Addressing Nonresponse Error within the Total Survey Error (TSE) Framework: Statistics Canada's "Sustainable collection: Optimising Population-based Surveying"

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Background

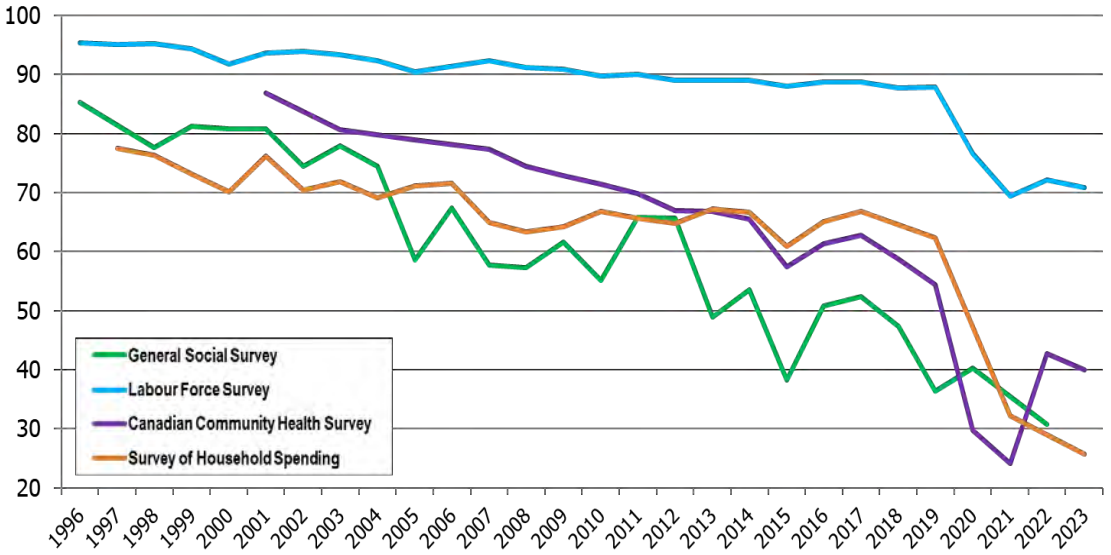
Context:

- Significant decline in survey response rates across the globe despite advances and much research.
- Factors mentioned in the United Nations 2021 Positioning Household Surveys for the Next Decade:
  - Overburdened statistical systems.
  - Respondent fatigue.
- Nonresponse bias as a critical risk to data reliability.

Need:

- Ensuring accurate, reliable data amidst declining response rates.

Response Rate trend for key StatCan Social Surveys



Sustainable collection: Optimising Population-based Surveying

Primary Goal:

Reduce Total Survey Error (TSE) with a focus on nonresponse error.

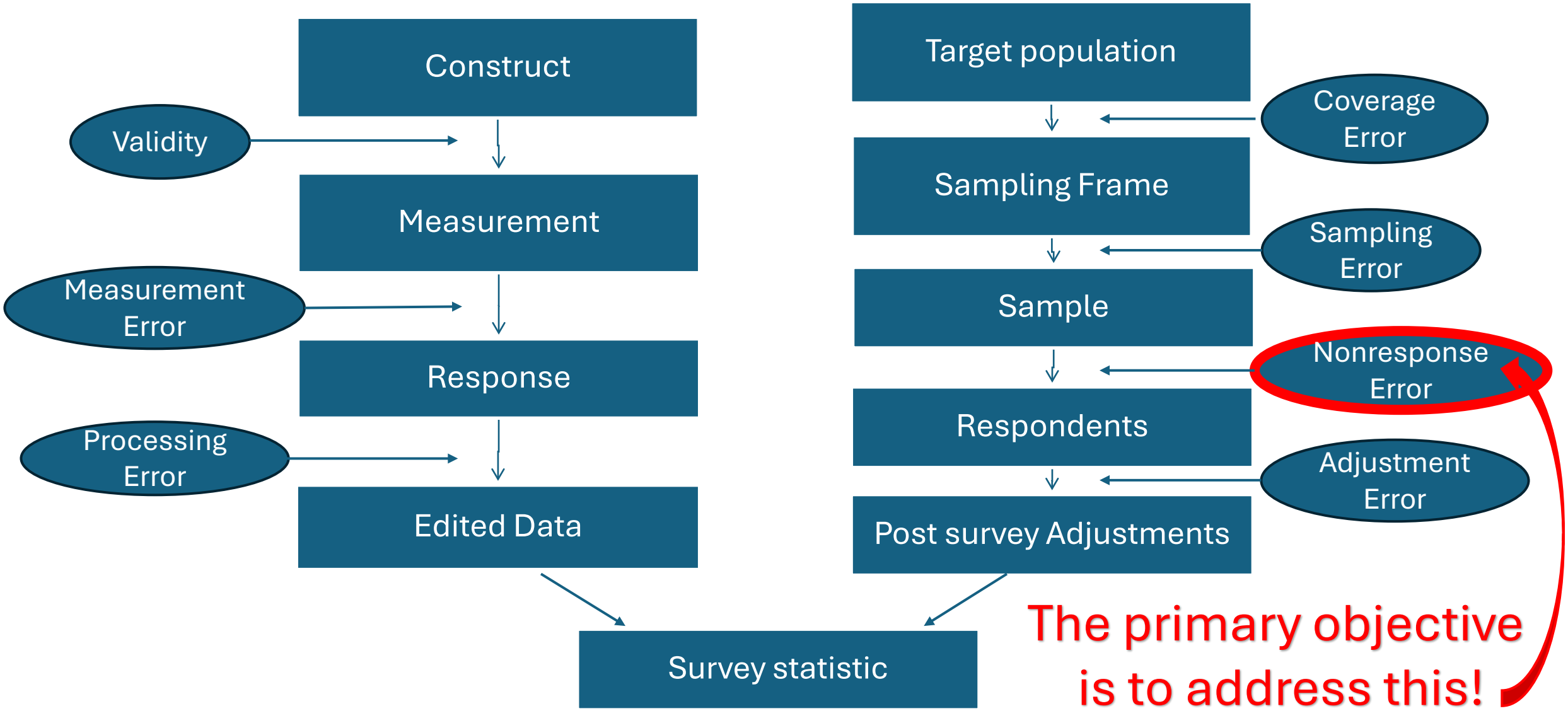
Strategic Aims:

