"Cell-Phone Sampling: An Alternative Approach"

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Abstract: Most current approaches to cell-phone sampling consist of overlapping frame designs that require non-empirical decisions in matters such as the proportion of cell vs. landline sample released, the proportion of cell interviews completed and the weights applied to cell-only, cell-plus-landline and landline-only samples. An alternative approach is to devise a non-overlapping dual-frame sampling plan that incorporates cell-only respondents as a specific issue of known non-coverage. This approach benefits from straightforward theoretical and empirical underpinnings, obviating guesswork in sampling and weighting; what it lacks is the inclusion of "cell-mostly" respondents. Our paper describes the theoretical and empirical bases for this approach, its operationalization in sampling, sample stratification and weighting, its cost efficiency and its impact on demographic and other estimates.

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After several years of watchful waiting the ABC News/Washington Post polling team[1] became convinced by spring 2008 that the time had come to address an increasing problem of non-coverage in its RDD telephone sampling. The challenge was clear: a continued rise in the number of Americans foregoing landline service to rely solely on their cell phones. The solution, however, was less clear.

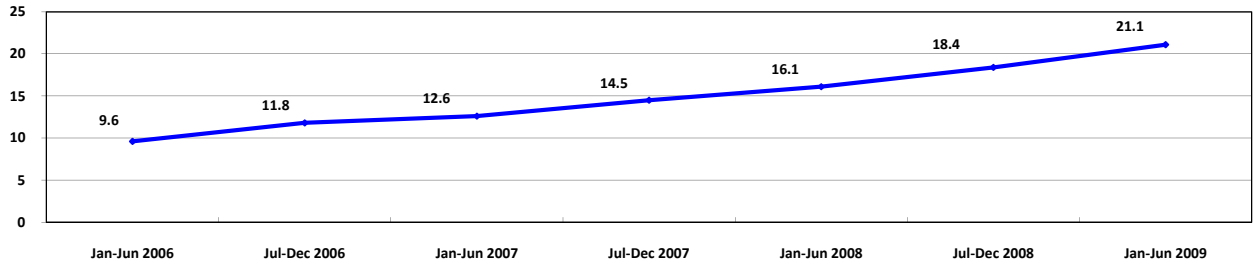
Estimates of the cell-only population from the National Health Interview Survey (NHIS) had increased from 9.6 percent in the first half of 2006 to 14.5 percent in the second half of 2007 (Blumberg and Luke 2008). This non-coverage was non-random, with significant demographic differences – cell-only respondents were disproportionately apt to be living with unrelated roommates, young, male, living in the South or Midwest, non-white, renters and living in poverty. And they were behaviorally different, with a higher propensity to report health risk behaviors. These differences were significant even within the 18- to 29-year-old group (Blumberg & Luke 2007), suggesting that weighting to age in a landline sample would not eliminate the disparities. But these are health variables. Would significant differences appear in public opinion measures?

Initial reports comparing weighted landline-only portions of overlapping frame samples with combined landline plus cell-only samples indicated little evidence of an effect on attitudinal data of the sort we measure, focused largely on political issues and other current events (Pew Research Center 2008); likewise little effect was seen on religious self-identification and customer satisfaction data (Pond et. al. 2008, Bryant et. al. 2008). Yet we had no assurance an impact could not arise in the future – a particular concern for the accuracy of our estimates in the then-upcoming presidential election of 2008 – and in any case the non-coverage was approaching the limit of

[1] Core members of this team included David Lambert and Mike McMenemy, then of TNS, now at Synovate; Gary Langer of ABC News and Jon Cohen of the Washington Post. (TNS continues to conduct field work for ABC/Post polls.) We were assisted in our cell-only deliberations by research consultant Paul J. Lavrakas. See Langer 2009 for sample design details beyond those described in this paper.

toleration on theoretical, or face-validity, grounds (Mokrzycki et. al. 2009). Beyond the election, in any case, further increases in this population seemed likely, and in fact now have been realized, with the cell-only population reaching 21.1 percent in the first half of 2009 (Blumberg and Luke 2009). (An updated NHIS estimate for the second half of 2009 is expected to be released at this conference.) The potential of a significant effect on attitudinal data in the future could not be ignored.

