Adaptive Survey Design in a Rapidly Changing World

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Adaptive Design

- A **tailored** and **dynamic** approach to case management in data collection
- Uses auxiliary **frame data**, **paradata** and **response data** to guide contact approaches and resource allocation
- Employs a **centralized system** for controlling multiple data collection modes
Rationale

• A response to declining response rates and rising costs
• A product of new data resources and recent research on nonresponse error
• A framework for weighing data quality and costs
Data Resources

- **Frame data:** type of structure, block group demographic statistics, alternative modes, (previous response data)
- **Paradata:** contact history (effort and response propensity), interviewer observations, time and travel, progress, Web survey metrics
- **Response data:** Current estimates for key variables
- **Quality metrics ->** sample balance, response rate, stability/quality of estimates
Tailored and Dynamic Case Management Examples

- Prioritize **cases**
- Prioritize **modes**
- **Shift** priorities with experience
- **Subsample** open cases
- **Stop** data collection
- **Faster** provision of data
Adaptive Design and the National Survey of College Graduates
National Survey of College Graduates

• Sponsored by National Center for Science and Engineering Statistics (NCSES) at the National Science Foundation (NSF)

• Part of the Science & Engineering Statistical Data System (SESTAT)

• Person-level survey sampled from American Community Survey (ACS)

• Target population is college graduates

• Occurs every 2-3 Years
2013 Data Collection

- February 21 – August 25

- Sample Size ~143,000 cases
  - 83,000 in New Cohort (2011 ACS)
  - 60,000 in Old Cohort (2009 ACS + 2010 NSRCG)

- Data collection modes include: internet, mail, phone
  - Different costs and effort
Methodology Studies

• What Strategies Work?
  – Incentive Timing
  – Priority Mail vs. First Class Mail
  – Mode Switching
  – Incentive Conditioning
Motivation for Adaptive Design

• NSCG Priority:
  – Reduce the time from start of data collection to delivery of finished product.

Needs to be done **without** sacrificing data quality!
Motivation for Adaptive Design

• Additional Goals
  – Allocate data collection resources efficiently
  – Avoid exhausting money and time
  – Move beyond response rate as the major metric of survey quality
Challenges to Implementation

• System:
  – Independent data collection systems

• Processing:
  – Move processing
  – Make assumptions

• Data Quality:
  – What measures do you use?
  – How do you use them in the decision-making process?
Adaptive Design Components
Targeted for 2013 NSCG

Challenges Served as a Roadmap for 2013

– Integrate Disparate Data Collection Systems
  • Integrated Systems
  • Integrated Reporting

– Institute Flow Processing

– Data Monitoring Methods
  • Increase Access to Paradata
  • Implement Methods

– Determine Possible Interventions
Integration of Systems
Integration of Systems

Baseline (2010)

• Input files must be delivered to several different locations
• Many unrelated handoffs
• Separate intermediaries for mail and telephone
• Response files located in several different locations
• No mode-level interventions or communication without data flow to/from NSCG
• Different contact paths by mode
Integration of Systems

New Version (2013)

• Input files now delivered to one location
• Response files are now all in one location
• Single intermediary
  – Aware of all modes
  – Can pass info between modes
  – No need to wait for NSCG to affect action/interventions
• Single contact path for all modes
Integration of Systems

New System Functionalities

• CATI Holds from Internet
  – Every 2 Hours
• Mail Processing Holds
  – Daily
• Data Monitoring Holds
  – Weekly
• Integrated Reporting
  – Daily
Integrated Reporting

• Universal Tracking System (UTS)
  – Census Bureau enterprise-wide reporting system
  – Combines data streams from various systems
  – Met two major NSCG needs for adaptive design
    • Full Contact Path Report
      – Chronological report of all contacts for a sample person
      – Allowed us to respond to a specific sample person request
    • Contact Aggregation Report
      – Total contacts by category for a sample person
      – Include in data monitoring
Flow Processing
Flow Processing

• Complete most/all parts of processing
• NSCG has a goal of daily processing
• Make some assumptions
  – Less editing or less manual review
• Need coding, editing, imputation, weighting, and variance estimation
Flow Processing

- Section in red is processing
- Normally completed after data collection
- Completed on a daily basis
- Allows daily production of estimates of interest and quality measures
Flow Processing Benefits

• Operational Benefits
  – Processing programs completed earlier
  – Real-world testing opportunities

• Data Benefits
  – See effects of changes in editing or imputation rules immediately in the data
  – Daily views of “final” data and data quality
  – This information is important for data monitoring
Data Monitoring
Data Monitoring & Intervention

- Data-driven view of “what’s going on?”
- Make data-driven data collection interventions
- Propensity models
  - Uses frame, 2010, and 2013 NSCG data
  - Determine propensity to be in the respondent population
- R-indicators\(^1\),\(^2\) (initial monitoring metric):
  - Great sampling frame (ACS)
  - What “type” of cases are responding?
  - Identify under-/over- represented groups
Data Monitoring & Intervention

• Benchmarking to frame and sample totals
  • Evaluate non-response propensity model
• Stability of estimates\[^3\]
  • Help develop stopping rules\[^4\][^5\]: Are new respondents moving the estimates/variance? Is it “worth it” to continue?
• Fraction of missing information\[^6\]
  • Help develop stopping rules: Measures uncertainty surrounding imputed values (Requires multiple imputation)
Interventions

