

ADAPTIVE AND RESPONSIVE SURVEY DESIGN WORKSHOP | NOVEMBER 2019

USING AUXILIARY DATA TO TAILOR RESPONSE MODE WITHIN A SEQUENTIAL MIXED-MODE TWO- PHASE HOUSEHOLD SURVEY

WORKING PAPER

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MAKING
RESEARCH
RELEVANT

Introduction

- Increased ubiquity of mixed-mode designs
 - Compensates for weaknesses of individual modes (de Leeuw 2005; Dillman, Smyth, and Christian 2014)
- Often modes offered sequentially rather than concurrently
 - Allows for maximization of less-expensive mode (e.g., web-push)
 - Often yields higher response rates compared to offering choice (cf. Biemer et al. 2018; Bucks, Couper, and Fulford 2019)
- Sample members' preferred mode may not be one-size-fits-all (Olson et al. 2012; Smyth et al. 2014)

Introduction (cont.)

- Sequential mixed-mode may introduce inefficiencies in data collection
 - Some sample members may wait to respond until more appealing mode is offered
 - Others may be disinclined to respond at all even when preferred mode is offered at a later time
- Could mitigate effect by tailoring the mode offered at each contact to sample member's preference or sensitivity to alternative mode
 - Could increase efficiency, reduce mailing costs, and increase response rates and representativeness
 - Can consider this “static adaptive design” (Coffey, Reist, and Miller 2019)

Research Questions

- Can data appended to an ABS frame from a previous survey administration be successfully used to model mode preference/sensitivity in a new sample/cohort?
- Does tailoring offered mode based on predicted sensitivity...
 - improve final 1st phase response rates in a two-phase study?
 - improve early 1st phase response rates in a two-phase study?
 - improve overall response rates (after 2nd phase)?
 - reduce or control costs?
 - improve sample representativeness?

Data

National Household Education Survey

2016 & 2019

National Household Education Survey (NHES)

- Large-scale ($n \approx 200,000$) household survey sponsored by National Center for Education Statistics (NCES)
- Collects data on parent involvement in education, homeschooling, early childhood care/education, child health and development, and child and family demographics
- Administered as a two-phase mailed paper or web-then-mail survey (using ABS sampling frame)
 - Phase 1: Screener survey rostering household members
 - Phase 2: Longer “topical” survey for parents/guardians in households with children
- Most recent administrations: 2016 & 2019

NHES:2016 (Training Sample)

- **Majority received paper-only treatment (n=114,410)**
 - Up to four phase 1 mailings with introductory letter and paper questionnaire
 - Respondents mail back paper screener; eligible households are mailed longer 2nd phase “topical” questionnaire
- **Experimental web-push sample (n=31,680)**
 - First two phase 1 mailings are invitations to complete by web
 - » 1st phase questionnaire flows directly into 2nd phase questionnaire for eligible respondents
 - Second two phase 1 mailings included a paper questionnaire
 - » Same phase 2 protocol as paper group

NHES:2019 (Experimental Sample)

- **Web-push group (n=40,000)**
 - Up to two web invitations
 - » 1st phase survey flows directly into 2nd phase for eligible respondents
 - Up to two follow-up mailings include paper questionnaire
 - » Respondents mail back paper screener; eligible households are mailed longer 2nd phase “topical” questionnaire
- **Paper-only group (n=4,000)**
 - Up to four mailings with paper questionnaire
 - » Respondents mail back paper screener; eligible households are mailed longer 2nd phase “topical” questionnaire
- **Modeled-Paper group (n=36,000)**
 - Assigned (based on a paper-sensitivity model)
 - » Paper-sensitive group received same protocol as paper-only group (n=5,400)
 - » Non-sensitive group receiving the same protocol as the web-push group (n=30,600)