Graph 1. Percentage of adults in the United States with only wireless phone service: 2006-2009 (Blumberg and Luke 2009)



The most prominent approach to the growing cell-only population has involved an overlapping frame sample design in which respondents can be reached either by landline through numbers dialed via a traditional, random-digit dialed sample of all possible landline numbers; or via cell phone through a separate sample of all possible wireless numbers. (Keeter et. al. 2008, Benford et. al. 2009) We were troubled, however, by seemingly non-empirical judgments required by this approach: the proportion of landline sample vs. cell sample to be released; the proportion of completed interviews via landline vs. via cell to obtain; and the appropriate weights to be applied to the landline-only, landline-plus-cell and cell-only individuals interviewed.

It was argued that this overlapping frame approach was required not just to address the non-coverage created by the growing cell-only population, but additionally to address the perceived or potential non-coverage of so-called "cell-mostly" Americans – those who possess both landline and cell phones but who, it was feared, may never, or only infrequently, accept incoming landline calls (Blumberg and Luke 2008, Keeter et. al. 2008, Dimock et. al. 2009, Battaglia et. al. 2009).

While sharing concern about the issue, upon inspection we were unsure about the measurement and meaning of the cell-mostly population, and unconvinced its inclusion justified the seemingly non-empirical judgments in sampling and weighting that would necessarily follow. We chose instead to view the cell-mostly population as a problem of possible non-response rather than certain non-coverage, and rather to remain focused on our chief concern: the unquestioned and well-measured issue of non-coverage of cell-only Americans.[2]

This paper explains the alternative approach that ensued.

Sampling

NHIS data available in summer 2008 indicated that 19.1 percent of Americans had landline-only service, 63.2 percent had both landline and cell phones (a.k.a. "duals"), and (as noted) 14.5 percent were cell-only.[3] In initial discussions seeking an empirically based overlapping frame design, we considered interviewing all the landline-

[2] We note that overlapping frame designs have been more prevalent in publicly released public opinion surveys. Nonetheless other organizations beyond our own have opted instead for a dual frame, cell-only approach, including for example the Behavioral Risk Factor Surveillance System survey overseen by the U.S. Centers for Disease Control and Prevention. Discussing the rising cell-only population, the BRFSS said: "This threat to the validity of traditional RDD surveys such as the BRFSS can best be met by including cell phone-only adults in the survey." (Behavior Surveillance Branch, Centers for Disease Control and Prevention. "Behavioral Risk Factor Surveillance System Cell Phone Project Operational Protocol," Nov. 7, 2008.) Additionally, the Gallup Organization uses a non-overlapping dual-frame sample design in its multi-day Gallup and USA Today/Gallup polls.

[3] Of the rest, 1.9 percent had no telephone service, 1.2 percent had landlines with unknown wireless status and 0.1 percent had no landlines and unknown wireless status (Blumberg and Luke 2008).

only and half the landline-plus-cell respondents by landline, and all the cell-only and the other half of the landline-plus-cell respondents by cell phone. There were two problems: First, this would require 46 percent of interviews to be conducted via cell phone, at a cost per interview (CPI) estimated at 2 times the landline CPI (Keeter et. al. 2008, Pew Research Center 2008). Second, this approach included its own non-empirical assumption, that the propensity of landline-plus-cell respondents to be reached on either instrument was equal. And again we were left with no clear approach on weights. One approach applied an initial weight of 2 for landline only, 2 for cell only and 1 for duals. This step, again, seemed to presume a propensity to answer either phone that in fact was unknown. Existing ABC/Post methodology for landline RDD samples, moreover, included regional stratification, a feature absent in the sampling descriptions of the overlapping frame designs we reviewed.

