COMPARISON of WITH-REPLACEMENT and WITHOUT-REPLACEMENT VARIANCE ESTIMATES for a COMPLEX SURVEY

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MATHEMATICA
Policy Research, Inc.

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Overview

- Introduction
- Study Objectives and Methods
- Variance estimation considerations
- Comparisons for different assumptions
- Summary
Community Tracking Study (CTS)

- Data on changes in healthcare system
  - Primary focus on community
    - Site-level analysis
      - National estimates as byproduct
- Data made available to researchers
CTS Sample Structure
Multi-stage Multi-sample Design

- Two independent samples
- Multi-stage design
  - 60 PSUs (called sites)
  - 9 Certainty PSUs
- Supplemental sample
  - Stratified random national sample
Multi-stage Sample Design

- 60 PSUs / Sites
  - 12 for intensity study
  - 48 other sites
  - Improve national coverage and precision
- Probability proportional to size
- Stratified by MSA size and region
- Without-replacement selection
Survey Data Variance Estimation

- Two general approaches
  - Taylor series linearization
  - Replication methods
- Software available
  - SUDAAN (version 8)
  - Stata (version 8)
  - SAS (version 8) Surveyregs/Surveymeans
  - WesVar (version 4)
- Recommend SUDAAN for CTS
- WWW.FAS.HARVARD.EDU/~STATS/SURVEY-SOFT
Why Without Replacement?

- Without-replacement selection of PSUs (sites)
- Probability proportion to size
  - Certainty PSUs
- Small PSU frame
  - Sizeable finite population correction factor (FPC)
- FPC → Joint inclusion probabilities
- Only SUDAAN has capability
COMPARISON of ALTERNATIVES

- Study Measure: *Reldiff* (%):

\[
\text{Reldiff} = 100 \times \frac{\text{SEwr} - \text{SEwor}}{\text{SEwor}}
\]

- **SUDAAN** used for analysis
  - \( \text{SEwor} \) using `DESIGN = UNEQWOR`
  - \( \text{SEwr} \) using `DESIGN = WR`
Comparison of Variances Using WOR and WR Assumption

- Methods compared
  - SUDAAN, Stata, and SAS with-replacement
  - SUDAAN without-replacement

- Household survey
  - 126 Estimates (samples of 6000-60,000)
  - Domains: All, Hispanic, low income uninsured

- Physician survey
  - 35 Estimates (samples of 4,000-12,000)
  - Domains: All, high MC revenue, solo, group
Ref Difference of Standard Errors

ALL HOUSEHOLDS

<table>
<thead>
<tr>
<th>RelDiff</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50</td>
<td>2</td>
</tr>
<tr>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>25</td>
<td>16</td>
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<tr>
<td>15</td>
<td>28</td>
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<tr>
<td>5</td>
<td>51</td>
</tr>
<tr>
<td>-5</td>
<td>15</td>
</tr>
<tr>
<td>-15</td>
<td>3</td>
</tr>
</tbody>
</table>

frequency
ALL vs LOW-INCOME HH

ALL HOUSEHOLDS

LOW INCOME HOUSEHOLDS

Frequency
## HOUSEHOLD SURVEY SUMMARY

<table>
<thead>
<tr>
<th></th>
<th>ALL HH</th>
<th>HISP</th>
<th>LOW INCOME</th>
<th>NOT INSURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE RELDIFF(%)</td>
<td>12</td>
<td>-3</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>PERCENT WITH RELDIFF &lt; 0</td>
<td>14</td>
<td>63</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>
PHYSICIANS: ALL

