The additional effects of adaptive survey design beyond post-survey adjustment:
An experimental evaluation

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Many thanks to my committee:
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Dr. Philippa Clarke

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Caroline Egan
Adaptive survey design

-- Change and tailor recruitment procedures and protocols for different sample cases

2 fundamental ideas:

- Leverage-salience theory
- Not all cases have the same value

Under budget constraints, 2 goals:

- Reduce **variance** of survey estimates
- Reduce **bias**

Groves, Singer, & Corning, 2000
Post-survey adjustment

For example, **calibration**: Matching respondent distributions to population distributions

- Reduce bias
- Reduce variance
This is the research question of this study.
Current literature

Theoretically:

adaptive design + post-survey adjustment—smaller bias and variance than—post-survey adjustment

Current literature

Why?
Supposed that men are less likely to participate than women under a standard protocol

Solution 1: post-survey adjustment
• Large weights $\rightarrow$ increase variance
• Small number of men $\rightarrow$ imbalance in unobserved dimensions $\rightarrow$ increase bias

Solution 2: + adaptive design
More male respondents
• $\rightarrow$ less need for large weights
• $\rightarrow$ more likely to balance in other unobserved dimensions
Current literature

Limitation:
Theories and simulations
• The adaptive design is assumed to work efficiently
• In reality, there are constraints

→ In real surveys, can the adaptive design bring additional benefits?

Experimentally answer this question
Methods
Methods

Experiment in Detroit Metro Area Communities Study (DMACS)
• Panel study of residents of city of Detroit
• Wave 12; January - March 2021
• Refreshment sample (n= 9329) + panel sample (n= 1730)

• Address-based sample
• Refreshment cases: mailings; panel cases: emails/ texts/ mailings
• Two ways to participate: Self-administered web interview (87%) + interviewer-administered telephone interview (13%)
Methods

Experimental Randomization

Panel sample
- 1730
  - 70% Experimental group
  - 30% Control group
    - Adaptive design
    - Standard design

Refreshment sample
- 9326
  - 70% Experimental group
  - 30% Control group
    - Adaptive design
    - Standard design
Adaptive design

Three strategies
1. Higher incentives to lower-response propensity cases
2. Invitation materials, highlight different aspects of the survey
3. Invitation letter, region-specific fact about COVID-19

Bundled together $\rightarrow$ combined effect
Adaptive design

Categorize sample into subgroups

- Cluster analysis on block groups
  Input: Census planning database (PDB) + National neighborhood data archive (NaNDA)
- Smooth into geographically contiguous areas

General residential area

High proportion of Hispanic population

Commercial area
Adaptive design

Operationalizing adaptive strategies for the four regions

#1: Differential incentive

- **West**: $25 (lower)
- **East**: $25 (lower)
- **Southwest**: $30 (higher)
- **Downtown**: $30 (higher)
Adaptive design

Operationalizing adaptive strategies for the four regions

#2: Tailored invitation materials

“DMACS is an ongoing survey that asks residents *about neighborhoods, quality of life, and other topics important to Detroiters and their families.*"

“DMACS is an ongoing survey that asks residents *what they feel are the important issues related to residential and commercial growth in Detroit.*"

“DMACS is an ongoing survey that asks residents *best meet the needs of people of many races and ethnicities who live in Detroit.*"
Adaptive design

Operationalizing adaptive strategies for the four regions:

#2: Tailored invitation materials

Same as East
Adaptive design

Operationalizing adaptive strategies for the four regions
#3: Region-specific fact about COVID-19
According to our most recent survey from the end of October 2020, 42% of Detroiters on the west side reported having friends or family members who died from COVID-19, compared to only 30% in the rest of Detroit.

According to our most recent survey from the end of October 2020, 10% of Detroiters on the Eastside considered getting medication a major challenge, compared to only 5% in the rest of Detroit.

According to our most recent survey from the end of October 2020, a substantially higher percentage of Detroiters in Southwest Detroit (31%) are not covered by any insurance or health care plan compared to the rest of Detroit (14%).

According to our most recent survey from the end of October 2020, a substantially higher percentage of Detroiters in Downtown and Midtown (80%) considered COVID-19 to be a very serious problem for their communities, compared to 67% in the rest of Detroit.
Standard design in control group

1. Incentive: $25
2. Same invitation materials
3. No COVID fact was included
Refreshment & Panel sample

Same design with minor modifications

- Just accommodate the different contacts: emails/texts vs. mailings
Analysis

Experimental group

Adaptive design

Control group

Standard design

Compare response rates and respondents’ demographic representativeness
Analysis

Experimental group
- Adaptive design
- Calibration

Control group
- Standard design
- Calibration

On gender and age, education, race and ethnicity, and household income

Compare **bias and variance of univariate estimates** and conclusions drawn from **multivariate analysis**