Develop **sustainable frameworks** for **measuring** and **addressing nonresponse bias.**

Innovate **within fiscal limitations** to maintain data quality.

Ensure the **reliability of Official Statistics**.

Total Survey Error



Methodological Options Considered

Goal:
To measure or treat potential nonresponse error.

1. Follow-Up Surveys of Nonrespondents

- Subsample nonrespondents for secondary survey
  - Conditions for survey may be altered (collection period, questionnaire, modes- adding CAPI)
- **Results are informative** (can measure nonresponse bias but likely no corrections made)

2. Additional Treatment Phase for Nonrespondents **in** Collection

- Intensive collection efforts applied to a subsample of nonrespondents in collection (more CATI/ CAPI)
  - Additional responses from subsample are weighted to represent untreated units
- **Results incorporated directly in survey data** (can measure and treat nonresponse bias)

3. Reference Sample for Survey Calibration

- Calibrating to independent high response rate survey total estimates to treat nonresponse bias
  - Independent survey produces estimates highly correlated to response and variables of interest (age, gender, education, …)
- **Results can treat nonresponse bias** (relies on assumptions)

Regardless of the option, dwelling-based sampling is to be replaced with person-level sampling for surveys where the unit of interest is individuals to be more statistically efficient (i.e., reduces sampling error) then to reallocate cost savings.

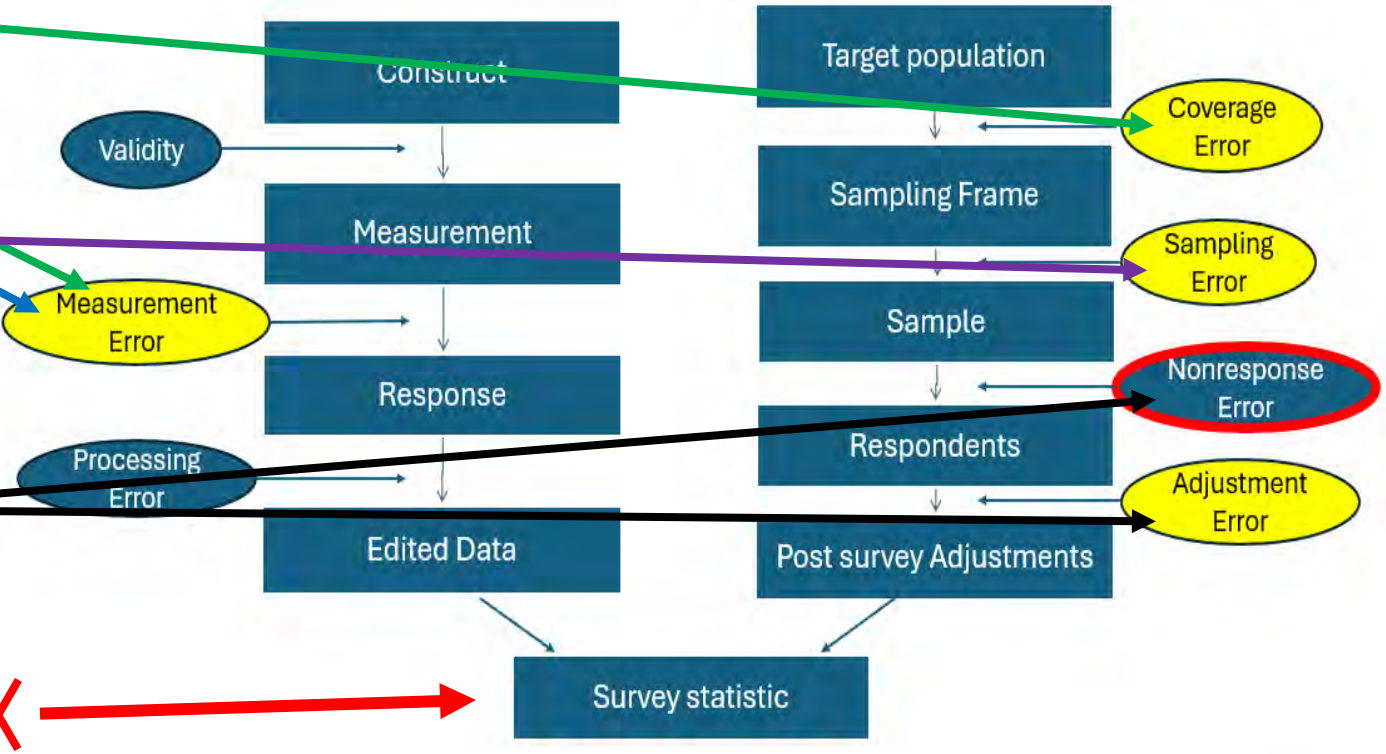
Total Survey Error Implications

Option 1 - Nonrespondent Follow-up (NRFU) Survey

Assumptions:

