Dual Frame (Landline and Cell RDD) Estimation in a National Survey of Latinos

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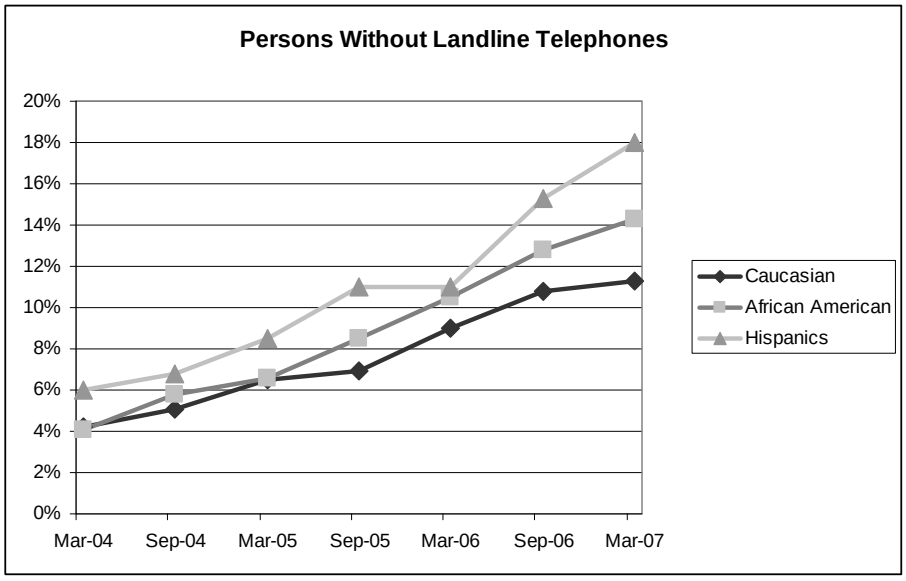
The past five years have seen the issue over cell phones rise from one of many concerns about survey bias and error to arguably the most central of concerns in the field of survey research today. Much like global warming, survey professionals initially held what might be considered a considerable level of alarm, but little data to go along with it. But the days of cell phones being a largely academic concern are gone. Evidence to this is the growing proportion of articles in major academic journals like *Public Opinion Quarterly*, which not only dedicated a special issue to the problem in 2007, but has regularly published articles on the topic at least practically every quarter for the past three years. Along the way, scholars have made major contributions to our understanding of the problem, its growth, present pitfalls, and future dangers.

The basic concern regarding cell phone use revolves around the fact that presently, it is estimated, fifteen percent—and possibly even more—of Americans no longer own a landline telephone. And most certainly, beyond the overarching concern of a fifteen percent gap in landline coverage of the U.S. population, the other most significant concern has been the specific loss of landline households among young Americans. Indeed, estimates from the National Health Interview Survey (NHIS) find that as of 2007, three out of ten 18 to 29 year old adults can only be reached via cell phone. Today, surely over a third of young Americans do not possess a landline telephone. And logically following this coverage gap among young Americans, the NHIS found that over half of households without children and that include unrelated adults (the typical young person household) are now only reachable via cell phone. And again following similar logic, nearly three out of ten renters are cell-only. It is unclear at this point how significant the overarching problem of cell phones will become. While the percent of Americans

who only own cell phones continues to increase, the rate of increase, luckily, has diminished somewhat from 2006 to 2007 (NHIS, 2007).

The impact of this decline in young persons in landline telephone samples has been the focus of a number of research articles, as will be reviewed shortly. However, the young are not the only population of concern. Specifically, there is a growing concern over the ever-increasing gap in coverage of the Hispanic population as well. Hispanics are the fastest growing ethnic group in the U.S. today, having gone from 11.8 percent in 2002 to 13.3 percent in 2007, a 13 percent increase in just five years (2002 and 2007 Current Population Surveys, March Supplement). The U.S. Census Bureau estimates that by 2050, Hispanics will comprise one quarter of the total U.S. population. Yet at the same time, the rate at which the Hispanic population is growing is paralleled by the rate at which Hispanics are becoming a cell-only population, which as of early 2007 stood at 18 percent (see figure 1):



This paper will explore the depth of the problem concerning the under coverage of Hispanics within landline survey samples. To date, there have been a number of threads in papers exploring the issue of cell phones among the general population broadly and young

Americans more specifically. Specifically, as reviewed below, the research to date has explored who is it exactly that only owns a cell phone (Link, Battaglia, Frankel, Osborn, and Mokdad, 2007; Keeter, 2006; Keeter, Kennedy, Clark, Tompson and Mokrzycki, 2007), whether weighting in landline samples adequately corrects for the bias introduced through cell-only non-coverage in landline samples (Blumberg and Luke, 2007b; Keeter, 2006; Tucker, Brick and Meekins, 2007), which weighting procedure best corrects for this non-coverage (Brick, Dipko, Presser, Tucker, and Yuan, 2006; Brick, Edwards, and Lee, 2007), and the implications of conducting interviews using a dual-frame sampling design, that is, through both landline and cell phone telephone interviews (Brick, Brick, Dipko, Presser, Tucker, and Yuan, 2007). The present paper will review each of these issues specific to the Hispanic population, and draw conclusions as to the degree of concern survey researchers should have in interviewing Hispanics in the U.S. today and in the future.

Cell Phone Noncoverage

As previously noted, young Americans are particularly likely to eschew a landline telephone. As well, poor populations are now over twenty percent cell-only (Blumberg and Lake, 2007). Looking at exit poll data in the 2004 election, Keeter (2006) found that nearly twenty percent of 18 to 29 years olds did not own a landline. Cell phone only persons also skewed toward lower levels of educational attainment. Among race and ethnicity, Hispanic voters were most likely to be cell-only. The most substantial difference was within marital status, as three percent of married voters were cell only, compared to thirteen percent of those who were not married. Keeter also found that cell phone only persons were much more likely to have voted for John Kerry, by about nine percentage points, and thus were also more likely to identify as Democrats.