Sensitivity Model Development & Analytic Methods

Mode Sensitivity Model Specification

- Binary logistic regressions
- Dependent Variable: Phase 1 (screener) response
 - Early screener response (after 2nd mailing, before mode switch in web-push)
 - » Assesses mode preference (paper vs. web)
 - Final screener response (after 4th mailing, after mode switch in web-push)
 - » Assesses mode protocol preference (paper-only vs. web-push)
- Independent Variables:
 - Subset of available auxiliary variables
 - Treatment indicator (paper-only or mixed-mode)
 - Interactions between auxiliary variables and treatment indicator

Predictor variable selection

Description	Source	Examples
Address characteristics	ABS frame	Route type, dwelling type, vacancy flag
Address-level demographics	Sample frame vendor	Household income, age of HoH, race/ethnicity of HoH
Stratification variables	Sample frame vendor	Tract race/ethnicity percentages
Block group demographic estimates	Census Planning Database	Low Response Score, median household income
Tract-level Internet penetration estimates	Federal Communications Commission	High-speed connections per 1,000 households

HoH = head of household

30 variables in final model: any predictors for which neither main effect nor treatment interaction was statistically significant at 0.05 level (based on a Wald joint significance test) were removed from final model

Mode (Paper) Sensitivity Scores

- Predicted individual treatment effect— how much receiving paper increases probability of response, relative to mixed-mode

$$S = \rho_{paper} - \rho_{web}$$

Where:

ρ_{paper} = RP conditional on paper-only treatment

ρ_{web} = RP conditional on mixed-mode treatment

- Use sensitivity scores to create:
 - **High-sensitivity** cohort (sensitivity score above 85th percentile)
 - **Low-sensitivity** cohort (sensitivity score 85th percentile or below)

Model Validation

- Measure of fit: *difference* in treatment effect between high-sensitivity and low-sensitivity cohorts
 - Treatment effect = paper-only RR – mixed-mode RR
 - More accurate model → larger difference-in-effects

Model Results and Cross Validation

- Larger treatment effect among sensitive than non-sensitive cohort
- **Early response** as dependent variable showed greater potential treatment effect
 - Potential for cost savings by encouraging earlier response
 - Out-of-sample effects still evident but slightly smaller

Cohort	In-sample treatment effects		Out-of-sample treatment effects	
	Early response rate	Final response rate	Early response rate	Final response rate
Sensitive	17%	9%	15%	8%
Non-sensitive	5%	5%	6%	6%
<i>Difference</i>	<i>11%</i>	<i>4%</i>	<i>9%</i>	<i>2%</i>

NOTE: All response rates are screener response rates ; 5-fold cross-validation to assess out-of-sample validity

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Analysis of NHES:2019 Tailored Experiment

1. Protocol Sensitivity

- Comparison of final phase 1 (screener) response rates by treatment (modeled vs. web-push vs. paper-only) and cohort (sensitive vs. non-sensitive)
- Comparison of final phase 2 (topical) and combined (screener x topical) response rates by treatment and cohort

2. Mode Sensitivity

- Comparison of early (prior to mode switch) phase 1 and phase 2 response rates by treatment and cohort

3. Analysis of Respondent Characteristics

- Comparison of sampling frame characteristics for respondents by treatment compared to full sample
- Comparison of phase 2 eligibility rates by treatment

Results

Protocol Sensitivity – Phase 1 Response Rates

- Higher treatment effect overall (modeled mode vs. web-push)
 - Effect is small however (**1.6 percentage points**).
- Sensitive cohort had **7 percentage point** difference between modeled group and web-push group
 - However, nonsensitive group had **5 percentage point** difference between modeled-mode and paper-only

Cohort	Treatment Group (Response Rate)			Difference between Modeled-mode and Web-push		Difference between Modeled-mode and Paper-only	
	Modeled- Mode	Web-Push	Paper- Only				
Overall	60.5	59.0	64.3	1.6	**	-3.8	**
Sensitive	80.0	73.0	78.3	7.0	**	1.7	
Non-sensitive	56.8	56.3	61.7	0.5		-4.9	**
Difference	23.3	16.7	16.6	6.5	**	6.6	**

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Protocol Sensitivity (cont.)