- **Respondents from the NRFU survey can represent all nonrespondents from original survey**
- **Results will NOT be used to correct nonresponse error in the original survey**
- **Goal : Understand nonresponse behavior, measure nonresponse bias, support future survey planning**

- **Different collection period**
- **Could use a different questionnaire**
- **For cost reasons, uses a subsample of all nonrespondents (but also requires a large enough sample to be informative)**
- **NRFU survey subject still prone to nonresponse error (may require a high response rate to mitigate)**
- **Largest limitation is that the results cannot be used to correct nonresponse error in the original survey**



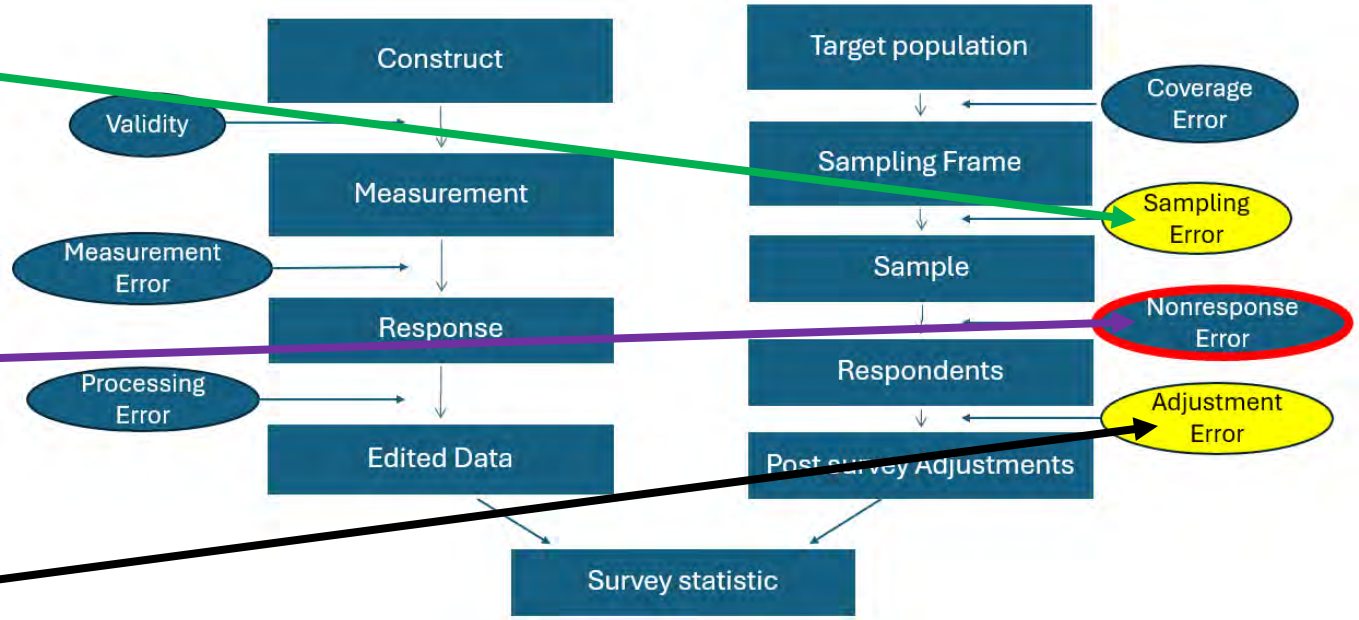
Total Survey Error Implications

Option 2 - Additional Treatment Phase for Nonrespondents in Collection

Assumptions:

- **Nonrespondents can be sampled mid-collection for additional efforts (including CAPI) to improve response rates.**
- **Respondents from the treatment group through estimation can represent both the untreated nonrespondents and treated nonrespondents.**
- **Goal : Address nonresponse bias through an additional phase in design, collection and estimation.**

- **An additional sample, within the sample is drawn (sample size needs to balance costs and quality constraints)**
- **Complex model for collection**
- **Assumes respondents in the treatment plan through estimation will represent outstanding nonrespondents**
- **Adds complexities to estimation methods**