As well, in comparing samples from landline-only respondents, dual users interviewed on a landline, dual users interviewed on a cell phone, and cell phone only respondents, Link et al (2007) found differences not just between cell only and landline respondents, but also within dual users captured in landline versus cell phone sampling frames. Indeed, landline interviews that came from dual users were eight points more likely to be male; eight points more likely to be age 65 or older; twelve points more likely to be Caucasian; and nine points less likely to be employed than were respondents who owned both a cell and landline and were interviewed on a cell phone. And of course, the differences between landline only and cell phone only respondents were even greater, as interviews from landline only respondents were thirteen points more likely to be female; 36 points more likely to be ages 18 to 34; sixteen points more likely to be Caucasian, and 30 points less likely to be employed, than respondents interviewed on a cell who only owned a cell phone.

Taking a slightly different approach, Keeter et al (2007) compared weighted landline samples to unweighted cell-only respondents and found major differences across a host of variables. For example, while 78 percent of landline respondents said they were registered to vote, only 49 percent of cell-only respondents were registered. Along with registration, there were appropriate differences in related measures such as ever voted, being sometimes too busy to vote, and the degree to which respondents were closely following the election. Again Keeter found a liberal bias in the cell-only sample, with an eight point drop in self-identified conservatives. As well, Keeter and colleagues found the cell-only respondents are much less likely to follow the news, at least with regard to network news and/or AM news. That said, cell-only respondents were more likely to get news from websites or a personal device such as a cell phone.

Importantly, differences were not just limited to behavioral measures. Cell only respondents were found to be more detached from politics (24% landline versus 30% cell only for "Washington issues don't affect me"). As well, taking one issue as an example, over half of cell-only respondents approved of gay marriage, compared to 37 percent in the weighted landline sample.

Finally, Keeter and colleagues developed a logistic regression model to ascertain the strongest predictors of cell-only status . Wanting to understand specifically how 18 to 25 year olds with landlines differed from those who were cell-only, they limited their analysis to this critical age cohort. They found a substantially negative association to living with parents and to being married. As well, substantial positive associations were found with population density and Hispanicity. These in fact not only exhibited main effects but an interactive effect as well, such that some of the most likely cell-only 18 to 25 years olds were Hispanics living in high density areas.

As well, Tucker et al (2007) conducted a logistic regression analysis on a full sample of respondents in a dual frame survey. Similar to Keeter, he found that 18-24 year olds were nearly six times more likely to be cell-only compared to adults ages 55 and older. Persons in the South were 1.4 times more likely to be cell-only than were persons in the West. And persons without a high school diploma were also twice as likely to be cell-only than persons with further educational attainment. Unfortunately, given a small sample of ethnic minorities, Tucker and colleagues were not able to break Hispanicity out in their analysis.

Corrective Factors

Overall, clearly, considering the range of differences found across demographic, attitudinal and behavioral variables alike, there is considerable justification for concern as to

potential bias generated by the noncoverage of cell phone only respondents in landline telephone sampling designs. But just because there are differences between landline and cell-only samples across a host of variables does not necessarily imply that properly weighted landline samples contain significant bias due to cell-only non-coverage. And indeed, once weighted, nearly all of the differences found in the 2007 article by Keeter fell into statistical insignificance when comparing a properly weighted landline sample to a weighted dual-frame (landline and cell phone) sample, even when solely focusing on the 18 to 25 population. However, it must be noted that differences still existed, only to a smaller degree. Given a larger sample base, it is certain that a number of small yet significant differences would have been found.

Still, if weighting is to remain effective, many scholars have underscored the importance of investigating which weighting procedure in fact has the greatest chance of success in making landline samples look most representative to the general population. As well, there is the question of which weighting scheme best "balances" dual frame designs to look most like the general population. Brick et al (1996) compared four overall estimation schemes to their Joint Program in Survey Methodology Practicum Survey of 2004. The first, used largely for comparison, was a simple composite measure that contained a simple proportional corrective factor to each frame. This composite weight was found to estimate cell-only households at 14.2 percent, compared to 6.4 percent in the 2004 CPS. They concluded that such a simple measure leads to considerable bias in estimating households by telephone service. They further concluded that the only practical solution is to weight control totals of telephone service to outside estimates of telephone service and demographics. The first attempt by the authors weighted by Hispanicity, number of adults and marital status, and home ownership. This was done to the full sample. A second weight was calculated by raking to these measures in each

survey frame (landline and cell) separately. A third weighting attempt raked again to the three demographic variables noted above, as well as a variable denoting the percent of households that were cell-only, dual, and landline-only. For comparison, they also weighted the landline sample alone, with cell phone respondents getting a weight of zero.

The authors found that the only measure that adequately estimated cell phone only households was the measure that specifically weighted to telephone status (the third weight). More importantly, they investigated bias across the four weights by some basic demographic measures. They found, compared to the CPS, that the landline-only weight significantly under-estimated low income households. As well, persons ages 55 years of age and older were estimated to be 41 percent in the landline-only sample, compared to 36.5 percent in the CPS estimate. On the other hand, the landline only sample was the most accurate estimate of race, being 2.8 percent less Caucasian than the CPS, compared to an average of 5.6 percent difference in the four dual frame estimates combined. As well, the landline only sample most accurately matched the CPS in age for persons under the age of 34, and also best matched on number of (landline) telephone numbers. In short, the data not only did not reveal a best weight between the four dual frame weights, but also, did not show that a properly weighted landline sample contained any greater degree of bias than did any of the weighted dual-frame samples.

