

Dual Frame Fixed Line/Cellular Phone Survey: Determining Sample Design Weights

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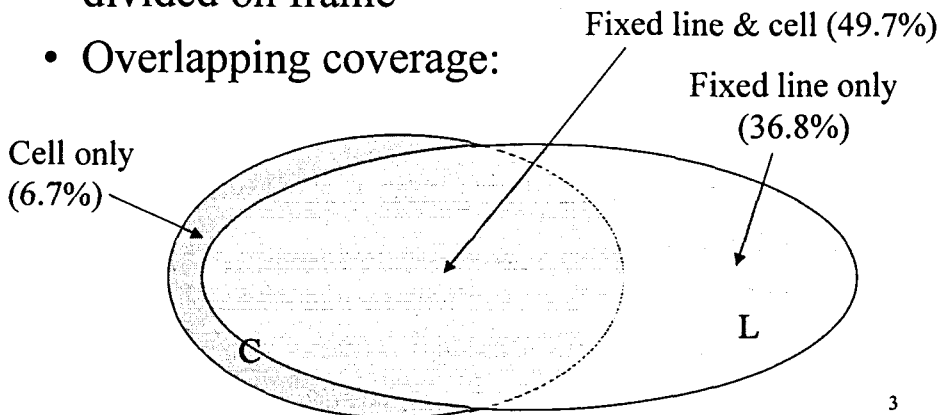
It will be published in the 2005 proceedings of the Section on Survey Research Methods, American Statistical Association.

1. Fixed Line and Cell Phones

- Fixed line (Landline) coverage through mid-1990's increasing modestly
- Cell phone growth (Kim & Lepkowski, 2002)
- Cell only population: increasing coverage problem
 - Tucker and Brick
 - Steeh: including cell phones in a telephone survey
 - Brick et al.: JPSM survey
- New technologies: VoIP (Internet Voice)
 - Alternative to fixed lines
 - VoIP numbers are in plain old telephone service (POTS) prefixes or others

Dual frames for telephone households

- Fixed line and cell phone numbers can be divided on frame
- Overlapping coverage:



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Dual frame sample selection/estimation

- Select sample from each frame, combine data through weights
- Select n_F from Fixed line frame, n_C from Cell
- Sampling rates: π_F, π_C
- Compute weights to compensate for unequal probabilities of selection across domains for telephone numbers:
 - Cell only: $1/\pi_C$
 - Fixed line only: $1/\pi_F$
 - Fixed line and cell: $1/(\pi_C + \pi_F - \pi_C\pi_L)$

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2. Household selection: FHD

- Fixed line telephone samples: Fixed line frame (F) only
 - All residential telephones in a household are household devices (FHD)
 - Every eligible person within the household can be reached through every FHD
 - Residential fixed lines in household (N_{FHDi})
 - Household weight:
$$\frac{1}{\pi_F N_{FHDi}}$$

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Within household selection: FHD

- Eligible person level
 - Select one eligible person from each household (N_{Ei})
 - Person weight:
$$\frac{N_{Ei}}{\pi_F N_{FHDi}}$$

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Cell only, personal device: CPD

- Cell only household
- Suppose the cell phone(s) is(are) only used as personal device(s) (CPD)
 - Number of CPD devices: N_{CPDi}
 - Household level selection probability: $\frac{1}{\pi_C N_{CPDi}}$
- Person level: person answering cell phone is chosen
 - Person level probability: $\frac{1}{\pi_C}$

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Cell only, household device: CHD

- Cell only household again
- But there is only one cell phone used as a household device (CHD)
 - Household level selection probability: $\frac{1}{\pi_C}$
 - Person level: select from among all eligibles in household
 - Person level probability: $\frac{N_{Ei}}{\pi_C}$

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Fixed & cell mixed: FHD & CPD

- Suppose we have one FHD and one CPD
- If the CPD is selected, that eligible person will report for the household, and themselves
- If the FHD is selected, one eligible (including the person with the CPD) is selected.
- Household probability: $\frac{1}{\pi_F + \pi_C}$
- Person probabilities $\frac{1}{N_{FHDi}}$
 - CPD person: $\frac{\pi_F}{N_{FHDi}} + \pi_C$
 - All other eligible persons: $\frac{N_{FHDi}}{\pi_F}$

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3. General framework: devices

- Mixed telephone devices
 - Fixed household (FHD)
 - Cell personal (CPD)
 - Cell household (CHD)
- Shared devices
 - Cell shared: more than one eligible person can be reached, but not all household eligibles (CSD)
 - And Fixed shared device (FSD)
- Fixed personal device: not considered routinely
 - Fixed person device (FPD) – not considered in telephone surveys before

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General framework: within household

- Select one eligible person in household, regardless of telephone devices
 - Provides household level report
 - Provides person level report
- Select one eligible person who uses the device selected
 - Provides household level report
 - Provides person level report

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Device and person array: ‘use’ indicator