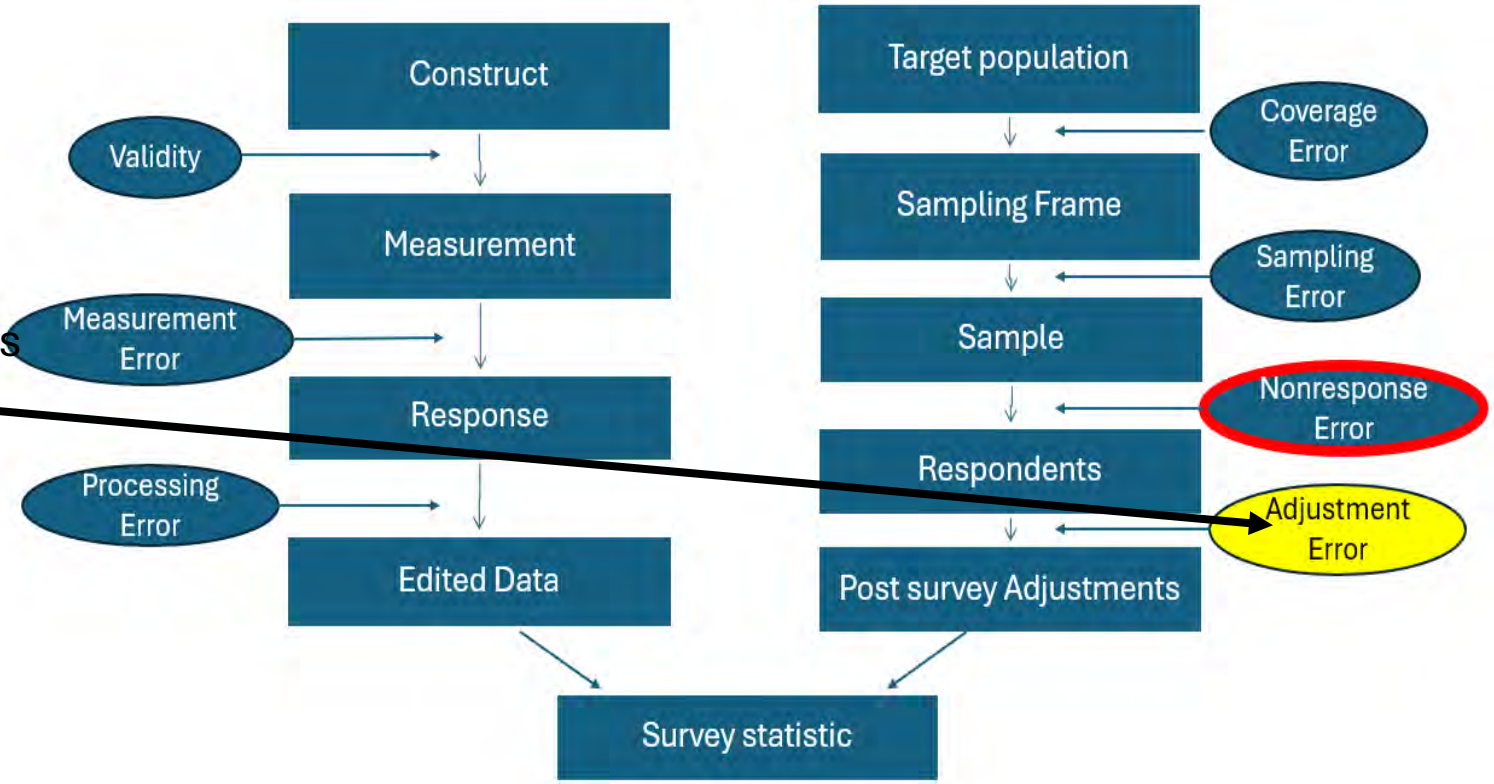
Total Survey Error Implications

Option 3 - Reference Sample for Survey Calibration

Assumptions:

- **Accurate estimates of population totals for characteristics correlated to nonresponse and survey content can be produced.**
- **Calibrating to these estimates will reduce nonresponse bias in survey variables for social surveys**
- **Goal: Use advanced post-collection weighting steps to reduce nonresponse bias**

- Population estimates for additional characteristics such as highest education achieved, ethnicity, language or occupational group are incorporated at estimation (assumes these characteristics are correlated to propensity to respond and key survey variables)



Current Progress

1. Follow-Up Surveys of Nonrespondents

- Tested small "proof of concept" pilot using the General Social Survey's Time-Use (TUS) cycle
  - TUS response rate was 30%
  - Sampled 400 nonrespondents
  - Achieved a 70% Response rate with CAWI/CATI/CAPI and shortened questionnaire
    - Nonrespondent demographics differed
    - Sample too small to find significant differences in key survey estimates

2. Additional Treatment Phase for Nonrespondents **in** Collection

- Researched estimation methods (Concurrent Multi-Mode Estimator) to minimise MSE for subsampled collection treatment group
- Piloting person-level sampling (sample size reductions will fund additional CAPI)
- Planning project to determine required sample size
- Exploring responsive design research

3. Reference Sample for Survey Calibration

- Amalgamated research findings related to nonresponse correlates across a variety of social surveys
- Planning research study to simulate results using past survey and Census data

For all options: Exploring the costs and infrastructure implications as well as the impacts on stakeholders

Questions for the Workshop Attendees

…as we pursue these options with the goal to make uniform recommendations…

DO YOU KNOW OF RELEVANT RELATED RESEARCH OR EXPERIMENTATION?

ARE THERE ELEMENTS RELATED TO TSE THAT WE HAVE MISSED?

ARE YOU INTERESTED IN FUTURE RELATED KNOWLEDGE SHARING OR COLLABORATION?

References

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Merci / Thank you!