Our approach, then, was to continue to view the landline sample as our primary sampling source (then as now, most households did have a landline), and to draw a separate, non-overlapping sample of cell phone numbers to obtain a supplemental sample of cell-only respondents. We continued to stratify our landline sample at the Census division level; given less granular data from the NHIS, we stratified the cell-phone sample at the Census region level for proportions of cell-only adults. Reflecting budgetary constraints, we set quotas at two-thirds the cell-only population by region, to be corrected by weighting.

Screening and Coverage

Cell-phone samples do not contain information indicating whether or not cell owners also have a landline at home. Our approach, then, requires screening would-be cell-phone respondents for landline ownership and politely terminating interviews with those who have landlines, since they are covered in the landline frame. This admittedly requires the near-heresy of hanging up on otherwise willing respondents; approximately 60 percent of our cooperating cell-phone respondents are terminated as landline-equipped.

While our approach, as noted, leaves cell-mostly respondents unaddressed, research suggests this approach can be justified. As early as 2008, reports suggested that greater than 50 percent of cell-phone respondents would have been surveyed via their landline had it been dialed at that time (Keeter et. al. 2008, Dimock et. al. 2009**)**. This left open the question of how many would have been available had their landline been dialed at another time, especially relevant since presumably not all those cell-phone respondents were home at the time of the interview, the cell phone being a mobile device.

Said Keeter et. al.:

"…there is no strong evidence that a landline-only sample cannot reach a vast majority of these dual users. Even those who express the strongest orientation to their cell phones are reachable by landline, with enough phone room effort." (Keeter et. al. 2008)

An inherent problem in the "cell-mostly" definition was its assumption that these respondents are in fact unwilling or unavailable to participate in a landline interview. More direct subsequent measures have suggested otherwise. In a recent report, although nearly 16 percent of adults indicated they were cell-mostly, fewer than 4 percent said it was "very unlikely" or "not at all likely" that their landline would be answered when someone was home – dubbed "cell-mainly" respondents (Boyle, Lewis and Teftt 2009). Paradoxically, most of these cell-mainly respondents actually were interviewed on their landline telephones, indicating that even this measurement was not capturing true non-coverage. Only 1.5 percent of the total dual frame sample consisted of cell-mainly respondents reached on cell phones. The authors concluded: "This survey suggests that the proportion of adults in the United States who have a landline home phone, but are not accessible by their household landline for telephone surveys, appears to be very small at this time."

Citing such evidence, Blumberg, who first described the potential cell-mostly challenge, said at a recent presentation to New York AAPOR, "The wireless mostly may not be as big of a threat as we were worried about."[4]

Weighting

At that same NYAAPOR session, Blumberg noted that the overlapping frame design "creates a real headache when it comes to weighting," an issue briefly described above and well covered by others (e.g., Brick and Morganstein 2009, Brick 2009, AAPOR Cell Phone Task Force 2008)**.** As noted above, some approaches require giving all adults in dual households half the initial weight of those who are landline or cell-only; others are more elaborate. The optimal weighting approach for overlapping landline and cell phone frames, per Blumberg, "Still does not exist in the literature."

A cell-only approach avoids these complications. As noted, we stratify landline sample at the Census division level and cell-phone data at the Census region level for proportions of cell-only adults. Cell-only and landline samples first are weighted by Census region to their respective proportions of the population (per NHIS cell-only estimates)[5] (Langer 2009). The combined sample is then balanced via iterative proportional fitting to full-population Census parameters for age, race, sex and education.

Since the cell-only sample is comprised of more respondents from underrepresented groups, one artifact of applying demographic balancing after a ratio adjustment for cell-only penetration is that the overall percentage of

[4] Stephen J. Blumberg, "Cell Phones and Survey Accuracy: Findings from the National Health Interview Survey," presentation at NYAAPOR, New York, N.Y., April 13, 2010.