Kennedy (2007) advanced the work on weighting samples by not only replicating Brick's work but also attempting another alternative. Using the NHIS as a benchmark, Kennedy developed a simple six-demographic overall weight, a weight that also contained a telephone status variable, and as well, a weight that contained an expanded telephone status variable, which had points not just for landline-only, dual, and cell-only, but as well broke out duals to mostly landline and mostly cell phone. As well, Kennedy noted that a particular question of interest

presently is whether from an operational perspective it makes more sense to conduct cell phone interviews only of persons who do not own landlines, since theoretically, there is overlap between the duals from a landline frame and duals from the cell phone frame in dual frame studies (though we have already seen that the demographics of these two groups suggests they are to some degree, different respondents).

Overall, again, there was no clear "winner." Similar to Brick, Kennedy found that low income persons are under sampled in landline only sample designs, compared to dual frame designs. Yet at the same time, home ownership was most accurately estimated in the landline-only group. A similar result was found for marital status. Interestingly, the error measured in samples with duals only from landline samples were larger than full dual frame samples. With regard to political affiliation, again the landline sample was the winner with a spot-on estimate of Republicans compared to the NHIS (importantly, though, none of the weights differed significantly by Republicanism and the NHIS). And that said, the landline sample estimated liberalism with the greatest degree of error, some eight percentage points off from the NHIS. Generally, the best dual frame weight was that which weighted to the expanded telephone usage variable, and within this design, the cell-only design (no duals from the cell phone sample) was slightly, though insignificantly, closer to the NHIS than was the full dual frame sample, when averaged across all demographic variables tested. That said, this final weight, using the expanded telephone usage variable, contained the largest design effect.

Overall, there remains no clear winner with regard to weighting dual frame designs. That said, the good news is that to date, properly weighted landline samples still do not differ significantly to population estimates derived from large-scale in-person sampling designs, the benchmark for comparison purposes. Nevertheless, as noted with Keeter's weighting

comparison, many of the differences that remain after properly weighting a landline sample will become significant given larger samples and perhaps a greater percentage of the population that becomes cell-only.

Present Analyses

The main purpose of this paper is to replicate the research on bias, error, and estimation that has been done in the above-reviewed research on cell phone and the general population (and younger Americans) with Hispanics. Without rehashing the importance of understanding bias and error within Hispanics due to cell-only under- or non-coverage, it is important to note, at least anecdotally, the substantial increase in Hispanic-only research in the past five to ten years. Certainly the primary author of this article has witnessed an exponential increase in the demand for Hispanic research. To meet the demand, ICR's bilingual interviewing staff has gone from about ten percent of the total share of interviewers to nearly forty percent, its omnibus products expanded to include a monthly Hispanic-only omnibus, and its clientele has gone from a small but highly interested academic core of researchers to a vast litany of for-profit companies interested in tapping into this ever-growing population. And perhaps there is no better measure of the rising importance of the Hispanic population than the emphasis that political organizations and commercial marketers alike have placed on researching this population. Indeed, the Pew Hispanic Center, founded in 2001, has gone from periodic surveys on the national Hispanic population to ever-increasing annual surveys as well as specialized surveys of Hispanic sub-populations.

It would indeed be ironic if, at the very point at which Hispanics are taken seriously as a population important to research, survey methodology begins to break down in its ability to attain samples of Hispanics that are relatively low in bias and error. Thus the importance of the

present study, to begin to understand the degree to which bias and error may be present in landline-only surveys of Hispanics, and as well, to develop best practices in dual-frame surveys of Hispanics with regard to weighting and estimation.

Interviewing Hispanic Populations

Interviewing Hispanics can be an expensive endeavor. Despite their tremendous growth compared to other Americans, they still constitute under 14 percent of the overall population. And, as is often said in telephone interviewing, there is nothing more expensive than having to hang-up on a household willing to do a survey. By this we are referring to non-Hispanics, who willingly screen through a last-birthday or other type of screener, agree that their call may be recorded for quality purposes, and answer a question about their Hispanicity, only to then be told their time and efforts are no longer needed.

Because of this expense it has become standard procedure to interview Hispanics using alternative sampling strategies. One such strategy is to interview only listed households with a recognizable surname. While far more inexpensive, research finds that less than half of all Hispanics have a listed number and a recognizable surname, and the bias of interviewing only such persons can be substantial (Dutwin and Herrmann, 2006). A second, more methodologically rigorous method is a disproportionate stratified sampling design as the one described in the data section of this paper. This design takes all telephone exchanges and uses known or estimated incidences of Hispanic households to place them into key strata, ordered by Hispanic incidence. A typical design might divide telephone exchanges into four strata, very high, high, medium, and low incidence strata. If, for example, twenty five percent of all Hispanics may reside in each strata, the survey will in fact interview forty percent of its interviews from the very high strata and only ten percent from the low strata, as the incidence of

reaching a Hispanic household in the very high strata is likely around fifty five percent, compared to three percent in the low strata. Thus, instead of attaining approximately a thirteen percent incidence of reaching a Hispanic household, as one would attain in an RDD design, a disproportionate stratified design may attain as much as 25 – 30 percent incidence.

The primary implication of such a design is with the design effect, as the disproportionality of the sampling must be corrected with a base weight correctional factor. However, clients and research suppliers can work together on any given study to strike a balance between design effect and survey cost upfront. The problem, however, becomes exacerbated when one considers dual frame designs. That is, not only must the base weight correct now for disproportionate sampling of telephone exchange, but as well, researchers may choose, as is often done, to correct for number of adults in the household and number of telephones in the household, and finally, the impact of a dual frame design. And then, post-stratification procedures are normally enacted to correct the sample on a host of demographic variables. The question then becomes, if one were to fully correct for all of these measures, would the design effect be prohibitive? Design effect is defined as the degree to which the standard errors of the estimates are inflated due to the weights used on a sample, compared to an unweighted sample. Potentially, the cumulative effect of all of these corrective factors would lead to a design effect over, or even well over, two. Thus, if one were to interview 1,000 respondents, the standard errors of the estimates would be more akin to having interviewed 500 respondents. And thus, the cost savings of the disproportionately stratified design are mediated, or eliminated entirely, due to the extremity of the weights.