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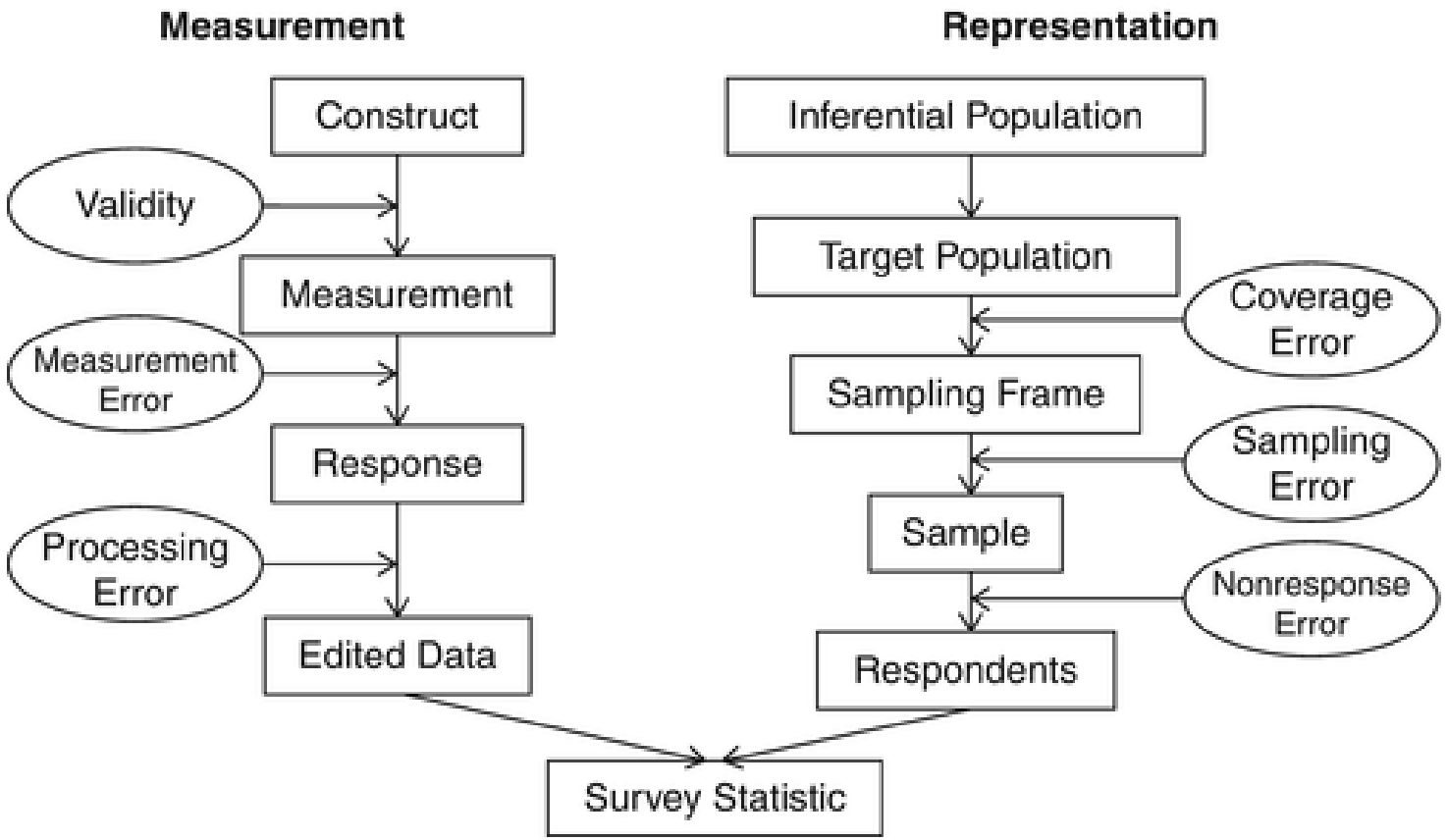
Total Survey Error

Groves, Fowler, Couper, Singer, and Tourangeau (2004)



Total survey error components linked to steps in the measurement and representational inference process

