the auditors have a really small initial sample size, and they do not care to proceed to a full hand count when things look grim (i.e., they don't waste any risk in the first and third areas), Wald-based audits are most efficient. BRAVO (traditional RLA) audit w/ replacement examines on average **608** ballots if it is really made ballot-by-ballot.

Takeaway

- If auditors start with a decently-sized initial sample (and so would waste first area risk), and are going to go a FHC after a certain point anyway (and so would waste third area risk), just reallocating *that* wasted risk leads to a substantive efficiency improvement.

- Some efficiency improvement over BRAVO while improving flexibility of convolution approach!