- Is increased RR in Sensitive group simply due to the increased percentage receiving paper?
 - If 12.5% of the sample were randomly assigned to receive the paper-only protocol (not based on their paper sensitivity), the final screener response rate would be **59.62%** (compared to 60.5 from modeled treatment)
- Possible overlap between paper sensitivity and response propensity
 - Sensitive group seems to have higher response propensities.
 - Difference in response rates between the sensitive and non-sensitive groups are nearly identical in the web-push and paper-only treatment groups.
- Both groups prefer paper
 - when higher propensed cohort offered most popular mode and lower propensed cohort offered less popular mode, difference between groups increases.
 - If respondents in the sensitive group are the most likely to respond anyway, then the treatment **may be exacerbating nonresponse bias in the responding sample**

Protocol Sensitivity – Phase 2 Response Rates

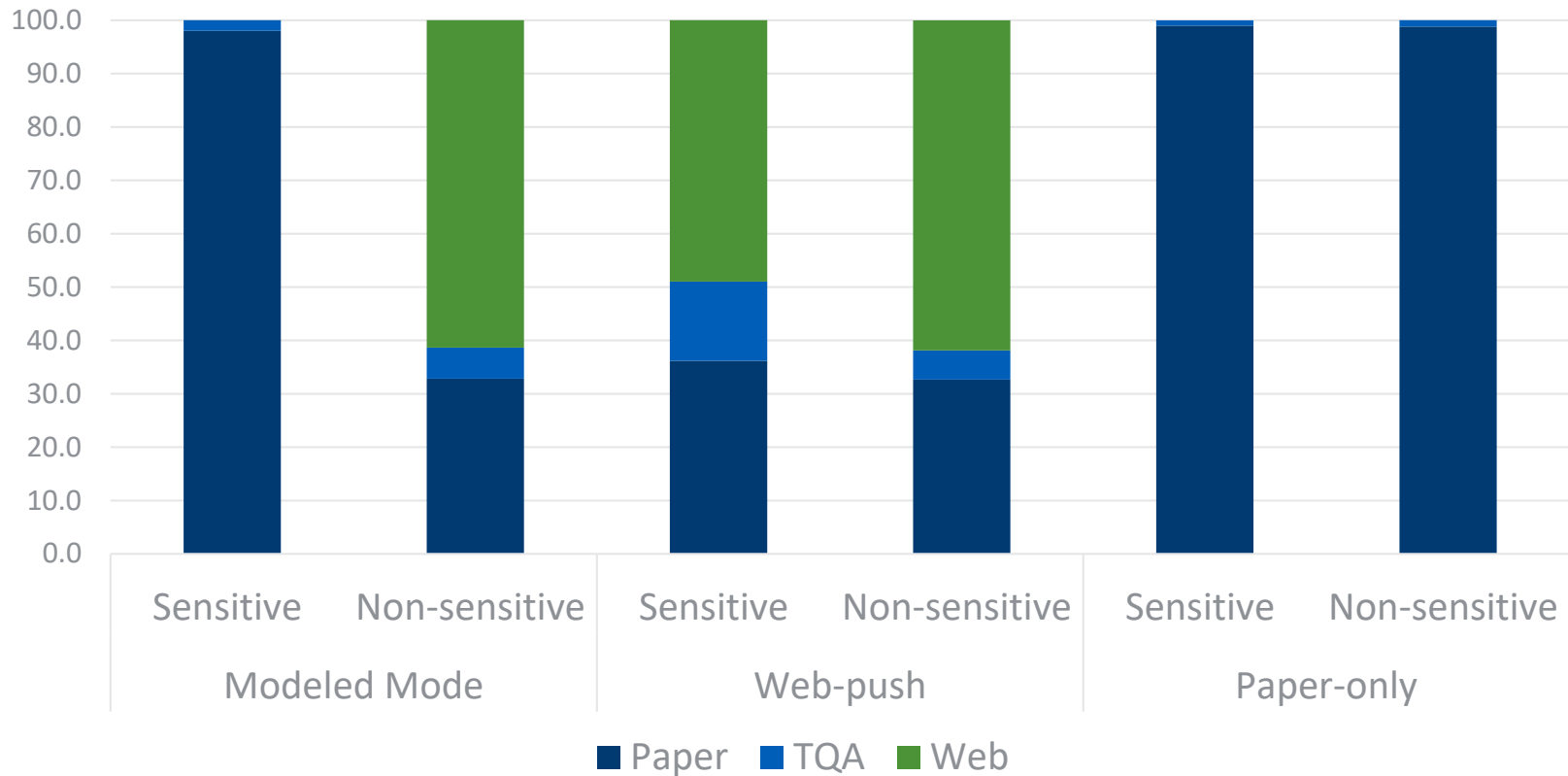
- Topical response rate significantly higher in web-push condition
 - Due to ability to transition immediately to extended survey
- Impact of paper-mailing on 2nd phase response washes out boost from 1st phase.
 - Modeled-mode and web-push groups have equal overall (screener*topical) response rates (~53.5%)