Variables used in nonresponse adjustments

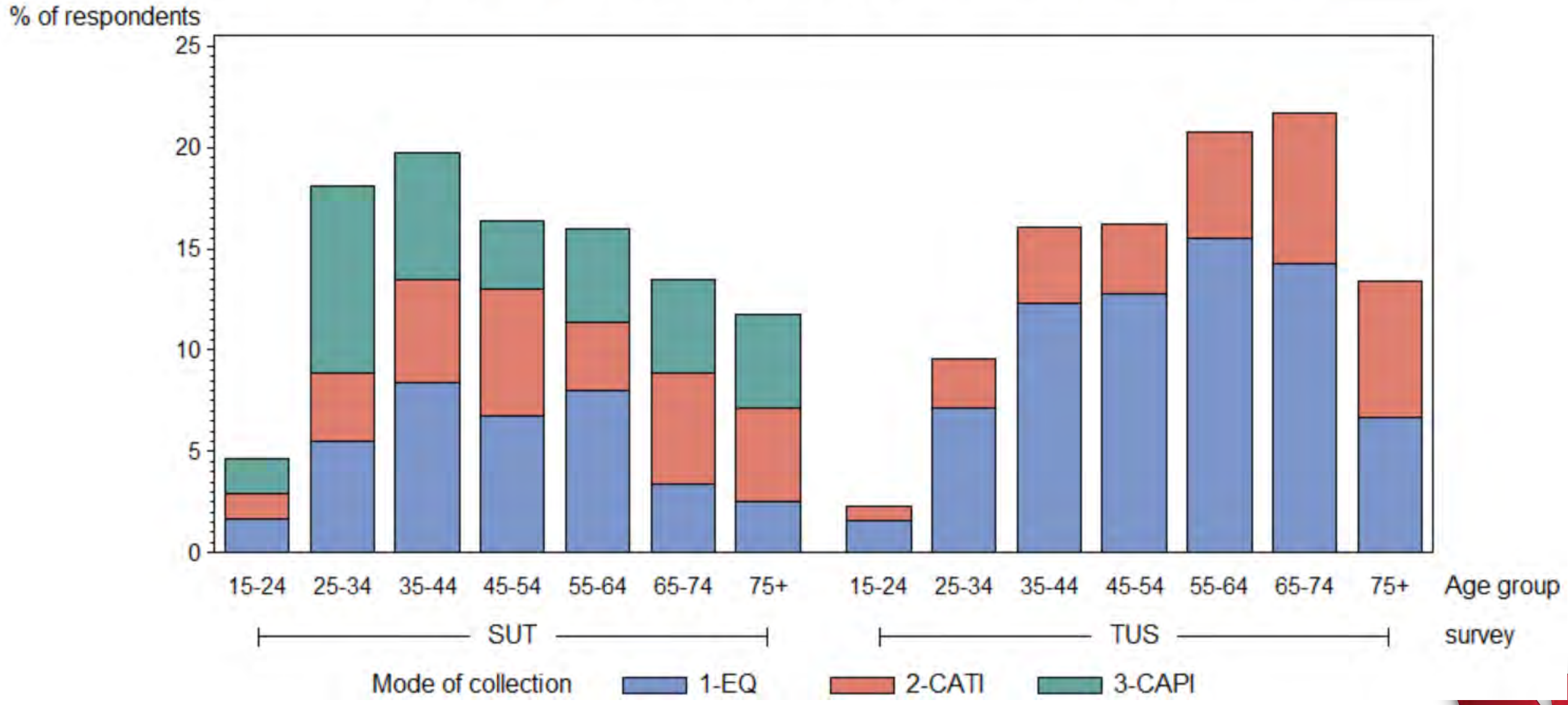
Variable or Category of Variables used to Adjust for Nonresponse	Census Undercoverage Study	Canadian Survey on Disability (With a Disability)	Canadian Survey on Disability (Other Units)	Survey of Official Language Minority Populations	Indigenous Peoples Survey (Adult Sample)	Mental Health and Access to Care Survey	Canadian Perspectives Survey Series	Households and the environment survey
Age	✓	✓	✓	✓	✓	✓	✓	
Household Composition	✓	✓	✓	✓	✓	✓	✓	
Education			✓	✓	✓	✓	✓	✓
Occupation/Industry		✓	✓	✓	✓	✓	✓	
Paradata (incomplete info, mode, …	✓	✓	✓		✓	✓	✓	
Gender/Sex	✓	✓		✓	✓	✓	✓	
Household Income		✓	✓	✓	✓	✓		
Ethnicity-related		✓	✓	✓	✓	✓		
Cognitive/physical/health impairment		✓	✓	✓	✓	✓		
Other dwelling characteristics		✓	✓	✓	✓			✓
Marital Status		✓		✓	✓	✓	✓	
Language (Mother tongue)		✓	✓	✓	✓			
LFS status			✓	✓	✓		✓	
Moved (last year/previous 5 years)		✓	✓	✓	✓			
Geography (Region, pop size)			✓	✓	✓			✓
Dwelling Tenure			✓	✓		✓	✓	
Language (First Official Language)		✓	✓	✓				
Country of Origin/Immigration/NPR	✓					✓	✓	

Green boxes are for "personal" traits. Yellow boxes indicate variables that were selected first in the propensity models.

Survey on Unpaid Time

- Nonrespondents to the TUS who answered the SUT were:
  - Younger people
  - Males
  - Immigrants
  - People with lower levels of education

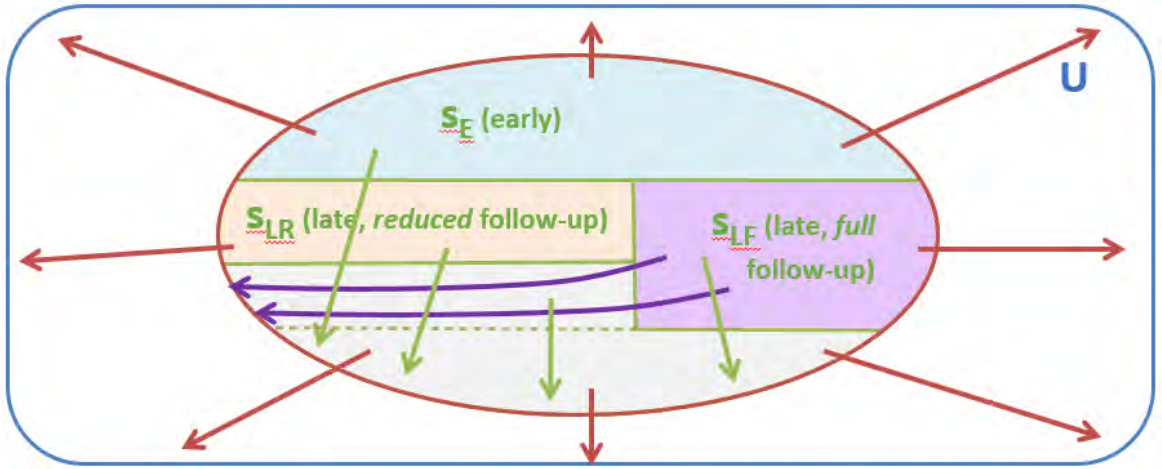
Distribution of age (groups of 10 years) by survey and mode of collection



