Utilizing Matrix Sampling to Reduce Respondent Burden

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Outline

Background and motivation

Matrix sampling and burden

Statistical and operational considerations

Discussion

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Background

Increasing concerns from the public and Congress regarding the actual and perceived burden of the American Community Survey (ACS) questionnaire and follow-up procedures

National statistical organizations (NSOs), in general, are dealing with concerns regarding respondent burden as well as declining survey response rates and questionable data quality

NSOs are actively exploring innovative survey designs and other features to improve overall survey quality and reduce survey costs and burden while meeting the growing information needs of various governmental and non-governmental stakeholders

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Motivation for utilizing matrix sampling

High respondent burden, low survey response rates, and questionable data quality may each be associated with lengthy surveys (Fricker et al., 2011; Bogen, 1996; Galesic and Bosnjak, 2009)

Possible solution: administer a reduced-length questionnaire

- Has the potential to address issues related to burden while improving the measurement (data quality) and nonresponse (response rates) properties of a survey
- Challenge becomes eliminating questions from the original questionnaire

ACS possibility: divide the lengthy questionnaire into subsets of questions, and then administer each subset to subsamples of the full sample

- Referred to as matrix sampling (Shoemaker, 1973) or a split questionnaire (Raghunathan and Grizzle, 1995)

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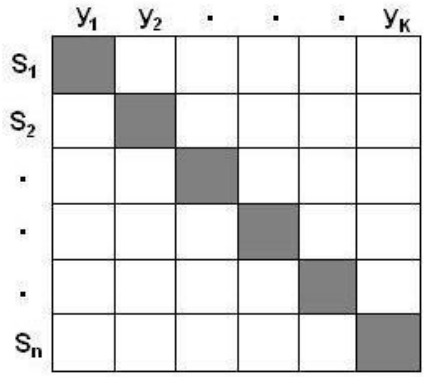
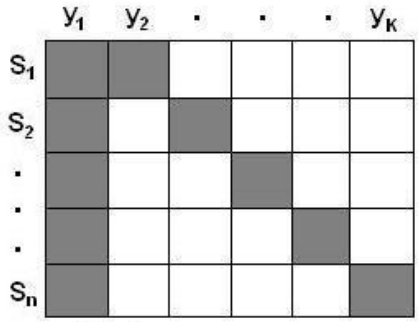
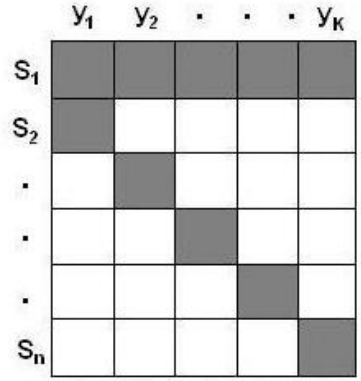
Illustrations of possible matrix sampling designs



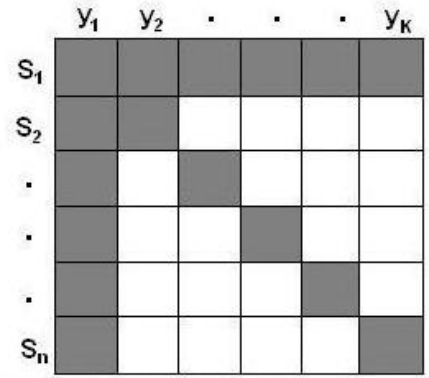
[a]. One specialized subset



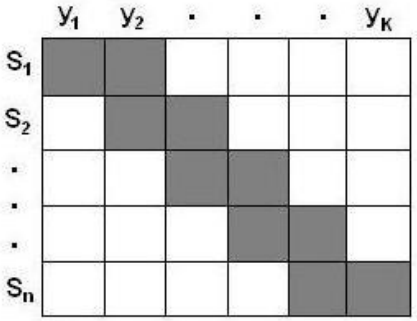
[b]. Common core + one specialized subset