Costs
Results
Response rate

**Panel**
- Con. vs. Exp.: 0.69 vs. **0.72**

**Refreshment**
- Con. vs. Exp.: **0.10** vs. 0.09

**Panel**
- Con. vs. Exp.: 0.72 vs. **0.78**

**Refreshment**
- Con. vs. Exp.: 0.11 vs. **0.11**

**Panel**
- Con. vs. Exp.: 0.66 vs. **0.74**

**Refreshment**
- Con. vs. Exp.: **0.08** vs. 0.11

**Panel**
- Con. vs. Exp.: **0.78** vs. 0.70

**Refreshment**
- Con. vs. Exp.: 0.13 vs. **0.13**
Panel sample
1730

70%

Experimental group
Adaptive design

Control group
Standard design

30%

Refreshment sample
9326

70%

Experimental group
Adaptive design

Control group
Standard design

30%
Representativeness

Imbalance score (IMB)

\[ \text{IMB} = \sum_{c=1}^{C} \frac{(\text{Population}_c - \text{Sample}_c)^2}{\text{Sample}_c} \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adaptive design (experimental)</th>
<th>Standard design (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender * Age (8 categories)</td>
<td>21.5</td>
<td>19.1</td>
</tr>
<tr>
<td>Education (4 categories)</td>
<td>24.2</td>
<td>33.4</td>
</tr>
<tr>
<td>Race and ethnicity (5 categories)</td>
<td>5.0</td>
<td>5.2</td>
</tr>
<tr>
<td>Income (5 categories)</td>
<td>4.1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Brick, Kennedy, Flores Cervantes, & Mercer, 2021; Särndal & Lundquist, 2019
Univariate estimates – bias

Separately for the experimental and control data:

- 5000 bootstrap samples
- On each sample:
  - Calibration
  - Weighted mean estimate

Benchmark: 2015-2019 ACS estimate
Univariate estimates – variance

Separately for the experimental and control data:

• 5000 bootstrap samples
• On each sample:
  o Calibration
  o Sampling variance estimate (VAR)
• Take a ratio $\frac{VAR_{exp}}{VAR_{con}}$, if $< \frac{3}{7}$
Multivariate associations

Compare statistical significance in regression models

Separately for the experimental and control data:

• 5000 bootstrap samples

• On each sample:
  o Calibration
  o Fit regression models

• Count # of times that predictors emerge as significant
  (*adjusted SE based on 30%/70%)
# Multivariate associations

Outcome = Neighborhood satisfaction (1 = very dissatisfied, 7 = very satisfied)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reputation</td>
<td>1.00</td>
<td>0.95</td>
</tr>
<tr>
<td>Walk unsafe</td>
<td>-0.99</td>
<td>-0.94</td>
</tr>
<tr>
<td>Owner</td>
<td>0.24</td>
<td>0.03</td>
</tr>
<tr>
<td>Access to computer</td>
<td>-0.25</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Averaged coefficient across 5000 bootstrap samples

% of times the predictor emerge as significant
Multivariate associations

Outcome = Neighborhood satisfaction (1= very dissatisfied, 7= very satisfied)

<table>
<thead>
<tr>
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<th>Experimental</th>
<th></th>
<th>Control</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff</td>
<td>% sig</td>
<td>Coeff</td>
<td>% sig</td>
</tr>
<tr>
<td>Reputation</td>
<td>1.00</td>
<td>100%</td>
<td>0.95</td>
<td>100%</td>
</tr>
<tr>
<td>Walk unsafe</td>
<td>-0.99</td>
<td>100%</td>
<td>-0.94</td>
<td>100%</td>
</tr>
<tr>
<td>Owner</td>
<td>0.24</td>
<td>74%</td>
<td>0.03</td>
<td>17%</td>
</tr>
<tr>
<td>Access to computer</td>
<td>-0.25</td>
<td>54%</td>
<td>0.19</td>
<td>39%</td>
</tr>
</tbody>
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\(\Delta\)
Multivariate associations

A couple more models:
• Outcome: Likelihood of getting COVID-19 vaccine
• Outcome: personal homeowner

Result pattern:
• Intuitive associations: Adaptive design captures a few intuitive associations more stably
• Uncertain associations: Different results based on adaptive and standard design data
Costs

Incentive per respondent:
• Adaptive: $26.7; Standard: $25

Incentives account for about half of total survey costs

Other factors:
1. Labor intensive
2. Costs of preparing multiple versions of materials: e.g., design
3. Printing costs
Summary
Adaptive design + post-survey adjustment better than post-survey adjustment? Partly.

<table>
<thead>
<tr>
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<th>With Adaptive design</th>
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</table>
| **Response rate**              | • Slightly higher in panel sample  
|                                | • No difference in refreshment sample |
| **Representativeness**         | • More representative in education distribution |
| **Univariate estimates – bias**| • **No differences in bias** |
| **Univariate estimates – variance** | • **Smaller variances** |
| **Multivariate associations**  | • More stable associations for a few intuitive predictors  
|                                | • Different results on uncertain predictors |
| **Costs**                      | • More costly and troublesome |

Small benefit
Future research ideas

• How to design adaptive strategies? How to tailor the materials? Qualitative evidence

• Factorial experimental design: separate the effect of each strategy

• A more heterogeneous context? E.g., national sample?

• What sort of post-survey adjustment? E.g., calibration vs. propensity-score adjustment?

• Richer auxiliary information? E.g., panel data
References