Cohort	Treatment Group (Response Rate)			Difference between Modeled-mode and Web-push		Difference between Modeled-mode and Paper-only	
	Modeled- Mode	Web- Push	Paper- Only				
Overall	87.3	88.9	76.0	-1.6	**	11.3	**
Sensitive	69.7	87.2	72.4	-17.4	**	-2.6	
Non-sensitive	88.9	89.1	76.3	-0.2		12.6	**
Difference	-19.1	-1.9	-3.9	-17.3	**	-15.2	**

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Protocol Sensitivity – Distribution by Response Mode

- When treated identically (e.g., web push treatment), Sensitive cohort had significantly higher TQA rates - suggests Sensitive cohort less inclined to web



SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Mode Sensitivity – Phase 1 *Early* Response Rates

- Higher treatment effect overall between modeled-mode and web-push
- Sensitive cohort had **24.1 percentage point** difference between modeled group and web-push group
- Nonsensitive group only had **12.9 percentage point** difference between modeled-mode and paper only
- Difference between cohorts suggests model is effectively identifying cases sensitive to receiving paper (for early response)

Cohort	Treatment Group (Response Rate)			Difference between Modeled-mode and Web-push		Difference between Modeled-mode and Paper-only	
	Modeled- Mode	Web-Push	Paper- Only				
Overall	41.4	37.4	51.8	4.0	**	-10.4	**
Sensitive	68.6	44.5	65.9	24.1	**	2.7	
Non-sensitive	36.2	36.0	49.1	0.2		-12.9	**
Difference	32.5	8.5	16.9	24.0	**	15.6	**

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Mode Sensitivity – Phase 2 *Early* Response Rates

- With early response, overall response rates (accounting for phase 2) still higher for modeled group compared to web-push

Cohort	Treatment Group (Response Rate)			Difference between Modeled-mode and Web-push		Difference between Modeled-mode and Paper-only		
	Modeled-Mode	Web-Push	Paper-Only					
Topical Response								
Overall	97.5	99.7	79.1	-2.3	**	18.3	**	
Sensitive	76.3	100.0	77.6	-23.7	**	-1.3		
Non-sensitive	99.7	99.7	79.3	0.0		20.5	**	
Difference	-23.4	0.3	-1.7	-23.7		-21.7	**	
Overall Response								
Overall	40.3	37.3	41.0	3.1	**	-0.6		
Sensitive	52.4	44.5	51.1	7.9	**	1.2		
Non-sensitive	36.1	35.9	38.9	0.2		-2.8	**	
Difference	16.3	8.6	12.2	7.7		4.1		

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Mode Sensitivity – Cost Implications

- Early response boost may offer multiple avenues for cost savings
 - Decreased mailing costs for nonresponse follow-up mailings
 - » Though early paper mailings are more expensive than web-push mailings
 - NHES (as well as other studies) uses increasingly expensive nonresponse follow-up strategies (e.g., FedEx or Priority Mail). Early response can reduce the number of more costly contact procedures
 - NHES 2nd phase incentives (sent with the paper topical mailing) vary based on the timing of screener response. **Possible that adaptive mode targeting can augment follow-up mode tailoring.**