ALL PHYSICIANS

RelDiff

<table>
<thead>
<tr>
<th>RelDiff</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;50</td>
<td>2</td>
</tr>
<tr>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>35</td>
<td>7</td>
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<tr>
<td>25</td>
<td>8</td>
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<td>15</td>
<td>8</td>
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<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>-5</td>
<td>2</td>
</tr>
<tr>
<td>-15</td>
<td>1</td>
</tr>
</tbody>
</table>

frequency
HOUSEHOLDS vs. PHYSICIANS

ALL HOUSEHOLDS

-5 3
-15 1

-15 3

-5 15

5 28

15 28

25 16

35 6

45 4

>50 2

ALL PHYSICIANS

-5 2

-15 1

-15 1

5 3

15 8

25 8

35 7

45 2

>50 2

frequency

frequency
## PHYSICIAN SURVEY SUMMARY

<table>
<thead>
<tr>
<th></th>
<th>ALL PHYS</th>
<th>HIGH M.C. REVENUE</th>
<th>SMALL PRACTICE</th>
<th>GROUP PRACTICE</th>
<th>PCP</th>
<th>SPECIALIST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AVERAGE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rel Diff (%)</td>
<td>22</td>
<td>18</td>
<td>2</td>
<td>28</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td><strong>PERCENT WITH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rel Diff &lt; 0</td>
<td>10</td>
<td>3</td>
<td>44</td>
<td>4</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

**Notes:**
- **Rel Diff (%)** represents the percentage change in revenue.
- **Rel Diff < 0** indicates the percentage of providers with a decrease in revenue.
### Comparison for Descriptive Statistics

#### Relative Differences in RSEs

<table>
<thead>
<tr>
<th>Household</th>
<th>All</th>
<th>Hispanic</th>
<th>Low Income</th>
<th>Uninsured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>11.8</td>
<td>-2.9</td>
<td>8.4</td>
<td>6.2</td>
</tr>
<tr>
<td>%&lt;0</td>
<td>14</td>
<td>63</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physician</th>
<th>All</th>
<th>Solo</th>
<th>Group</th>
<th>High M.C. Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>21.5</td>
<td>1.7</td>
<td>27.6</td>
<td>17.6</td>
</tr>
<tr>
<td>%&lt;0</td>
<td>10</td>
<td>44</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
## Comparison for Multivariate Statistics

### ~RelDiff for Coefficient RSEs~

<table>
<thead>
<tr>
<th>CTS Household Models</th>
<th>Ambulatory visits</th>
<th>Cost concerns</th>
<th>Health status</th>
<th>Health plan rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model (vars)</td>
<td>Linear (12)</td>
<td>Linear (24)</td>
<td>Linear (7)</td>
<td>Logit (23)</td>
</tr>
<tr>
<td>Mean</td>
<td>5.0</td>
<td>20.3*</td>
<td>11.0</td>
<td>9.6</td>
</tr>
<tr>
<td>% &lt; 0</td>
<td>25</td>
<td>16</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>
## Comparison for Multivariate Statistics

### ~ReIDiff for Coefficient RSEs~

<table>
<thead>
<tr>
<th>Model (vars)</th>
<th>Hours of charity</th>
<th>Income</th>
<th>Career satisfaction</th>
<th>Charity care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear (20)</td>
<td>Linear (13)</td>
<td>Logit (32)</td>
<td>Logit (21)</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>9.3</td>
<td>18.7</td>
<td>9.3</td>
<td>14.8</td>
</tr>
<tr>
<td>% &lt; 0</td>
<td>5</td>
<td>8</td>
<td>16</td>
<td>5</td>
</tr>
</tbody>
</table>
Summary of Findings

- Minor SE differences for household survey, major differences for physician survey
- Small domains => Unstable variances
- Hispanic domain clustered: 40% in 3 sites
- WOR incorporates more of the CTS sample design
CONCLUSIONS

- CTS has complex sample design
  - requires weights
  - specialized variance estimation software

- Without-replacement assumption (SUDAAN) more fully accounts for sample design

- WR assumption generally conservative
  - Some unpredictable results
  - small variance estimates for some subgroups

- Accepting conservative WR SEs has costs in statistical power
CTS Publications

- Center for Studying Health System Change
  - WWW.HSCHANGE.ORG
  - Links to ICPSR for data
  - CTSonline: an interactive system

- Information available
  - Data Bulletins
  - Issue Briefs
  - Community Tracking Reports
Public and Restricted Use Files

- Public Use Files
  - Available to all researchers via ICPSR
  - Some limitations
    - Some variables deleted or modified
    - Other limitations
- Restricted Use Files
  - Must sign data-use agreement
  - Variance estimation parameters