	Person 1	Person 2	Person 3	Person 4	Person 5
Device 1	1	1	1	1	1
Device2	0	1	0	0	0
Device 3	0	0	1	0	0
Device 4	0	0	0	1	1
Device 5	0	0	0	0	1

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Indicator variables

- δ_{ij} : denotes 'use' of device i by person j
 - $\delta_i = \sum_{j=1}^{N_E} \delta_{ij}$: number of eligibles using device i
among N_E total eligible persons
 - $\delta_j = \sum_{i=1}^{N_D} \delta_{ij}$: number of devices used by person j
among N_D devices in the household

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Person level weight

- Weight for selected person j :

$$\frac{1}{\sum_{i=1}^{N_D} \frac{\delta_{ij} \pi_i}{\delta_i}}$$

- π_i is the probability of selection of device i

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Illustration: FHD, CPD, and CSD

	Person 1	Person 2	Person 3	Person 4	Person 5
FHD	1	1	1	1	1
CPD	0	0	1	0	0
CSD	1	1	0	0	0

$$j = 1, 2: \frac{1}{\frac{\pi_F}{5} + \frac{\pi_C}{2}} \quad j = 3: \frac{1}{\frac{\pi_F}{5} + \pi_C} \quad j = 4, 5: \frac{1}{\frac{\pi_F}{5}}$$

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4. Application: George State University Survey

- National Science Foundation sponsored survey
- Investigated use of cell telephones and feasibility of ‘calling’ cell telephones by RDD
- Sample design
 - Fixed line phone sample: RDD with FHD
 - Cell phone samples: RDD of cell phone numbers
 - Treat all devices as CPD for respondent selection
 - Under certain assumptions, can determine CPD & CSD as well
- Completed interviews (1,564)
 - RDD: 743
 - Cell: 821

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GSU survey weights

- Combining two frame survey into single national telephone survey
- Two types of weighting
 - FHD, CPD, and CHD
 - FHD, CPD, CHD, and CSD
- No non-response adjustment
- Poststratification
 - Bureau of the Census June 1, 2003 projection
 - Age groups by gender

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GSU questions on devices & persons

QCONV:

Do you live in a household that has at least one conventional fixed line telephone, that is a telephone that is connected to a telephone outlet and is also called a landline or home telephone?

- Yes
- No

QMORE:

Excluding all cellular telephones and pagers, how many different fixed line telephone numbers will reach your household?

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GSU questions on devices & persons

QUSECELL:

Do you ever use a wireless, cellular, or mobile phone?

- Yes
- No

QOWNCELL:

Do you personally own, lease, or rent a cellular phone?

- Yes
- No

QUSE:

Who uses the cell phone most of the time?

- Me
- Spouse
- Child under 18
- Someone else in the same household
- Someone else who does not live in the same household
- Phone is in common use

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GSU questions on devices & persons

QOTHER:

In addition to your phone, how many other cellular telephones are there in your household?

QUSE2 (QUSE3 and QUSE4):

Who mainly uses this phone?

- Me
- Spouse
- Child
- Someone else
- Phone is in common use

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Devices by household: fixed line phone survey

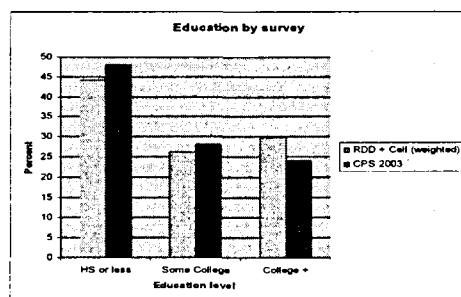
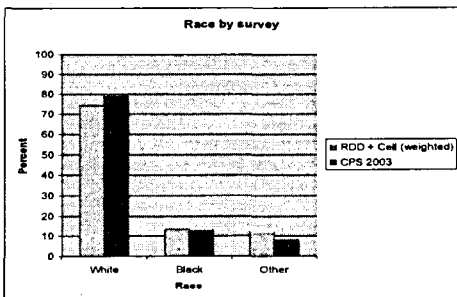
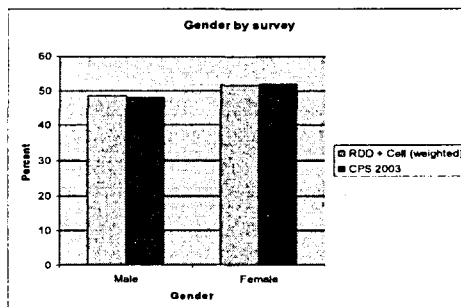
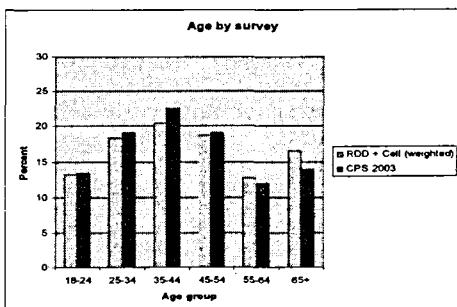
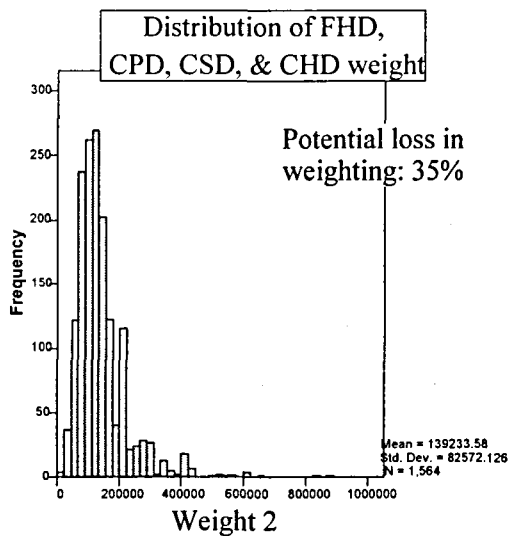
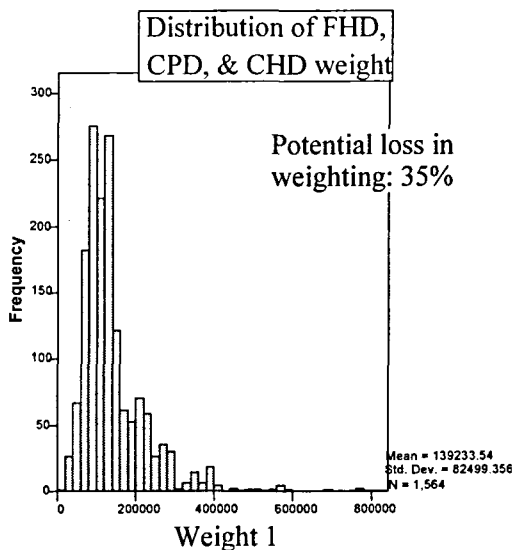
Fixed line only households	FHD	208	28.0%	28.0%
Fixed line & cell households	CPD & FHD	428	57.6	72.0%
	CHD & FHD	34	4.6	
	CPD, CHD & FHD	31	4.2	
	Combinations	42	4.7	