Data

The data used in this research are from the 2007 National Survey of Latinos, conducted by International Communications Research for the Pew Hispanic Center. The survey contains 1,101 landline telephone interviews and 899 cell phone interviews. Because of our concern about the possibility that many cell phone respondents would not tolerate a longer interview, the instrument was pared down from its original intended length of 25 minutes to a final average of 21.1. Interviewing was conducted from October 3 to November 9, 2007. The landline response rate was calculated to be 58.9%, the cell phone response rate was calculated to be 17.2% and the overall response rate for this study was calculated to be 32.4% using AAPOR's RR3 formula. (Note that the response rate is based upon all successful screenings, whether an Hispanic respondent was identified or not.)

The survey included batteries of questions on life satisfaction, TK, and politics, with a particular focus on immigration, as well as measures of telephone use and a complete set of demographics. The study employed a disproportionate landline stratified design by taking all telephone exchanges and ordering them by Hispanic incidence. This led to the development of very high, high, medium, and low strata. Then, all sample with a recognizable Hispanic surname were extracted and placed into a separate strata. Sample was then disproportionately extracted from each of these strata. Given the lack of reliable lists of cell phone telephone numbers, it was not possible to extract surnames for the cell phone sample. As well, given the lack of data on cell phones at the exchange level, stratification by the density of the Hispanic population was possible only using the rougher cut of area code. This was done, leading to high, medium and low incidence strata.

Stratum	Estimated Incidence Hispanic	Percent of Total Hispanic (w/n Frame)	Completed Latino Interviews
Landline Surname	80.0%	35.9%	525
Landline Very High	61.0%	20.9%	256
Landline High	27.7%	16.1%	163
Landline Medium	13.4%	16.0%	118
Landline Low	1.8%	11.1%	39
Landline SubTotal	*11.7%*	*100.0%*	*1,101*
Cell Phone High	53.0%	33.2%	555
Cell Phone Medium	27.6%	34.4%	223
Cell Phone Low	6.6%	32.4%	121
Cell Phone Subtotal	*14.7%*	*100.0%*	*899*
TOTAL	**13.3%**	**100.0%**	**2,000**

Study Weights

Thus, with Hispanic research, the question of weights goes beyond whether different corrective factors are better or worse at eliminating bias in the samples. As well, one has to ask, to what degree can we weight to minimize bias, while at the same time avoid a large inflation of the design effect? To explore such questions, a number of weighting procedures were calculated.

First was the basic stratification correction that is required in every weight. Using a simple calculation of percent of completes in strata / percent of Hispanics nationally residing in strata, one can attain this correctional factor. Overall, the design effect for the stratification was 1.22.[1] In addition to the correction for the stratification, we investigated whether we should correct for the number of persons in the household as well as the number of landline telephone numbers (not used for business, security systems, the Internet, or fax/data/modems) in the

[1] The scheme for stratification is itself designed with the impact on the design effect in mind. Much greater efficiency in reaching Hispanics could be achieved by focusing a greater percentage of calling in areas of high Hispanic density, but at the expense of effective sample size. The stratification method used in PHC surveys was calculated to achieve a balance between increased interviewing efficiency and a minimal increase in the design effect.

household. This is done by assigning a weight equal to the number of adults in the household (capped at 3), multiplied by the reciprocal of the number of telephones in the household (capped at a minimum of .33). Overall, the design effect for the combined corrections for adults and number of phones was 1.33. Combined, the stratification, phone, and adults corrections create a total design effect of 1.61, quite large considering this does not include corrections for sampling frame and demographic post-stratification.

The third correction we computed was a correction for the sampling frame. We specifically created a measure to balance based who were landline-only, cell phone-only, or dual users. Estimates for this measure were computed using the most up to date figures by the NHIS, extrapolated to fit the trend in coverage that has occurred since the most recent NHIS data were made available. Overall, this estimate put landline-only Hispanics at 34 percent, dual users at 49 percent, and cell phone only users at 17 percent. Overall, our sample was 29 percent landline only, 40 percent dual, and 32 percent cell phone only, leading to a sampling frame correctional design effect of 1.10. Combined, the total base weight design effect using all correctional factors was 1.82.

To mediate this large design effect, it was decided to forgo the adults and phones correction, and to replace it with a basic .5 correction to dual users. That is, since dual users in theory have double the chance of being sampled in a dual frame study, minimally one should provide such respondents with a corrective factor of .5, even if one chooses not to correct for adults in the household and number of phones. Using this change, the .5 correctional design effect was a minimal 1.09, leading to a combined phone and stratification design effect of 1.41. As well, because the impact of the .5 corrective weight was largely erased when correcting for sampling frame (duals being weighted down with the .5 correction, then later weighted up when

correcting for landline only/dual/cell phone only), the overall design effect of the sampling corrections was 1.53.