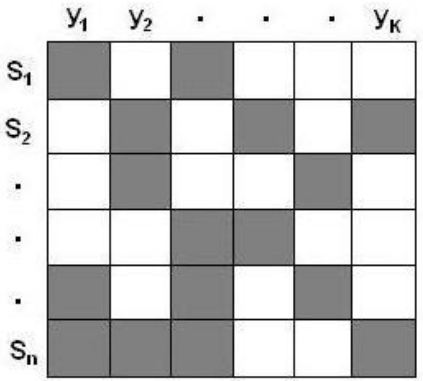
[c]. Full questionnaire subsample; One specialized subset



[d]. Full questionnaire subsample; Common core + one specialized subse



[e]. Two specialized subsets



[f]. Unstructured

Potential disadvantages of matrix sampling

1. Loss of information obtained from the survey
   $\Longrightarrow$ *Incomplete/missing data*

2. Introduction of additional sources of variation
   $\Longrightarrow$ *Measurement errors due to context effects*

3. Reduction in the precision of estimates from those questions which are "matrix sampled"
   $\Longrightarrow$ *Reductions in sample size lead to increased sampling variance*

4. Survey operations are more complicated since there are multiple instruments
   $\Longrightarrow$ *Case management systems must keep track of various forms*

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Potential benefits of matrix sampling

From Chipperfield and Steel (2009):

1. Increased efficiency with which design objectives can be met by allowing the number of survey items administered to each sample unit to vary

   $\Longrightarrow$ *Sample size requirements to meet survey objectives often differs by survey item*

2. Improved efficiency in estimation by exploiting the correlation among the survey items collected

   $\Longrightarrow$ *Leveraging information can enhance design and analysis*

3. Flexibility to restrict the maximum number of survey items collected from a sample unit to be less than that of the full set of survey items

   $\Longrightarrow$ *Shorter questionnaire may reduce burden*

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Respondent burden

From the literature:

1. "...the notion of respondent burden is most naturally related to variations in the nature of [the interviewing] task."(Bradburn, 1978: p36)
2. "'Burdensomeness' is not an objective characteristic of the task, but is the product of an interaction between the nature of the task and the way in which it is perceived by the respondent." (Bradburn, 1978: p36)
3. "Response burden is not a straight forward area to discuss, measure and manage." (Jones, 2012: p1)

Implication: Respondent burden is a *perception of the respondent* and concerns not only length, but other factors

$\Longrightarrow$ It is *multidimensional* (e.g., effort, difficulty, sensitivity, frequency of being contacted)

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Designing matrix samples

Primary question: Given the multidimensionality of respondent burden, how should NSOs design matrix samples to reduce respondent burden?

- Easy to observe that simple implementations of matrix sampling reduce burden when measured via objective criteria such as number of questions and length of interview

Subsequent questions:

1. How to allocate survey items to forms, then forms to subsamples of the full sample so as to improve on other dimensions of respondent burden?
2. Are there additional design features that can combined with matrix sampling to achieve further reductions in burden?
3. To what extent, if any, does burden reduction achieved through (1) and (2) affect quality/precision?

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Typical design of matrix sampling forms

Allocate survey items to forms, then randomly distribute forms to subsamples of the full sample

Ability to address dimensions of respondent burden other than length can be affected by the allocation of survey items to forms

Previous research has included the following allocations

1. Randomly (Shoemaker 1973)
2. Item stratification (Shoemaker 1973)
3. Correlation-based (Raghunathan and Grizzle 1995; Chipperfield and Steel 2009, 2011)

Item stratification can ensure that forms are balanced with respect to stratification classes where strata are formed by sensitivity, effort, difficulty, etc.

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Implications of typical design

Greatest impact on burden reduction may not be achieved with random (e.g., equal probability) distribution of forms to sample members

Implication 1: Auxiliary information about the sample unit is ignored

1. ACS collects information from a heterogeneous target population
2. Incorporating auxiliary information has been shown to have positive effects on data quality and burden reduction

Implication 2: Ineffective for "rare event" items and small geographic or other domains

1. Estimation/precision issues due to sample size reductions
2. Allocating to a "core" set of questions does not address issues related to burden (no questions eliminated!)