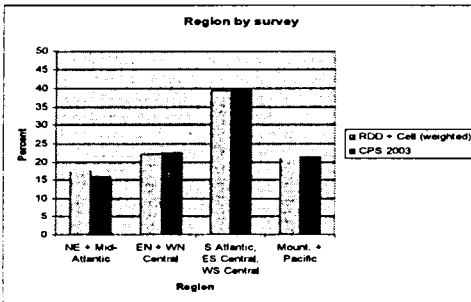
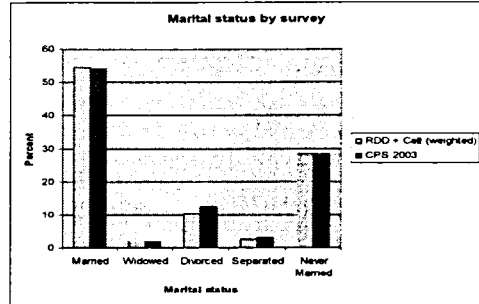
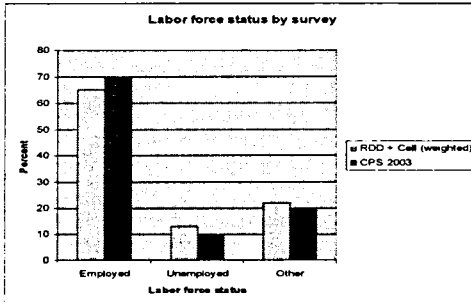
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Devices by household: cell phone survey

Cell only households	CPD	80	9.7%	11.9%
	CHD	9	1.1	
	CPD & CHD	7	0.9	
	Other combinations	2	0.2	
Cell & fixed line households	CPD & FHD	620	75.5	88.1%
	CHD & FHD	23	2.8	
	CPD, CHD & FHD	42	5.1	
	Other combinations	38	4.6	

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5. Questions about eligible persons

PERSON:

How many people, including yourself, answer (use) this telephone number for personal calls?

(IF OTHER PERSONS) Please tell me first name of each of the other persons.

1. _____
2. _____
- ...
6. _____

(RESPONDENT SELECTION)

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Questions about devices

OTHER:

Are there any other phone numbers where you can be reached for person calls?

- Yes
- No

(IF YES) How many?

(IF ONLY ONE) Is that number a cell phone or a landline phone?

- Cell
- fixed /Landline

How many people, including yourself, use that telephone number for personal calls?

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Questions about devices

USE1:

For the first of those numbers, is it a cell or a landline phone?

- Cell

How many people, including yourself, use that telephone number for personal calls?

USE2, USE3, USE4:

For the second of those numbers, is it a cell or a landline phone?

- Cell
- Fixed/ Landline

How many people, including yourself, use that telephone number for personal calls?

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6. Research questions

- Coverage and accuracy of device questions
 - How well can individuals answer such questions?
- Alternative dual frame allocations: optimal?
- Distribution of weights: potential increase in variance due to weighting
- Response rates by frame
- Integrating new technologies: VoIP