[5] This initial weight would not be required were it not for our intentional disproportionate underrepresentation of cell-only respondents for cost-control purposes. It should be noted that our weighting approach with regard to cell-only respondents is necessarily constrained by the size of this sample.

cell-only respondents in the weighted data often rises slightly higher than the NHIS cell-only estimate. We allow this (within limits), for two reasons: First because the NHIS estimate is a retrospective measure of what has been a steadily growing population; and second because one benefit of cell-only interviews is to include these underrepresented groups. A regional cell-only post-weight is applied to the weighted total sample, if needed, to cap the final cell-only proportion at the current projected level based on NHIS data.

Brick, in a November 2009 webinar presentation,[6] reported that when a survey produces large variation in response rates within the cell frame of an overlapping sample, the cell-only screener approach has lower non-response bias; when the variation in response rates is smaller, the overlap approach has lower bias. To choose an estimator in adjusting an overlap design, he added, it's necessary to compare telephone usage estimates from NHIS with those in reported in the survey. On this basis Brick expressed preference for an overlap design for national surveys. However he also noted the benefits of a screened cell-only approach, including simple weighting, reasonable assumptions about non-response bias (a feature of both approaches) and low variance, "often lower than with overlap." For state surveys, on the other hand, Brick expressed preference for cell-only sampling "for all but the largest states" because of the errors in state-level NHIS estimators.

While we await further investigation, there are challenges. Production schedules for news polling does not allow time to calculate and choose estimators on a survey-by-survey basis. To the extent possible we seek to avoid variability in our approach from survey to survey, preferring consistent protocols. We also seek consistency in our approach to state and national polls. Finally, given cost considerations we like not to conduct cell interviews we don't need to conduct. All those militate from our perspective for the cell-only approach.

[6] "Dual Frame Theory Applied to Landline and Cell Phone Surveys," Survey Research Methods Section Webinar, Nov. 10, 2009.

Characteristics of Dual Frame vs. Cell-only Approach

	Overlapping Frame	Cell-Only
Sampling	Cell sample size set by budget or design with no fixed cell-only strata	Set regional cell-only targets reflecting NHIS estimates (which vary by region from 10% to 20%).
	No cell-only strata	Cell-only strata set at 2/3 target to contain costs.
Interviewing	Ask phone status, but don't terminate dual cell and landline respondents.	Ask phone status of cell respondents; terminate those with landlines
	100% - no screening	Incidence about 40%
	"Cell mostly" reached via landline or cell phone	"Cell mostly" only reached via landline
Weighting	Adjustment for phone usage (e.g., dual-use households receive an initial weight of .5).	No such adjustment needed.
	Not necessary	Initial weight to correct disproportionate cell-only strata
	Demographic balancing	Demographic balancing
	Maybe. Some dual frame designs weight to cell- only.	Post-weight cell only if proportion exceeds projected NHIS estimate
Costs	2 x landline CPI (but more completes)	Appx. 3 x landline CPI (but fewer completes)

Data Comparison

The ABC/Post poll first tested cell-phone-only sampling in August 2008 and has continued cell-only sampling since. Our data confirm some striking differences between cell-only and landline-equipped respondents (e.g., cell-only respondents are younger, less educated, more apt to be male, and less apt to be white than their counterparts reached on landline. See Table 1).

Nonetheless we have found minimal attitudinal differences when comparing traditional landline samples with the landline-plus-cell-only samples we have produced. In our initial August 2008 study, across 100 attitudinal variables the rounded difference was 0 in 56 comparisons, 1 point in 41 and 2 points in three instances, averaging 0.45 percentage points (Langer 2008). A subsequent analysis of aggregated data from the 19-day ABC/Post pre-election tracking poll showed similar results. Across 148 attitudinal variables, the rounded difference between the landline sample and the landline-plus-cell-only sample was 0 in 80 comparisons, 1 point in 52, 2 points in 13 and 3 points in three cases, with an overall average difference of 0.57 percentage points. (Langer et. al. 2009).