Concurrent Full and Reduced Follow-up

$$\hat{t}_{y,CMME} = \sum_{k \in s_E} \frac{y_k}{\pi_k f_k} + \sum_{k \in s_{LR}} \frac{y_k}{\pi_k f_k} + \sum_{k \in s_{LF}} \frac{y_k}{\pi_k f_k} \left(\frac{1}{\varphi_k} - \frac{(1-\varphi_k)}{\varphi_k} q_k \right)$$

- $\hat{t}_{y,CMME}$ is the **Concurrent Multi-Mode Estimator** (CMME) of t_y

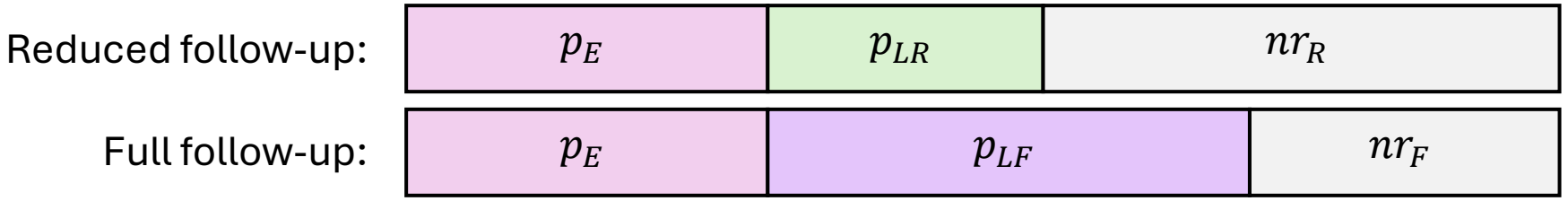


- s_E, s_{LR}, and s_{LF} are early survey respondents, late respondents under reduced follow-up, and late respondents under full follow-up
- f_k is the probability of response under full follow-up collection operations
- φ_k is the probability being selected for full follow-up collection operations,
- q_k is the ratio between a unit's probability of responding late under reduced follow-up to their probability of responding late under full follow-up.

Concurrent Full and Reduced Follow-up

$$\hat{t}_{y,CMME} = \sum_{k \in s_E} \frac{y_k}{\pi_k f_k} + \sum_{k \in s_{LR}} \frac{y_k}{\pi_k f_k} + \sum_{k \in s_{LF}} \frac{y_k}{\pi_k f_k} \left(\frac{1}{\varphi_k} - \frac{(1-\varphi_k)}{\varphi_k} q_k \right)$$

- Definition of q_k:
  - Probability of responding early before the start of CAPI (p_E)
  - Probability of responding late (p_{LR} for reduced and p_{LF} for full follow-up)
  - Probability of not responding (nr_R, nr_F)



$$q_k = \frac{p_{LR_k}}{p_{LF_k}}$$

Concurrent Full and Reduced Follow-up

$$\hat{t}_{y,CMME} = \sum_{k \in s_E} \frac{y_k}{\pi_k f_k} + \sum_{k \in s_{LR}} \frac{y_k}{\pi_k f_k} + \sum_{k \in s_{LF}} \frac{y_k}{\pi_k f_k} \left(\frac{1}{\varphi_k} - \frac{(1-\varphi_k)}{\varphi_k} q_k \right)$$

- CMME is unbiased with correct specification of f_k and q_k
- Modelling of f_k:
  - Using frame variables only
- Modelling of q_k:
  - Using survey variables from late respondents in both the full and reduced follow-up groups
  - The Canadian Social Survey has used calibration for this model
    - $\sum_{k \in s_{LF}} \frac{c_{i,k}}{\pi_k \varphi_k} g_k = \sum_{k \in s_{LR}} \frac{c_{i,k}}{\pi_k (1-\varphi_k)}$ for each calibration variable c_i (such as age, gender, and education)
    - $\widehat{q_k}$ is equal to g_k, the calibration factor