• Data Monitoring provides information
  – Watch it or act on it?
  – 2013 NSCG includes mode-switching test
  – Monitoring methods help identify target cases
    • Move case to mode with the highest response propensity
    • Hold a case in web if it is a “low impact” case
    • Put a CATI case on hold (no contacts) if R-indicator indicates the group is over-represented
    • Need to identify more possibilities
  – Interventions are part of cost/quality tradeoff in adaptive design
Interventions

• Other types of interventions
  – Investigate and react to issues in data collection
    • Web server was extremely slow during first week of data collection
    • Used web paradata to identify time frame of slow service
    • Identified respondents affected by slow service
    • Mailed apology letter
R-Indicators Overview

- **Sample R-Indicators**
  - Evaluate representativeness of respondent population as compared to the sample population, given a set of balancing variables

- **Unconditional Partial R-Indicators**
  - **Variable-Level**
    - Evaluate which variables are driving the variation in propensities
  - **Category-Level**
    - Evaluate which subgroups of a variable or a cross of variables are over- or under-represented
R-Indicators Overview

Sample R-Indicators (Balancing Model) for Incentives Study Groups vs. Weighted Response Rate

\[ R(\hat{\rho}) = 1 - 2 \left( \frac{1}{N - 1} \sum_{i=1}^{N} s_i \pi_i (\hat{\rho}_i - \hat{\rho})^2 \right) \]

\[ 0 \leq R(\hat{\rho}) \leq 1 \]

- \( R(\rho) = 1 \) means that the respondent population is fully representative of the sample population (all cases have the same propensity to respond)
- A decreasing R-Indicator means an increase in the variation in propensities.
- Can compare different samples (as here) provided the same variables are used in the balancing propensity model.
Data Monitoring Example

Unconditional R-Indicators for Variables in the Balancing Propensity Model (with Data Through 8/17) - MOSW

\[ R_u (\text{var}, \hat{\rho}) = \sum_{k=1}^{K} \frac{N_k}{N} (\hat{\rho}_{x,k} - \hat{\rho}_x)^2 \]

\[ 0.00 \leq R_u \leq 0.50 \]

Variable –Level Unconditional Partial R-Indicators:
- **Identify variables** that drive variation in propensity.
- \( R_u = 0 \) means the variable does not drive variation in propensities.
Data Monitoring Example

Partial Unconditional R-Indicators for Race/Ethnicity
(Data Through 8/17) - MOSW

\[ R_u(\text{var, } k, \rho) = \sqrt{\frac{N_k}{N}(\bar{\rho}_{x,k} - \bar{\rho}_x)} \]

-0.50 \leq R_u(\text{var, } k, \rho) \leq 0.50

Category – Level Unconditional Partial R-Indicators:
- **Identify subgroups** that are over- or under-represented.
- This information can be used for targeting cases

[Graph showing R-indicators for different races and ethnicities over time]
Intervention Example

Cases in the over-represented group & in CATI were put on hold to reduce contact attempts/shift resources to other cases. (Total of 40 cases)

For this intervention, cases in the over-represented group were identified. 50% of cases will only receive a web invite instead of a full questionnaire packet. Results in cheaper mailings, and reduction in future resources needed for keying. (Total of 498 cases)

Cases in over-represented group were not sent week 18 questionnaire or week 23 final mailing. (Total of 508 cases)

Cases in over-represented group & not in CATI were held out of CATI to reduce contact attempts. (Total 495 cases)

Cases in under-represented groups moved to CATI to pursue those cases more aggressively. (Total of 85 cases)
- All interventions improved representativeness vs. a control where no mode switching occurred.

- Sending a web-invite only to over-represented cases resulted in fewer responses and reduced over-representation. (Tradeoff between Response/Representativeness)

- Moving cases to CATI in the under-represented groups resulted in increased response rates and representativeness as compared to the control.

- Until the end of data collection, the black bachelor population behaves nearly identically in both the mode switching and control group.
The Center for Adaptive Design in Census Bureau Strategies

- *Simplify processes and systems* through shared services

- *Implement adaptive design methods* in all our surveys and censuses

- *Organize functionally, manage programmatically*
Early Decisions/Guiding Principles

• Emphasize common solutions for the Census Bureau as opposed to individual solutions targeted for a particular survey or census

• Develop and build the system internally as opposed to a buying a solution contract
  – Bring in contractors for expertise, but own and control the solution
Early Decisions/Guiding Principles

• Integrate systems by implementing a Service Oriented Architecture
  – Service enable all data

• Choose tools that enable high flexibility and speed for deploying new capabilities
  – Business Process Management (BPM)
  – Flexible business rules engine approach

• Develop systems iteratively
Progress

• Defined and documented adaptive design capabilities and high-level requirements
• Completed the National Survey of College Graduates (NSCG) pilot and fielded the NSCG test
• Selected an internal team to build the Multi-mode Operational Control System (MOCS)
• Completed the Adaptive Design Solution Architecture
• Created the adaptive design development and implementation timeline through 2021
• Partnered with the American Community Survey (ACS) to make it the first survey to use the MOCS in production
• Completed the Adaptive Design Program Roadmap
• Completed an initial proof of concept for development tools using ACS data collection scenarios
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<td>2015</td>
<td><strong>Baseline 1</strong>: MOCS Platform: Support ACS in 2016</td>
<td><strong>Baseline 2</strong>: MOCS in place, add Paradata &amp; Concurrent Analysis – Bring on <strong>Decennial</strong> and some Demo surveys in 2017</td>
<td><strong>Baseline 3</strong>: Bring on more Demo surveys, start bringing on Econ surveys and Econ Census</td>
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Backup Slides
References