Overall, similar procedures were used to generate two more weights for later comparison: a weight for persons who completed the study via landlines (replicating a "normal" landline-only sample), a weight for persons who completed the study via landlines or those who did the survey on a cell phone and did not own a landline (dual sampling design with cell phone duals screened out, mirroring Kennedy, 2007). Each of these three weights (full sample, landline only and landline + cell only) were post-stratified to 2007 Current Population Survey figures for Hispanics (March supplement). Specifically, the data were weighted by gender, age, educational attainment, region, Hispanicity (Mexican, Cuban, Puerto Rican, Central American, South American, other), and place of birth (U.S. versus other) by years in the U.S. While post-stratifying by six variables may be considered more than typical, the impact of weighting by region is minimal since region is moderately correlated with strata, which has of course already been adjusted. As well, our experience is that Hispanic surveys can vary from study to study more significantly than general population studies because Hispanic studies are greatly impacted by the degree to which bi-lingual interviewers are assigned to the study. For this study, interviewers were assigned by strata, with all strata except the two Low strata (in the landline and cell frames) being assigned interviewers who were all bilingual. Given that most Hispanics residing in telephone exchanges with 5% or fewer Hispanics tend to speak English well, The Low strata were assigned English-bound interviewers; any households that were encountered where the respondent did not speak English well were immediately called back by a bilingual interviewer.

Our experience is that not all Hispanic studies are afforded such extensive coverage of bi-lingual interviewers. As well, interviewers ask respondents which language they would prefer to use during the interview. Given that about one-third of Hispanics can speak both English and Spanish well or very well, there is also the potential for a natural variation of English and Spanish interviews in any given study.

All of this underscores the importance of including a weighting variable that, while not completely controlling language of interview, should at least control for key underlying factors that might naturally lead to variance in language of interview and the degree to which Hispanics in the sample are assimilated (or not) into American culture. We have found that the combination variable of being born in the U.S., and if not, how long the respondent has been in the U.S., is an effective control from study to study with regard to these critical Hispanic-specific variables of acculturation and language of interview.

Overall, after post-stratification, the overall weight yielded a design effect of 1.45; the landline only weight was 1.37, and the landline plus cell phone only weight was 1.40.

Cell Sample Younger But More Acculturated

Hispanic respondents reached on a landline are quite different on many demographic measures from those reached on a cell phone, and especially from those who are cell-only. As with the non-Hispanic population, the most notable difference is that cell phone respondents are younger: 37% of those reached on a cell phone, and 39% of the cell-only, are under age 30, compared with just 20% among the landline respondents. Just 6% of cell-only respondents are 55 or older; the comparable figure in the landline population is 22%.

As would be expected with this age difference, the cell phone population is less likely to be married, with just 38% among the cell-only group reporting that they are currently married. More than half (56%) of landline respondents are married. There is a smaller difference, however, in parenthood: 47% of cell-only respondents have minor children in the household; among the landline respondents, the comparable figure is 52%.

One other notable difference between respondents in the two sampling frames is the level of acculturation. This was measured first by two basic measures and a derived scale. The basic measures are what language the interview was conducted in and the percentage born in the U.S. The derived scale was a measure used in past research (see Dutwin et al, 2005). This particular scale averaged the ability to speak and read English and Spanish, four questions in all (a = .73). From this raw measure, a tri-level measure of acculturation was computed, ranging from traditional to bi-cultural to assimilated. as measured by language facility. In the cell sample, 57% of respondents chose to be interviewed in Spanish, while in the landline sample 73% did so. As for the percentage born in the U.S., show a similar pattern. And

Demographic Composition of the Landline, Cell, and Cell-Only Samples

		--Cell sample--	
	Landline sample	Total cell	Cell only
	%	%	%
18-29	20	37	39
30-39	27	23	25
40-54	27	26	24
55+	22	9	6
Traditional	57	33	35
Bi-Cultural	28	36	37
Assimilated	15	31	28
Spanish interview	73	57	61
English interview	25	42	38
Born in U.S.	25	36	34
Citizen of U.S.	55	61	58
Male	51	54	54
Female	49	46	46
College grad	15	16	15
Some college	14	32	15
H.S. grad	30	35	35
Less than H.S.	38	30	31
$50,000 or more	17	16	12
$30-49,999	17	19	18
Less than $30K	47	51	54
Mexican	64	55	55
Puerto Rican	7	8	8
Cuban	4	9	8
Dominican	4	3	3
Salvadoran	4	3	3
Married	56	41	38
Never married	15	28	28
Parent of minor	52	45	47
Time in the U.S.			
< 6 years	11	14	15
6-10 years	15	13	16
11-20 years	21	18	18
> 20 years	26	18	16
1-person HH	19	25	27
Sample size	(1101)	(899)	(636)

Figures based on unweighted data.

the acculturation scale exhibited perhaps the most dramatic difference of all, as 57% of landline respondents were found to be culturally traditional, compared to 35% of cell only respondents.

On a few other demographic variables there are only modest differences between the respondents from the two sampling frames. The cell frame respondents are slightly more likely to be male or to have had at least some college experience.

Social and Political Attitudes

As noted earlier, previous research with the general public in the U.S. has found only minor differences between the landline and cell phone populations on most political and social attitudes. Moreover, even the differences that exist tend to be eliminated when the cell phone data are weighted and blended with landline data. The same is true with the topics probed in this survey.

The study focused on the debate over illegal immigration in the U.S. as well as the race for the presidential nomination. On a wide variety of questions on these topics, the study found some significant differences between the landline and cell-only population,

Blended Sample Not Very Different from Landline Sample

	Landline sample	Cell only	Total sample
Better party on illegal immig.	%	%	%
Democratic	34	41	36
Republican	13	15	13
Party affiliation			
Democratic/lean Democrat	43	52	46
Republican/lean Republican	20	16	19
Democratic preference (late '07)			
Clinton	58	57	58
Obama	12	13	13
Richardson	10	9	10
Republican preference (late '07)			
Giuliani	29	26	29
McCain	11	17	12
Illegal immigrants help economy	77	72	75
Illegal immigrants hurt economy	16	20	17
Local govt attn to illegal immig.			
A lot	31	34	32
Not too much	42	39	40
None at all	20	22	21
Approve of workplace raids	20	17	20
Approve states checking immig. status for driver's license	39	38	40
Worry that you/family/friend could be deported?			
A lot	34	33	33
Some	20	20	20
Not much/not at all	44	46	46
Ever discriminated against by/at…			
Other people	60	66	63
Restaurants or stores	50	59	53
Government offices	44	53	46
Traditional	37	35	35
Bi-Cultural	32	37	34
Assimilated	31	28	31
Sample size	(1,101)	(636)	(2,000)

The landline and combined samples are weighted. The cell-only column is unweighted. Combined sample includes all cell phone respondents (not just cell only).

but the total weighted survey estimates were changed by a maximum of only 2-3 percentage points with the inclusion of the cell phone samples.