Intersecting Adaptive Interventions

- Early experiments with static adaptive design in NHES found that late phase 1 responders required larger incentives at phase 2
 - Analysis conducted on paper-only protocol
 - Respondents to 1st or 2nd screener mailing, receive \$5 at phase 2; respondents to 3rd or 4th screener mailing receive \$15 at phase 2
- This design is complicated by the shift to web-push
 - 3rd & 4th mailings are also the first introduction of the paper option
- Possible that some respondents to 3rd and 4th mailings just needed paper, and would not require a larger incentive for phase 2.
- **Modeled mode design can disentangle these groups somewhat.**

Mode Sensitivity – *Late Responders*

Cohort	Treatment Group (Response Rate)			Difference between Modeled-mode and Web-push		Difference between Modeled-mode and Paper-only	
	Modeled-Mode	Web-Push	Paper-Only				
Screener Response							
Overall	19.1	21.6	12.6	-2.5	**	6.6	**
Sensitive	11.4	28.5	12.3	-17.1	**	-0.9	
Non-sensitive	20.6	20.3	12.6	0.3		8.0	**
Difference	-9.2	8.2	-0.3	-17.4	**	-8.9	**
Topical Response							
Overall	70.0	71.0	66.6	-1.0	**	3.4	**
Sensitive	50.7	70.3	53.6	-19.6	**	-3.0	
Non-sensitive	71.1	71.1	67.5	0.0		3.6	**
Difference	-20.4	-0.8	-13.9	-19.7		-6.5	**

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Household Education Surveys Program (NHES), 2016.

Mode Sensitivity – *Late Responders* (cont.)

- For sensitive cohort – Web-push cases had an **over 17 percentage point higher** *late screener* response rate compared to the modeled-mode or paper-only design
 - Believe this is due to the added cases who would have responded earlier but were waiting for paper-questionnaire
 - All these cases will receive higher \$15 topical incentives
- Significantly higher topical response rate (**almost 20 percentage points**) among the sensitive cases for the web-push group.
 - Small portion due to web-push respondents responding to the screener (and therefore topical) by web
 - We believe modeled-mode protocol weeded out the more likely respondents, by sending them their preferred mode up front.

Sample Representativeness & Survey Eligibility

- All three treatments showed similar bias compared to full sample on frame characteristics.
- No observed differences between treatments
- Similar rates of eligibility for 2nd phase survey by treatment.

Conclusions & Discussion

Conclusions

- Insignificant effect of static adaptive design on overall response rates, when accounting response at both phases of two-phase design
 - Marginal impact on first-phase response, which could be beneficial to ABS household surveys using a single-phase approach
 - However, effect is likely due to the remaining preference for paper-mode overall
- Notable impact of tailored mode on eliciting response **earlier**
 - Specifically, obtaining earlier response from respondents likely to prefer paper
 - Modeled approach performs better than simply increasing the proportion (randomly) receiving paper early
 - Eliciting earlier response can lead to cost savings if benefit outweighs the complexity of the adaptive approach (additional cost-modeling is needed)

Discussion, Considerations, and Next Steps

- Within the framework of these static adaptive designs, especially for two-phase studies, must consider interaction of treatments
 - For NHES, the mode-sensitivity model could be used to offset the cost of the variable 2nd phase incentive under a web-push design
 - The tailored design allows for better integration of multiple adaptive interventions maximizing response at the lowest possible cost
- Since many efficiencies and cost savings gained by pushing respondents to web, may be worth investigating whether there is a group that can be identified a priori that will never respond by paper. Reduce cost by never sending paper follow-up to those cases.
- No improvement on representation by modeled mode treatment, but no detrimental impact either. Would need to continue to monitor if a larger portion of sample were allocated to paper-mode.

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