Discussion

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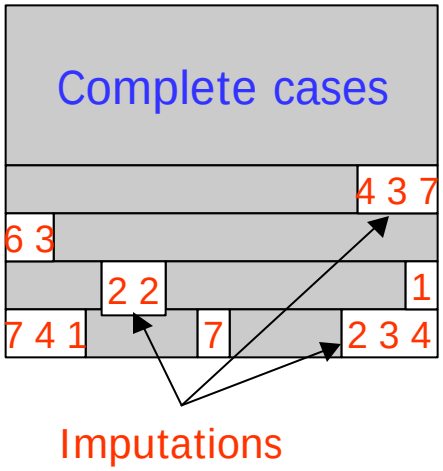
Goals of discussion

- Thank presenters for fine set of talks
- Advocate model-based multiple imputation as a flexible, practical approach for handling item nonresponse in surveys
- Discuss papers in context of this position
- Be somewhat provocative (no offense intended)
- Generate discussion and debate

Item nonresponse in surveys

- Not inherently different from other missing data problems in statistics (see e.g. Little and Rubin 2002), but:
  - Large sample sizes argue for "weak models"
    - Propensity Spline prediction (Little and An 2003)
  - Sample design features (stratification, weighting, clustering) need to be modeled

Features of Imputation



Good

Rectangular File

Retains observed data

Handles missing data once

Exploits incomplete cases

Bad

Naïve methods can be bad

Invents data –
Understates uncertainty

Properties of a good imputation method

- Imputations should:
  - Condition on observed variables in each case
  - Take account of the sample design
  - be general enough to handle general "swiss-cheese" patterns of missing data, mixed variable types
  - preserve associations between missing variables
  - generally be draws rather than means, to preserve marginal and joint distributions
  - Be multiple, to improve precision and allow propagation of imputation uncertainty

Accounting for Imputation Uncertainty

- Imputation "makes up" the missing data
  - treats imputed values as the truth
- For statistical inference (standard errors, P-Values, confidence intervals) need methods that account for imputation error
  - Replication methods (jackknife, bootstrap)
  - Multiple imputation (MI) (Rubin 1987)
  - In my view MI is method of choice for public use files

Harel and Schafer paper

- Harel and Schafer propose nested form of MI, varying number of MI's for different variables
  - Interesting idea, value in real settings to be explored
  - Reduction in computation in some settings (though gain needs to compensate for increased complexity of nested MI inference)
  - Applications to sensitivity analyses for mixed types of nonresponse
  - even basic MI has not been widely embraced by survey practitioners, and I'll focus discussion on that issue here

MI – neglected by survey practitioners?

- Beaumont et al. cite MI as early approach (Rubin 1977, 1987), but do not use method
- Copeland does not discuss MI, or how to propagate imputation uncertainty
- Census Bureau still uses single imputation methods that ignore imputation uncertainty
- Other survey organizations Like NORC, Westat make at best limited use of MI

Myths inhibiting the application of MI in survey settings

- MI is model-based and Bayesian, therefore vulnerable to model misspecification
  - Survey samplers don't like models
  - Consequences of uncongeniality between imputation and analysis models (Fay, Meng)
- MI flawed since it does not take into account survey design
- MI (and MI inference) is too difficult to implement in real settings

- MI is model-based and Bayesian, therefore vulnerable to model misspecification
  - True! But all imputation methods require a model (implicit or explicit); assumptions are needed, and burying them in the choice of estimator does not make them “any more right”
  - Other approaches, such as adjustment cell methods, are simpler but much more limited
  - MAR assumption weakened by conditioning on more covariates

- MI flawed since it does not take into account the survey design
  - But MI can be based on models that incorporate design features:
    - Design variables as predictors
    - Clusters as random effects
    - Even if design features are not properly modeled, the complete-data inference can be design-based, confining the misspecification error to the imputations

- MI (and MI inference) is too difficult for real settings
  - Software for creating MI's is available (Schafer's programs, SAS Proc MI, S-Plus, IVEware, MICE, …)
  - MI inference methods are straightforward for the survey user
  - On the other hand, other methods are in my view too limited for real settings, e.g. compare IVEware and adjustment cell methods...

IVEware vs adjustment cell methods

Features:	IVE	Adj cell
Handles mixed type covariates	yes	no
Handles “swiss-cheese” pattern	yes	no
Allows conditioning on many covariates	yes	no
Handles survey design	yes	yes, but*
Propagates imputation uncertainty	yes	yes, but**

* Computing design-weighted cell mean is inferior to using design weight as covariate in model (Little and Vartivarian 2002)

** Custom formulae for simple estimands

Comments on Copland paper

- Current “imputations” based on implicit ratio model within estimation cells based on industry and region
- Proposed model to allow ratios to vary by reporting pattern (“pattern-mixture model”)
- OutlineSuggested approach: create multiple imputations using multivariate predictive distribution of missing values given observed values for each establishment, based on a repeated-measures model that makes full use of observed information
- A starting point for modeling is …

Copland paper

$$(y_{i1},\ldots,y_{iT} \mid x_i) \sim N_T(Bx_i \mid s_i\Sigma(f))$$

y_{it} = employment at time t for estab. i

x_i = baseline covariates, incl. design variables

s_i = measure of size to model heteroskedasticity

B = matrix of regression coefficients

$\Sigma(f)$ = cov matrix parametrized by f

- Notes:
- Assumes MAR; first task is to make best use of available covariate data
- In principle, imputations should be revised to take account of new data (conditioning on data at later time points)

Comments on Beaumont et al paper

Paper describes a useful set of tools for evaluating nonresponse methods and their impact on variance.

"With sample surveys and official statistics where single imputation is the norm…"

- Why not consider MI? Couldn't it be "the norm"?

"[GENESIS] represents the population used as the starting point for the simulations…"

- This population needs to consist of complete cases, since missing values are created by deletion. The different imputation methods imply different models, and these could be assessed by checking how well the models fit the data.

Beaumont et al.

"Instead of forming classes, one could impute values using a regression model. There are at least two reasons for using classes: it is more practical when imputing a large number of variables at once,"

- The multivariate imputation is easily accomplished as a set of sequential univariate imputations. In fact IVEware is multivariate and allows for any pattern of missing data …

"and classes provide a degree of robustness compared to regression imputation"

- Concerning robustness, adjustment cell methods are a special case of regression. They are inferior with many covariates, since with too many cells, main effects of covariates are sacrificed for high-order interactions. This is not the way we usually do prediction.

Conclusion

- Thanks for opportunity to review papers
- Consider MI for item nonresponse!