Among the largest differences were party affiliation and perceptions of discrimination. The percentage of Democratic and Democratic-leaning respondents was considerably higher in the cell-only sample than in the landline sample (52% vs. 43%; the cell sample overall was 53% Democratic). As a result, the blended and weighted total sample was 46% Democratic, as opposed to 43% in the weighted landline sample. The Republican total was less affected (19% in the total sample, 20% in the landline sample).

Regarding discrimination, the cell-only were more likely to say that they had ever been discriminated against in restaurants or stores, government offices, or by other people. For each of these measures, total Hispanic population estimates for perceptions of discrimination were increased by 2-3 points when the cell phone sample was included.

On the other questions included in the survey, much smaller differences by sample were observed. There were only small differences in preferences among the candidates for the Democratic and Republican presidential nominations. And attitudes and perceptions about the government's response to the issue of illegal immigration varied little by whether a respondent was reached on a landline or a cell phone.

Additionally, we found that properly weighted landline samples exhibited no significant bias on acculturation when compared to a fully weighted sample. Specifically, traditional Hispanics dropped from 37% to 35% when the weighted landline sample is compared to the weighted full sample. The difference shifted only to bi-cultural respondents, however, while assimilated respondents were measured at 31% in both weighted samples.

Demographics and Attitudes among Younger Hispanics

Even within the youngest cohort of Hispanic respondents – those ages 18-29, respondents reached by cell phone are significantly younger than those reached by landline. Nearly two-thirds of the cell sample (65%) were under 25, compared with just 43% of the landline sample. This age difference is also a factor in some of the other demographic differences across sampling frames among young Hispanics, but it does not fully account for them.

Hispanics ages 18-29 reached on a landline are significantly more likely to say they are married than those reached on a cell phone. But even among the youngest Hispanics within this age group, a difference remains.

As with older Hispanics, those reached by landline are substantially less acculturated than those reached by cell phone. A significantly higher percentage of those reached by landline were interviewed in Spanish, and far fewer had been born in the U.S. On the acculturation scale, again we find that landline respondents are skewed toward being traditional. However, within cell phone and cell phone only young Hispanics, the distribution is more balanced. Indeed, cell phone respondents exhibited nearly the same percent within traditional, bi-cultural and assimilated as did the overall weighted sample of all Hispanics from all sample frames. This suggests that although we find strong biases in acculturation by telephone type in

Demographic Composition of the Samples among Hispanics Ages 18-29

		--Cell sample--	
	Landline sample	Total cell	Cell only
	%	%	%
18-24	43	65	62
25-29	57	35	38
Traditional	53	22	26
Bi-Cultural	28	37	37
Assimilated	20	41	37
Spanish interview	64	41	46
English interview	34	57	52
Born in U.S.	35	53	49
Citizen of U.S.	51	68	64
Male	48	55	56
Female	52	45	44
College grad	12	9	10
Some college	19	23	21
H.S. grad	37	43	42
Less than H.S.	32	23	26
Married	37	22	22
Never married	41	55	54
Parent of minor	55	35	45
1-adult HH	15	25	28
Sample size	(221)	(336)	(250)

Figures based on unweighted data.

the Hispanic population, such differences will become less so within cell phone respondents, but more so with landline respondents.

In general, the pattern of attitude differences across the sampling frames seen among the entire Hispanic population was also seen among the young cohort. And as with the full sample, weighting reduced or eliminated most of the differences between the landline sample and the blended sample. For many questions, however, the size of the differences between the landline and cell frames was somewhat larger than in the total sample. For example, the percentage of the weighted landline sample who identified or leaned to the Democratic Party was 12 points lower than among the cell-only respondents (38% vs. 50%), and the weighted blended sample was 7 percentage points higher than the landline sample (45%). This was among the largest differences seen between the landline and blended samples.

Attitudes and Perceptions among Respondents Ages 18-29, by Sample

	Landline sample	Cell only	Total sample
Better party on illegal immig.	%	%	%
Democratic	34	40	37
Republican	14	17	15
Party affiliation			
Democratic/lean Democrat	38	50	45
Republican/lean Republican	20	17	18
Democratic preference (late '07)			
Clinton	57	48	57
Obama	12	18	15
Richardson	12	7	8
Illegal immigrants help economy	79	72	76
Illegal immigrants hurt economy	16	21	19
Local govt attn to illegal immig.			
A lot	26	34	30
Not too much	51	38	46
None at all	19	22	19
Approve of workplace raids	20	17	22
Approve states checking immig. status for driver's license	37	43	40
Worry that you/family/friend could be deported?			
A lot	38	31	33
Some	21	20	19
Not much/not at all	41	49	48
Ever discriminated against by/at…			
Other people	60	70	66
Restaurants or stores	50	63	56
Government offices	41	57	47
Traditional	30	26	25
Bi-Cultural	31	37	34
Assimilated	39	37	41
Sample size	(322)	(250)	(605)

The landline and combined samples are weighted. The cell-only column is unweighted. Combined sample includes all cell phone respondents (not just cell only).

There also were differences in the percentage of respondents who reported having been discriminated against in government offices, restaurants or stores, or by other people more

generally, with the cell phone respondents more likely to report discrimination. At the same time, fewer cell respondents say they worry a lot that they or a family member or close friend could be deported.

