

Sample Design in 3-Stage Household Surveys Supplemented by Commercial Lists

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Household Surveys with Over- or Under-Sampling

- Household surveys often target particular demographic subgroups
 - Blacks
 - Hispanics
 - Age groups
- Different ways to obtain target sample sizes
 - Select equal probability sample of HUs, screen persons for eligibility, retain at rates to obtain sample size
 - Stratify SSUs by census or ACS data related to target groups; sample SSU strata at different rates
 - Use commercial lists with demographic info on HUs

Pros and Cons

(1) Equal probability with screening

- Expensive if oversampling rates differ by group
- Many HUs may be screened out and dropped

(2) SSU stratification

- More efficient than (1) if strata directly related to target groups
- Info is at block group level not HU

(3) Commercial lists

- Info is at HU level
- Only ~60% of HUs have demographic info & may be wrong

Goals of Dissertation

- Estimate accuracy of commercial lists for identifying households with certain characteristics (e.g. Hispanics, non-hispanic blacks, teens (15-19), females, etc.)
- Determine how to allocate two and three stage samples supplemented with commercial lists accounting for:
 - Inaccuracy of listings
 - Costs at each stage of sampling
 - Target sample sizes and CVs for estimates of subgroups
 - Stratification of SSUs by area characteristics (e.g. density of blacks, hispanics, others)
 - Stratification of HU's by list characteristics (e.g. Race/ethnicity, ages of persons in HU, etc.)⁷
 - Characteristics of different variables of interest

Goals of Dissertation (continued)

- Study alternative variance component estimators
 - Design-based (ANOVA)
 - Anticipated variances
 - Bayes

Previous Literature

Iannacchione, V., J. Staab, and D. Redden (2003), "Evaluating the Use of Residential Mailing Lists in a Metropolitan Household Survey," *Public Opinion Quarterly*, 67(2), 202–210.

Roth, S. B., J. Montaquila, and D. Han (2012), "The ABS Frame: Quality and Considerations," *Proceedings of the Section on Survey Research Methods*, 3779-3793.

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Shook-Sa, B., D. Currivan, J. McMichael, and V. Iannacchione (2013), "Extending the Coverage of Address-Based Sampling Frames: Beyond the USPS Computerized Delivery Sequence File," *Public Opinion Quarterly*. doi:10.1093/poq/nft041.

Valliant, R., Hubbard, F., Lee, S. and Chang, C. (2014), "Efficient use of commercial lists in U.S. Household Sampling. *Journal of Survey Statistics and Methodology*," 2: 182- 209.

Example from Health & Retirement Study

Example based on HRS; LBB = Late Baby Boomers

Data from screening results in National Survey of Family Growth compared to commercial list records

	Commercial list stratum	LBB; B	LBB; H	LBB; Other	Not LBB	Unoccupied	Total
1	LBB; no race-eth	0.0000	0.0125	0.5322	0.4065	0.0487	1
2	LBB; B	0.2213	0.0163	0.1586	0.5384	0.0654	1
3	LBB; H	0.0081	0.2730	0.1400	0.5336	0.0453	1
4	LBB; Other	0.0238	0.0101	0.4493	0.4657	0.0510	1
5	Has record; Not LBB	0.0139	0.0101	0.0566	0.8691	0.0503	1
6	Has record; No age info	0.0159	0.0198	0.0496	0.7995	0.1152	1
7	No record	0.0121	0.0136	0.0635	0.6933	0.2175	1
	Total	0.0163	0.0159	0.0883	0.7553	0.1241	1.000

- Commercial list info accurate enough to be useful but far from perfect
- MP allocation accounts for inaccuracies in finding sampling rates

Variance of an Estimator of Total

- 3-stage sample

- m PSUs selected with *pps* with replacement
- \bar{n}_a SSUs stratified and selected *ppswr* within stratum a
- \bar{q}_{ab} HUs selected by *stsr*s with SSU stratum a , list stratum b

$$\begin{aligned}
 V(\hat{t}_{pwr}) &= \frac{1}{m} \frac{S_{U1(pwr)}^2}{t_U^2} + \frac{1}{mt_U^2} \left\{ \sum_{i \in U} \frac{1}{p_i} \sum_{a=1}^D \frac{S_{U2ia(pwr)}^2}{\bar{n}_a} + \right. \\
 &\quad \left. \sum_{i \in U} \frac{1}{p_i} \sum_{a=1}^D \frac{1}{\bar{n}_a} \sum_{j \in U_{ia}} \frac{1}{p_{j|ia}} \sum_{b=1}^B \frac{Q_{iajb}^2}{\bar{q}_{ab}} S_{3iaj}^2 \right\} \\
 &\equiv \frac{B^2}{m} + \sum_{a=1}^D \frac{W_{2a}^2}{m\bar{n}_a} + \sum_{a=1}^D \sum_{b=1}^B \frac{W_{3ab}^2}{m\bar{n}_a\bar{q}_{ab}}
 \end{aligned}$$

- B^2 , W_{2a}^2 , and W_{3ab}^2 are relvariance components to be estimated

- Random effects model

$$y_{iajbk} = \mu_{iajbk} + \alpha_i + \gamma_{iaj} + \varepsilon_{iajbk}$$

$$\mu_{iajbk} = \mathbf{x}_{iajbk}^T \boldsymbol{\beta}$$

$$\alpha_i \sim (0, \sigma_\alpha^2), \gamma_{iaj} \sim (0, \sigma_{\gamma a}^2), \varepsilon_{iajbk} \sim (0, \sigma_\varepsilon^2)$$

- Anticipated variance

Compute $E_M V_\pi(\hat{t}_{pwr})$;

Estimate model variance components via ML, REML, Bayes

Sample Allocation is a Math Programming Problem

- Allocation problem

$$\text{Find } \{m, \bar{n}_a, \bar{q}_{ab}\} \text{ to } \min \left[V(\hat{t}_{pwr}) \right]$$

subject to

- minimum values of $m, \bar{n}_a, \bar{q}_{ab}$
- CV constraints on subgroup estimates (e.g., Blacks, Hispanics, Others)
- $deff(w) \leq d_{\max}$ for different subgroups

Or, could minimize cost s.t. constraints on sample sizes, CVs, etc.

Data & Analysis

- NSFG or HRS screening/interview results matched to commercial list information
- Estimate
 - List accuracy
 - Variance components
- Evaluate cost of MP allocations vs.
 - Equal probability allocation + screening
 - SSU stratification only + MP allocation
 - MP allocation to list strata and no SSU stratification