More Fully Capturing Uncertainty Associated with Official Statistics

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The findings and conclusions in this presentation are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.
FCSM Framework for Data Quality

Data Quality

Utility
- Relevance
- Accessibility
- Timeliness
- Punctuality
- Granularity

Objectivity
- Accuracy and reliability
- Coherence

Integrity
- Scientific integrity
- Credibility
- Computer and physical security
- Confidentiality
NCVS Rape, Robbery, Aggravated Assault

Millions of Victimization


Estimate
95% Conf. Int.

Courtesy of Sharon Lohr
Is It Really a Break in Series?

• Breaks in series may be reported when simple changes are made
  – Change in question ordering
  – Change in design
  – Change in level of interviewer training

• Are these breaks or a failure to fully reflect the uncertainty in the estimates?
Census of Agriculture

• Conducted every 5 years (ending 2 & 7)
• Count of all U.S. agricultural operations ($1,000 or more in sales or potential sales)
• Uses a list frame, the Census Mailing List
  – Census Mailing List is not complete
• An expanded June Area Survey sample drawn from the NASS area frame to assess undercoverage
  – 2009 study found substantial misclassification in the June Area Survey
Adjusting the Census Weights

• Sampling for nonresponse follow-up (new in 2017)
• Undercoverage modeled in a capture-recapture framework
• Nonresponse modeled
• Misclassification modeled
  – Misclassification of farms as non-farms
  – Misclassification of non-farms as farms
• Calibration of adjusted weights
• Rounded the calibrated weights to integers
2012 Standard Errors

- Capture-Recapture weight for record $i$: $\widehat{CR}_i$
- Group jackknife (10 groups)
- Refit the models selected from the full dataset to obtain the weight of record $i$ in jackknife group $j$: $\widehat{CR}_i^{(j)}$
  - Undercoverage
  - Nonresponse
  - Misclassification (both types)
- Obtained the jackknife estimate of standard error of the capture-recapture weights
- Calibrated and rounded to obtain the final adjusted weight for record $i$: $\widehat{w}_i$
- Calibrated and rounded the weights of each record $i$ in jackknife group $j$: $\widehat{w}_i^{(j)}$
- Obtained the jackknife estimate of standard error of the calibrated, rounded weights
- Used the larger of the two jackknife estimates as the standard error.
- Estimate population total $T$
  - Estimate using the integer, calibrated weights $\widehat{w}_i$
  - Reported the larger of the jackknife estimate of standard errors of the fitted weights and the jackknife estimate of standard errors of the calibrated weights
- Did not account for uncertainty due to model selection
- Accounted for uncertainty associated with model estimates

2017 Goal: Properly Account for the Variation Due to Calibration and Rounding
2017 Standard Errors

• Capture-recapture weight for record \( i \): \( \widehat{CR}_i \)
• Integer, calibrated capture-recapture weight for record \( i \): \( \widehat{w}_i \)
• Calibration-adjusted bootstrap weight of record \( i \) can be approximated by: \( \widehat{w}^*_i = a_i \widehat{w}_i \) where \( a_i \sim N \left( 1, \frac{\widehat{w}_i - 1}{\widehat{w}_i} \right) \)
• Using 10 jackknife groups, refit models selected from the full dataset
  – Obtain weight for record \( i \) in jackknife group \( j \): \( \widehat{CR}^{(j)}_i \)
  – Determine the integer, calibrated weight for record \( i \) in jackknife group \( j \): \( \widehat{w}^{(j)}_i \)
• Approximate bootstrapped-adjusted weight of record \( i \) in jackknife group \( j \): \( \widehat{w}^{(j)*}_i = a^{(j)}_i \widehat{w}^{(j)}_i \) where \( a^{(j)}_i \sim N \left( 1, \frac{\widehat{w}^{(j)}_i - 1}{\widehat{w}^{(j)}_i} \right) \)
• Estimate the standard error of the integer, calibrated capture-recapture weights by jackknifing the approximate bootstrap-adjusted weights
• Estimate population total \( T \)
  – Estimate using the integer, calibrated weights \( \widehat{w}_i \)
  – Estimate of standard error using bootstrap-adjusted jackknife weights
Relative Standard Errors: 2012 Number of Farms
Relative Standard Errors: 2012 Total Value of Production
Impact of Rounding and Calibration on CVs:
2012 Number of Farms
Impact of Rounding Calibration on CVs: 2012 Total Value of Production

CV of Modeled Estimates
CV after Calibration
Final Thoughts

• Accounted for variation due to sampling and modeled adjustments to the weights
  – Sampling error (2017 only)
  – Undercoverage
  – Nonresponse
  – Misclassification

• Accounted for variation due to rounding and calibration
  – Approximate, conservative approach in 2012
  – Fully in 2017
Final Thoughts

• Did not account for other sources of variation
  – Record linkage of Census Mailing List to NASS area frame
  – Editing
  – Imputation
  – Model selection

• Opportunity to develop more accurate standard errors
Thank You!

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