On acculturation, we do find a modest difference between the weighted landline sample and the weighted full sample within 18 to 29 year old respondents. Specifically, there was a five point swing from traditionalism in the landline sample (30%) to he full sample (25%). This difference was evenly distributed to bi-culturalism and assimilation.

Estimating Bias: Landline Only versus Combined Sample Estimates

As mentioned above, previous studies have found that supplementing a landline sample with a cell sample does not necessarily improve the accuracy of survey estimates (Brick et al., 2006; Keeter et al., 2007). The potential benefits from a cell sample are greater, however, among subgroups such as Hispanics who are more likely to only be reachable on a cell phone. We expected that for some Pew NSL measures, estimates based on the combined sample would be less biased than those based on just the landline sample. The most likely suspects for observing such a bias differential are survey measures correlated with cell-phone only status, such as age, income, and marital status.

Our approach is to investigate bias directly by comparing survey estimates to proxy values for the true values in the Hispanic population. We derived our benchmark values (the proxies for the true scores) from two national, area-probability studies that are conducted in both English and Spanish. These studies are the American Community Survey (ACS) and the General Social Survey (GSS). It is important to bear in mind that the benchmarks values may themselves contain error, and differences between the benchmarks and the NSL estimate may be attributable, at least in part, to factors other than differences in coverage. The most recent

publically available data for the ACS and the GSS come from 2006, which is one year earlier than the Pew NSL. Population values may have shifted somewhat during that time. In addition, differences in nonresponse and measurement (*e.g.*, mode features and question wording) may also have led to some differences between the Pew NSL differences and the benchmarks. That said, these benchmarks represent the best information available on several characteristics that the Pew NSL was designed to measure. Table 1 reports the weighted landline sample estimates, weighted combined sample estimates, and corresponding benchmarks for seven items in the Pew NSL.

Table 1. Weighted Pew Hispanic Estimates versus Benchmark Hispanic Estimates

	Pew NSL Landline Sample	**Pew NSL Combined Sample**	**Area-Probability Survey Benchmark**
Born in the U.S.[A]	41%	41%	44%
U.S. citizen[A]	62%	62%	61%
Employed full or part-time[A]	62%	65%	63%
Occupation[A]			
Management/Professional	25%	25%	17%
Sales/Office	15%	15%	22%
Other	60%	60%	61%
	100%	100%	100%
Marital status[A]			
Married	54%	50%	48%
Divorced	7%	8%	8%
Separated	5%	6%	4%
Widowed	4%	4%	4%
Never Married	30%	32%	37%
	100%	100%	100%
Political affiliation[G]			
Republican/Lean Republican	20%	19%	20%
Independent/Other	37%	35%	40%
Democrat/Lean Democrat	43%	46%	40%
	100%	100%	100%
Income[G]			
$0-$29,999	58%	58%	46%
$30,000-$49,999	21%	21%	25%

$50,000-$74,999	10%	10%	12%
$75,000+	11%	11%	17%
	100%	100%	100%
Median difference from the benchmark on the modal value[D]	3.0%	3.0%	
Sample Size	(1,101)	(2,003)	(3,871)*

[A]Benchmark estimates from the 2006 American Community Survey

[G]Benchmark estimates from the 2006 General Social Survey

[D]Based on the absolute values of the differences of the seven modal values

*This is the minimum sample size for the benchmark estimates

The two sets of weighted Pew survey estimates differ from some but not all of the benchmark values for Hispanics. The survey estimates for the proportion of Hispanic who are married, and who have a household income below $30,000 per year differ substantially from the benchmark figures, but the estimates for the proportion of Hispanics who are employed, are citizens, and affiliate themselves with the Republican Party are quite close to the benchmarks. Critically, there is no consistent evidence suggesting that the combined sample estimates are less biased, relative to the benchmarks, than the estimates based only on the landline sample. As a summary measure of performance, we identified the modal response for each of the several benchmarked items and calculated the absolute value of the difference between each Pew estimate and the benchmark estimate. The median of these differences was 3.0% for the landline estimates as well as the combined estimates. The combined sample estimates appear to be more accurate than the landline estimates for marital status, but no differences were observed for income.

The failure of the combined sample estimates to outperform the landline sample estimates in this study is somewhat surprising given the relatively high incidence of cell-only adults in the Hispanic population. Our post hoc explanation is that the post-stratification procedures played a greater role in reducing non-coverage and non-response error than adding the cases from the cell

sample. As described above, the post-stratification was somewhat involved and adjusted not only for traditional demographics but also for Hispanicity, place of birth, and years in the U.S. A related point is that the data from the cell sample may be reducing non-coverage bias, but it may also be subject to substantial non-response error (Brick et al., 2006). The results in Table 1 suggest that the non-response bias may be at least as great a source of error as the non-coverage bias.

Hispanic Dual Users from Cell and Landline Samples

Another key design question related to landline and cell phone samples is whether to interview persons with both types of phones in both samples. Theoretically, it is only necessary from a coverage standpoint to interview them in one sample. Nonresponse error and cost considerations, however, may make interviewing "dual users" in both samples more efficient than screening them out of one of the samples. If we knew that samples of dual users from landline samples had better nonresponse error properties than analogous cases from cell samples, this information would potentially lead researchers to screen dual users out of the cell sample, and vice versa. To gain leverage on this issue, we replicate an approach described by Kennedy (2007), which involves separating the duals users from the landline and cell samples and comparing them to the national subpopulation of dual users as measured by the National Health Interview Survey, which measures telephone service. The limitations of this analysis are the same as those discussed above with respect to the benchmark analysis in Table 1. The NHIS comparison features the additional wrinkle that the NHIS measures telephone service at the family level, while the Pew NSL instrument measures it at the adult level. These differences should be taken into consideration in evaluating the results.