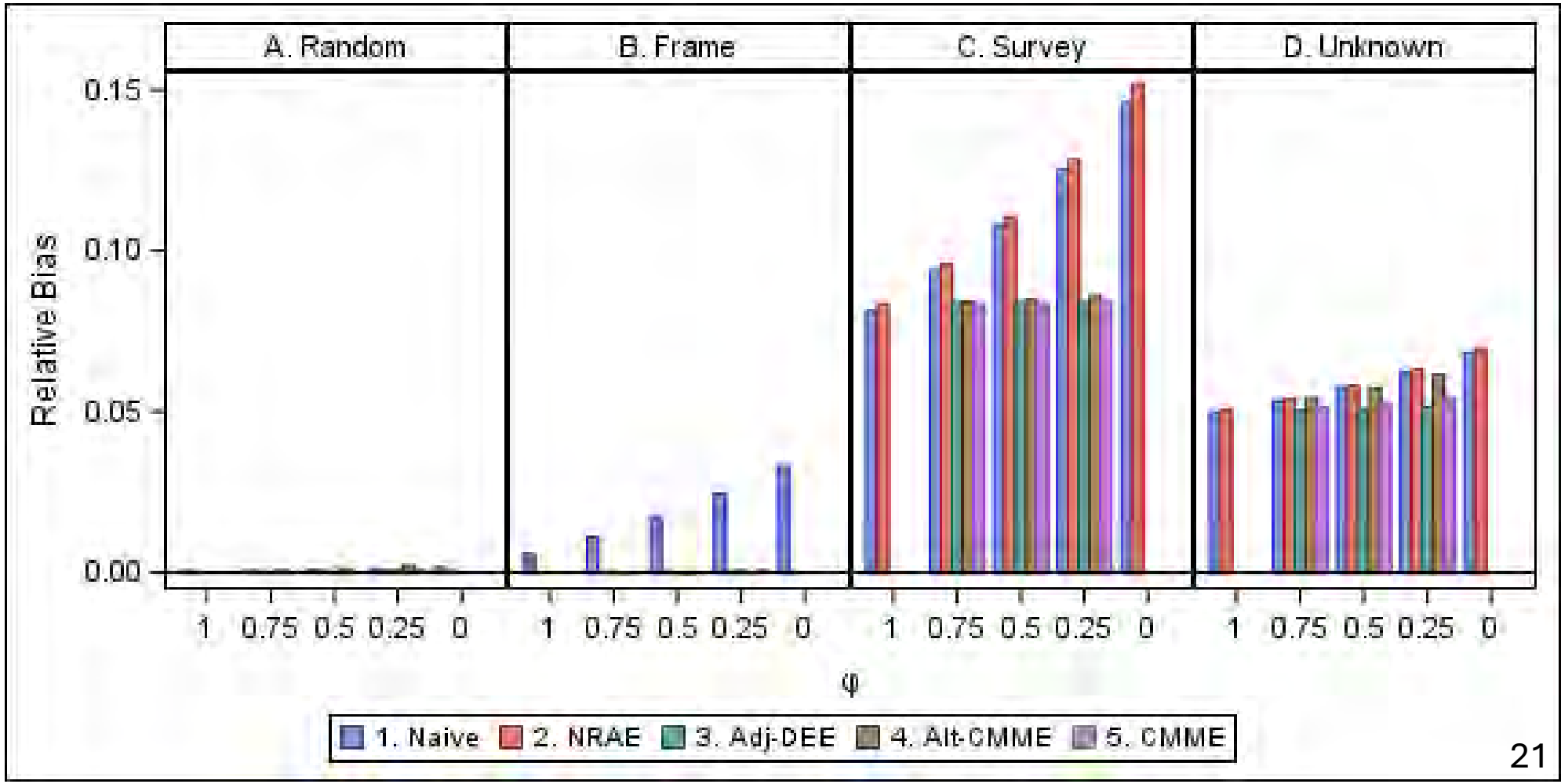
Simulations: Set-up

- Estimators compared were:

1. A "naïve" estimator, with $\widehat{p_k}$ = 1/(response rate) $\hat{t}_y = \sum_{k \in s_R} \frac{y_k}{\pi_k \widehat{p_k}}$
2. A non-response adjusted estimator, like the naïve estimator but with p_k estimated with a logistic regression model $\hat{t}_y = \sum_{k \in s_R} \frac{y_k}{\pi_k \widehat{p_k}}$
3. A non-response adjusted double expansion estimator $\hat{t}_y = \sum_{k \in s_E} \frac{y_k}{\pi_k \widehat{f_k}} + \sum_{k \in s_{LF}} \frac{y_k}{\pi_k \widehat{f_k} \varphi_k}$
4. An alternative CMME, expanding s_{LR} $\hat{t}_y = \sum_{k \in s_E} \frac{y_k}{\pi_k \widehat{f_k}} + \sum_{k \in s_{LR}} \frac{y_k}{\pi_k \widehat{f_k} \widehat{q_k}} + \sum_{k \in s_{LF}} \frac{y_k}{\pi_k \widehat{f_k}}$
5. The CMME $\hat{t}_y = \sum_{k \in s_E} \frac{y_k}{\pi_k \widehat{f_k}} + \sum_{k \in s_{LR}} \frac{y_k}{\pi_k \widehat{f_k}} + \sum_{k \in s_{LF}} \frac{y_k}{\pi_k \widehat{f_k}} \left(\frac{1}{\varphi_k} - \frac{(1-\varphi_k)}{\varphi_k} \widehat{q_k} \right)$

Simulations: Results for Relative Bias

- For the naïve estimator and NRAE, relative bias for variables C and D rises as φ decreases.
- For the others, the bias is not made substantially worse by subsampling for full follow-up at a lower rate.
- Note that any bias that cannot be accounted for by $\widehat{f_k}$ also cannot be reduced by these three estimators (so the adjusted DEE corresponds to the least amount of bias that could be achieved).



Simulations: Results for Relative SE

- The relative SE increases for all estimators as φ decreases.
- This increase is more modest for the naïve estimator and NRAE than for the others.