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Responsive/adaptive/multi-phase designs

Overview: Making mid-course decisions and unit-level survey changes based on accumulating process and survey data

Motivation: Decisions are meant to improve the cost and error properties of the resulting statistics

Concerns with adaptive designs

1. Need for useful auxiliary information
2. Understanding of how auxiliary information can be modeled to determine best protocol
3. Complicates analysis as data must be combined from multiple phases of data collection

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Burden reduction through adaptive designs

1. Perceptions of survey item characteristics
   $\Longrightarrow$ Tailoring to the sample unit may increase motivation or interest

2. Negative feelings about the survey request
   $\Longrightarrow$ Mitigate frustration or inconvenience if respondents feel they have been contacted too many times

3. Perception of time associated with response task
   $\Longrightarrow$ Tailoring may increase interest since "time flies when you're having fun"

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Integrating data sources

Overview: Comingling survey data with information provided in alternative data sources, such as administrative records, other surveys, and organic data sources to replace, edit, or impute collected survey data, for direct tabulation, or for indirect use in estimation

Motivation is similar to that of matrix sampling

1. Reduce respondent burden
2. Improve dimensions of data quality
3. Yield cost savings

Concerns with integrating data sources

1. Access, capture, and management
2. Requirements of statistical products, inference
3. Evaluation

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Burden reduction through integrating data sources

1. Perceptions of survey item characteristics
   $\Longrightarrow$ Items for which the recall task is difficult (e.g., expenditures, health care use/expense)

2. Negative feelings about the survey request
   $\Longrightarrow$ Mitigate frustration or inconvenience if respondents feel they already provided information

3. Perception of time associated with response task
   $\Longrightarrow$ Providing consent to link survey data would reduce respondent's perceived time spent completing survey request

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Data collection issues

1. As the number of "forms" increases, data collection management gets more complicated
2. Potential differential error properties of matrix sampling forms
3. Potential differential error properties of the same form across modes of data collection
4. Decisions required regarding follow-up collection instruments for "soft" refusals

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Response task/cognitive issues

Context effects: Suggest that responses to questions can be affected by prior items administered in the questionnaire as those prior items may provide cognitive cues to the respondent

- Matrix sampling may assume that eliminating questions from the questionnaire will not negatively impact the respondent's ability to accurately report information for the items actually asked
- Possible that measurement errors arising from context effects are offset by reduction in measurement errors from administering a lengthy questionnaire
- Cognitive testing required to assess impact of design on measurement error properties

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Data production and analysis issues

1. Implementation of a matrix sampling design will require modifications to data processing (editing, imputation, weighting, modeling) systems
2. Simple weighting adjustments can potentially be used, but requirements of some data products might not be met
3. Some concerns may be mitigated through inclusion of a "full questionnaire" subsample
   $\Longrightarrow$ Interesting problem to explore (e.g., possible to incorporate data quality metrics into this assignment)
4. As the number of "forms" increases, processing complexity increases

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General conclusions

1. Respondent burden is a multidimensional concept; focus on perceptions of burden rather than absolute reduction in questionnaire length
2. Simple implementations of matrix sampling are likely insufficient for many uses of ACS data
3. Considering additional design feature modifications in conjunction with matrix sampling may have the potential to yield significant reductions in respondent burden
4. Trade-offs among burden reduction, total survey quality, and costs
5. Deciding to utilize matrix sampling results in:
   - $\Longrightarrow$ Complexities for case management/data collection/ measurement
   - $\Longrightarrow$ Acceptance of necessity to modify/overhaul data processing systems

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High priority questions for expert panel

1. What does ACS mean by "burden reduction" and how can matrix sampling forms be designed to reduce burden?
2. What additional design features can be combined with matrix sampling to achieve greater reductions in burden and improve total survey quality and costs?
3. How can existing ACS data (survey and paradata) be used to inform the design of matrix sampling forms?
4. How will ACS follow-up procedures for soft/initial refusals be modified to account for the matrix sampling design?
5. Beyond standard measures of precision, what criteria will be used to evaluate the new design features?

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