Table 2. Comparison of Dual Users from the Landline and Cellular NSL Samples to NHIS Benchmarks

	Dual users in landline sample	**Dual users in cellular sample**	*NHIS Benchmark* **Dual users in U.S. Hispanic population**
	(N=529)	(N=451)	(N=1,671)
Age			
18-25	10%	26%	18%
26-35	26%	18%	27%
36-49	36%	33%	32%
50-64	20%	17%	17%
65+	8%	5%	6%
	100%	100%	100%
Male	54%	52%	51%
Income			
Under $20,000	23%	24%	11%
$20,000 to $74,999	57%	59%	49%
$75,000+	20%	17%	40%
	100%	100%	100%
Marital status			
Married	63%	45%	63%
Divorced	9%	8%	6%
Separated	5%	7%	2%
Widowed	3%	2%	3%
Never married	20%	38%	26%
	100%	100%	100%
Political affiliation			
Republican/Lean Rep.	17%	16%	--
Democrat/Lean Dem.	38%	31%	--
Independent/Other	45%	53%	--
	100%	100%	
Calls received on cell			
Almost all calls	33%	42%	--
Some calls	39%	38%	--
Very few or none	28%	20%	
Very few or none	100%	100%	--

NHIS estimates are weighted. Pew NSL estimates are unweighted.

Table 2 reports unweighted estimates for duals users interviewed in the landline sample and estimates for dual users interviewed in the cell sample. The estimates for all Hispanic dual users based on the NHIS are presented in the far right column. Regrettably, we were limited to

just a handful of common variables that we could identify in the two studies. Based on these four items, it is not clear that the dual users from the landline are any more representative of all Hispanic dual users than those captured in a cell sample. Cell sample dual users are more likely to be younger and unmarried, which meets with expectations from previous studies. The landline sample dual users appear to mirror the dual users from the NHIS with respect to marital status, but not on the other dimensions. These mixed results offer a partial explanation as to why the combined sample estimates are not uniformly more accurate than the landline sample estimates. The other factor is the nature of the cell-only Hispanics, who appear to not be dramatically different from other Hispanics on the characteristics measured in the Pew NSL.

Discussion and Conclusion

There has been a wealth of research on the potential bias caused by interviewing only on landline telephones. Thus far that research has been inconclusive on a number of counts. First, there is no weighting procedure that clearly is superior to others that have been tested. Secondly, while there is evidence that dual users interviewed via a cell phone are different both attitudinally and behaviorally compared to dual users interviewed from a landline telephone, there is little evidence to suggest one is superior to another, and the evidence is not particularly helpful in answering the question as to whether one can simply pick dual users from one frame to represent all dual users or whether instead it is critical to interview dual users from both frames. Finally, and most importantly, is the question as to whether interviewing landline respondents is not introducing insurmountable bias into telephone interviewing at large. Thus far, the weight of the evidence, for the general population, is no, that in fact, studies that have compared properly weighted landline samples have shown little if any significant differences compared to samples attained through dual frame designs. That said, there have been some difference found (Keeter,

2007), and particularly, one begins to see modest differences when the sample is limited just to 18 to 29 year olds, that portion of the population that is most likely to have eschewed a landline telephone.

Given that Hispanics are one of the fastest growing cell phone only populations, we considered it important to replicate the research questions that have been asked of the general population to this ever growing segment of the American population. Overall, our findings are consistent with findings among the general population. That is, there to date appears to be no superior weighting methodology with regard to Hispanics, as most schemes we tested performed comparably to one another. Given that studies of Hispanics tend to use stratified designs and other sampling designs that require some correct in the weighting, we find preference in utilizing weights that maintain a relative lack of bias while at the same time minimizing a study's design effect.

As well, since cell phone interviewing is expensive, and more so for Hispanic cell phone interviewing, we investigated whether dual users from one frame were more representative than another. The primary questions is whether there is some justification to gather interviews from dual users on cell phones, or whether to interview cell only respondents on cell phones. Our results again show no clear preference either way.

And finally, we explored the degree to which call phone and landline samples were significantly different from one another, and as well, whether when weighted the landline sample underperformed the full sample in comparison to known population estimates as well as in comparison to one another. There certainly are no lack of differences between cell phone and landline respondents, that much is clear. However, when weighted we again found no evidence

of substantial bias between weighted landline samples, dual frame samples, and national measures of key demographics, attitudinal and behavioral variables.

That said, when focusing solely on the 18 to 29 population, modestly significant differences were found. These included political party identification, attitudes toward the party's abilities to deal with various issues, and certain fears regarding immigration. Certainly, given that there were differences in many of the limited variables we measured in the study, it is likely that many other attitudinal and behavioral measures, if asked about in other surveys, would be different among weighted landline and weighted dual frame samples of Hispanics ages 18 to 29. Perhaps, within our own study, the most troublesome of the differences found is the difference found within acculturation. Again, the difference is a modest five percentage points. But given that such a measure is correlated with so many other attitudinal and behavioral variables, a difference in this core measure of Hispanics should be a cause for concern.

Still, the bias is to date largely limited to the 18 to 29 population. It of course remains to be seen whether, firstly, today's 18-29 year olds maintain these biases by telephone frame as they move into the 30-45 year old category and beyond. Secondly, we do not know whether tomorrow's 18-29 year olds will exhibit the same bias as today's 18-29 year olds. However, if both are true, the five percent (or more) bias found in many of our measures within 18 -29 year olds will become a greater and greater source of bias within the full Hispanic population. For now, it is important to continue to replicate the research reported here using different studies and different points of comparison. The cell phone issue, luckily, has had more bark than bite when one considers the current research as well as the weight of the research published in the last few years. But as researchers, we must continue to explore the issue as the U.S. population continues

to shift ever more toward more balanced, and separate, ownerships of landline and cell telephones.

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