A useful component of the tracking poll data analysis was its comparison of cell-only vs. landline data among young adults, made possible by the comparatively large sample size of this survey (N=10,213, including 942 cell-only respondents). This indicated that the effect of cell-only interviews on attitudinal estimates has been insignificant partly because of the relatively small size of the cell-only group, but also cell-only respondents are similar attitudinally to their demographic counterparts on landlines, as illustrated by a comparison of cell-only vs. landline-accessible 18- to 29-year-olds. (Langer et. al. 2009). Thus standard weighting to Census norms for age in itself did provide a correction.

This paper adds to our analysis using three ABC News/Washington Post polls, conducted via random-digit dialing in November and December 2009 and February 2010, each among approximately 1,000 respondents, including approximately 880 contacted on landlines and 120 cell-only respondents.[7] These polls had four-day field periods and averaged 14 to 18 minutes long, with sampling, data collection and tabulation by TNS of Horsham, PA.

[7] Reflecting updated NHIS estimates, ABC and the Post since have moved to 860/140 landline/cell-only respondents in their N=1,000 surveys. Our thanks to Vicki Pineau, Jinling Elliot and Tom Stoudt of TNS for the 2009-10 data used in this comparison and their ongoing consultation on ABC/Post sample design.

As in 2008, we compared the fully-reweighted landline sample with the combined weighted landline and cell sample. While again relatively few attitudinal differences are found when including cell-only respondents, the average gap between weighted landline results vs. the weighted landline and cell-only combined data has increased somewhat. Across 422 attitudinal variables in these polls, there was a rounded difference of 0 in 166 comparisons of weighted cell-only vs. cell-plus-landline results; 1 point in 185 cases, 2 points in 50 instances, 3 points in 18 instances, and 4 points in three cases.[8] The average difference was 0.83 points.[9]

The averages individually were 0.83 percentage points in the November 2009 poll, 0.94 percentage points in the December 2009 poll and 0.76 percentage points in the February 2010 poll. Each is higher, it should be noted, than in the August 2008 (0.45 points) or October 2008 (0.57 points) analyses, indicating that the impact of including cell-only interviews, while still small, is apparently increasing .

Design Effect

A necessary step in designing our cell-only approach was to evaluate its performance in terms of design effect, in comparison both to our traditional landline-only approach and to overlapping frames. On one hand, new weighting requirements added to DEFF (as our disproportionate representation of cell-only at .67 of their regional proportions would increase their weight magnitudes); on the other, new weights could be reduced given the better representation of cell-only demographic groups that are significantly underrepresented in landline-only surveys.

[8] For consistency and adequate sample size this analysis was limited to variables asked of all respondents.

[9] In aggregate data for matching variables from all three surveys, the average difference was 0.88 percentage points, including a rounded 0 points in 5 cases, 1 point in 17 cases, and 2 points in two cases. See Table 1.

In the three polls analyzed for this study, we find that the design effect for each poll was lower when cell-only interviews were included than for landline RDD samples alone. Specifically, for the November 2009 poll the design effect was 1.58 for the landline and 1.37 for the combined landline and cell-only sample. For the December 2009 poll, these compared design effects were 1.57 and 1.34 respectively. For the third poll, conducted in February 2010, the design effect for the landline alone was 1.67 compared to 1.42 for the combined sample. A lower design effect, given the increased inclusion of harder-to-reach respondents and therefore lower weights required to reflect their Census norms, appears to be a beneficial side effect of cell-phone sampling.

Design effects are similar for overlapping sample designs. The Pew Research Center, the Kaiser Family Foundation and AP/GfK report average design effects for their overlapping sample designs of 1.39, 1.33 and 1.68, respectively; ABC/Post's in the three surveys presented here has averaged 1.37[10].

Costs

Initial estimates suggested that while cell interviews in general cost 2 to 3 times landline interviews (federal legislation requires that cell numbers be hand-dialed, and co-operation is lower), the multiple for cell-only interviews is higher, more than 4 times the CPI of landline calls (Keeter et. al. 2009). More recent findings estimate cell interviews at 2 times the landline CPI, and cell-only at just under 3 times (Benford et. al. 2009).

By focusing on cell-only respondents, however, we are interviewing a smaller cell phone population than that targeted in most overlapping frame approaches. The Pew Research Center and the Kaiser Family Foundation collect 33 percent of their interviews by cell phone in their overlapping frame designs; the Associated Press/GfK

[10] Personal communication, Mollyann Brodie, the Kaiser Family Foundation; Trevor Thomson, The Associated Press; Scott Keeter, Pew Research Center. Pew data from May 2008 to June 2009, Kaiser from data from February to June 2009, AP/GfK for data from November 2008 to June 2009.

poll, 30 percent; the New York Times/CBS News poll, 10 to 20 percent.[11] At roughly 40 percent incidence of cell-only respondents, 12 to 14 percent of the Pew, KFF and AP/GfK samples would consist of the non-covered cell-only population, about the same as in our approach (and about twice as many as in the NYT/CBS approach), but accomplished in our case without the additional cell-phone interviews of cell-plus-landline respondents.

At 2 times landline CPI, the premium over landline costs for a sample with one-third cell interviews is 33 percent; while at 3 times landline CPI, the premium for a sample with 13 percent cell-only interviews is 26 percent. Again, both approaches yield approximately the same percentage of the total sample who are cell-only, but screening for cell-only is more cost-efficient. (Our approach is yet more cost-efficient if compensation or reimbursement for cell-phone respondents is offered.)[12]

Conclusion

The cell-only approach has several advantages over overlapping frames. It focuses on known non-coverage with a straightforward stratified sample and simple screening to identify eligible respondents. Even if disproportionate sampling is employed, the multi-stage weighting is simple to execute and based on clear empirical values. Design effects are lower than in landline-only samples and not substantively different from those reported in overlapping frame samples. Finally, costs are lower for cell-only than for unscreened cell phone

[11] Personal communication, April 2010, Mollyann Brodie, the Kaiser Family Foundation; Marjorie Connelly, The New York Times; Trevor Thomson, The Associated Press; Scott Keeter, Pew Research Center.

[12] We do not offer all respondents payment as an incentive for cooperation, given news policy of not paying for interviews. Instead we offer reimbursement only to respondents who raise the cost of the call as an objection – not a common occurrence, perhaps because cell-only respondents are likely to have less limited calling plans. Customarily between 3 percent and 9 percent of our cell-only respondents are offered and accept reimbursement.

interviews, given the differential sample sizes involved. The most recent research on cell-mostly (or cell-mainly) respondents seems to justify the approach further, although more study of this phenomenon is warranted.

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Table 1. Comparison of unweighted data for age, education, race and sex, landline vs. cell-only respondents, ABC News/Washington Post polls of November and December 2009 and February 2010.

	Landline	Cell only
N	(2,648)	(360)
18-29	8	45*
30-39	12	19*
40-49	16	18
50-64	35*	16
65+	29*	2
Non-college NET	60	66*
HS or less	31	39*
Some college	28	27
College NET	40*	34
College graduate	25	24
Post-graduate	15*	10
White	82*	64
Black	7	13*
Hispanic	5	12*
Asian	1	3*
Other	5	7
Male	48	60*
Female	52*	40

*Differences are statistically significant at the 95% level.

Table 2. Comparison of weighted aggregate data for common questions, landline only vs. landline and cell-only respondents, ABC News/Washington Post polls of November and December 2009 and February 2010.

	- '09/'10 Aggregate -	
	LL+CO	LL only
N	(3,008)	(2,648)
Democrat	33%	31%
Republican	24	25
Independent	38	39
Under $20K	20	18
20-34K	17	16
35-49K	15	15
50-74K	16	16
75-99K	13	14
100K+	17	18
Liberal	22	21
Moderate	37	38
Conservative	38	38
Obama approval		
Approve	52	52
Disapprove	45	46
Obama handling economy		
Approve	47	46
Disapprove	51	52
Proposed health care changes		
Support	46	45
Oppose	50	50
Trust handling economy		
Obama	49	48
Republicans	38	39
Economy begun to recover		
Has	47	46
Has not	52	53
Have health insurance		
Yes	83	84
No	16	15

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