

## HOUSEHOLD TELEPHONE SERVICE AND USAGE PATTERNS IN THE U.S. IN 2004

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### 1. Background

The percentage of households in the U.S. with a telephone is an important determinant of coverage in random digit dial (RDD) telephone surveys and also affects the efficiency of using the telephone as a mode of data collection in household surveys. In earlier years, RDD coverage issues were mainly concerned with households without phones because having a telephone in the household was nearly equivalent to having landline telephone service. As the percentage of households with only cell phones has increased, the difference between not having any telephone service and not having a landline is more important since virtually all RDD samples are selected from telephone exchanges that exclude cell phones. Members of households that have only cell phones are not covered under this traditional sampling procedure.

In the last few years, cell phones have become vastly more popular and the ability to assess the number and characteristics of households by the type of telephone service is limited. Tuckel and O'Neil (2004) report on cell phone ownership between 2000 and 2003. In 2003, the National Center for Health Statistics added items to its National Health Interview Survey that address this question. The initial results from the first half of 2003 are presented in Blumberg, Luke, and Cynamon (2004).

In addition to the estimates of prevalence, developments in telecommunications have added further complexity to the already complicated endeavor of sampling households by telephone. For example, some households are dropping their landline telephone and only using wireless phones, and others are keeping their landline but using their wireless phones most of the time. Some of these changes may involve acquiring new telephone numbers while in others the numbers are being ported across the types of service. Piekarski (2003) discusses this environment and some of its implications for telephone surveys. Needless to say, understanding the trends in the percentages of households with different types of telephone service and their uses of these services is essential for survey researchers using telephone methods.

In February 2002, a group of researchers met to discuss the implications of these emerging trends for survey research, particularly RDD surveys. One of the outcomes of the meeting was an offer by the U.S. Census Bureau and the

Bureau of Labor Statistics to collect data on telephone service in households as a supplement to its Current Population Survey (CPS). A subcommittee of the researchers developed and tested an instrument to assess the types of telephone services and key aspects of the use of these telephone services by household members. This short series of items was asked in about 32,000 households in the February 2004 CPS supplement. Some results from this survey are given here.

This paper begins with an examination of trends for different types of telephone service based on an examination of data from the BLS Consumer Expenditure Survey Program that measures expenditures for various forms of telephone service. Preliminary results from the CPS Supplement follow this analysis. Estimates include the latest numbers on the percentages of households with a landline only, those with no landline but with wireless service, those with both landline and wireless service, and those with no telephone services in the household. These estimates are further broken down by demographic characteristics, number of telephones in the household, and telephone usage patterns. Logistic models were run to predict household phone ownership and to predict ownership by adults. Finally, a cluster analysis was performed to identify different subgroups of households based on their types of telephone service.

### 2. Consumer Expenditure Interview Survey Estimates

The Consumer Expenditure Interview Survey (CEIS) is an in-person interview conducted by the Bureau of Labor Statistics that has included questions about cell or mobile phone service for a number of years. The purpose of the CEIS is to produce estimates of purchases of specific commodities made by households in the U.S. during the past quarter. In the CEIS a sample of about 5,000 to 8,000 respondents (generally households) are interviewed quarterly for five consecutive waves. The first quarter is treated as a bounding interview and typically excluded from analyses. The data used in this analysis are wave 2 interviews collected from the first quarter of 1994 to the first quarter of 2003.

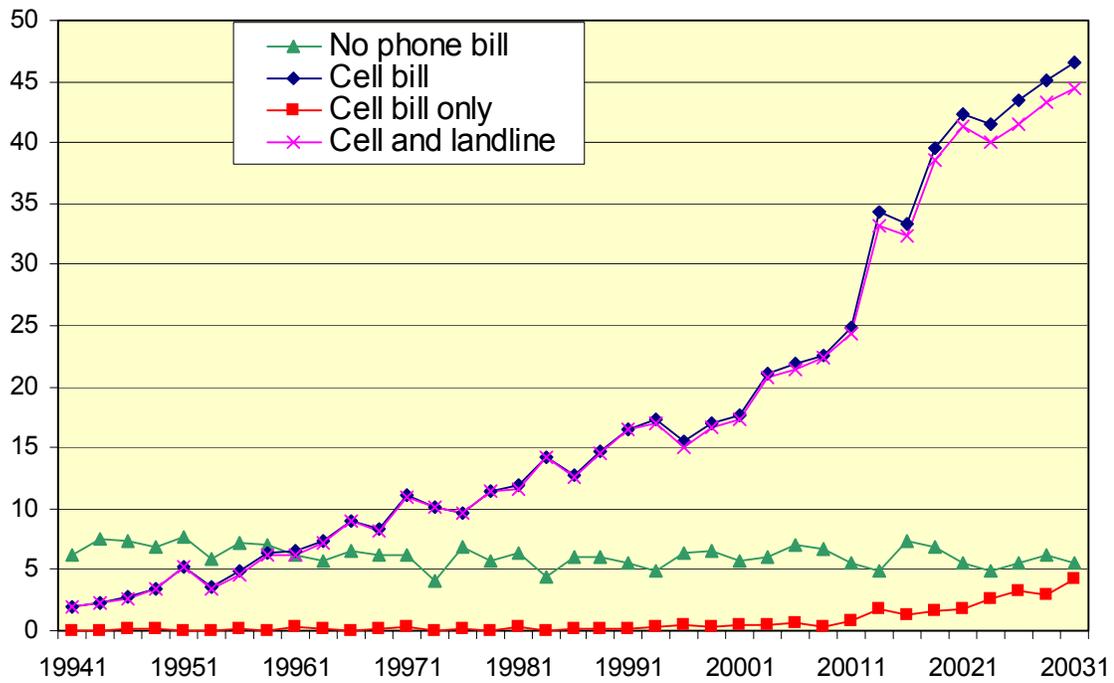
During the interview respondents report on whether they received a landline phone bill (broken out by long-distance, local, etc.) and if they received a cell or mobile phone bill for each of the past three months. For this analysis, if a respondent reports a cell phone bill for any of

the past three months they are considered to have cell phone service during that quarter. Likewise, if a household received a local or long distance (not calling card) phone bill for any of the past three months then they are considered to have landline service. In this way, four groups of households are formed based on their reported telephone service—those with both landline and cell service, those with landline service only, those with cell service only, and those with no phone service. Based on other research, we know that purchases are not reported without error and the probability of not reporting an actual purchase can be high, although utilities seem to have a lower error rate than other commodities. Therefore, we would expect that the CEIS underestimates both cell service users and landline service users, resulting in upwardly biased estimates for no-phone households. Because of this potential for bias, results from the CEIS were analyzed primarily to assess trends in telephone service in households.

Figure 1 shows the percentage of households in the CEIS that reported telephone bill in a given quarter from the first quarter of 1994 to the first quarter of 2003 (each point in the figure represents a quarterly estimate), by the type of bill.

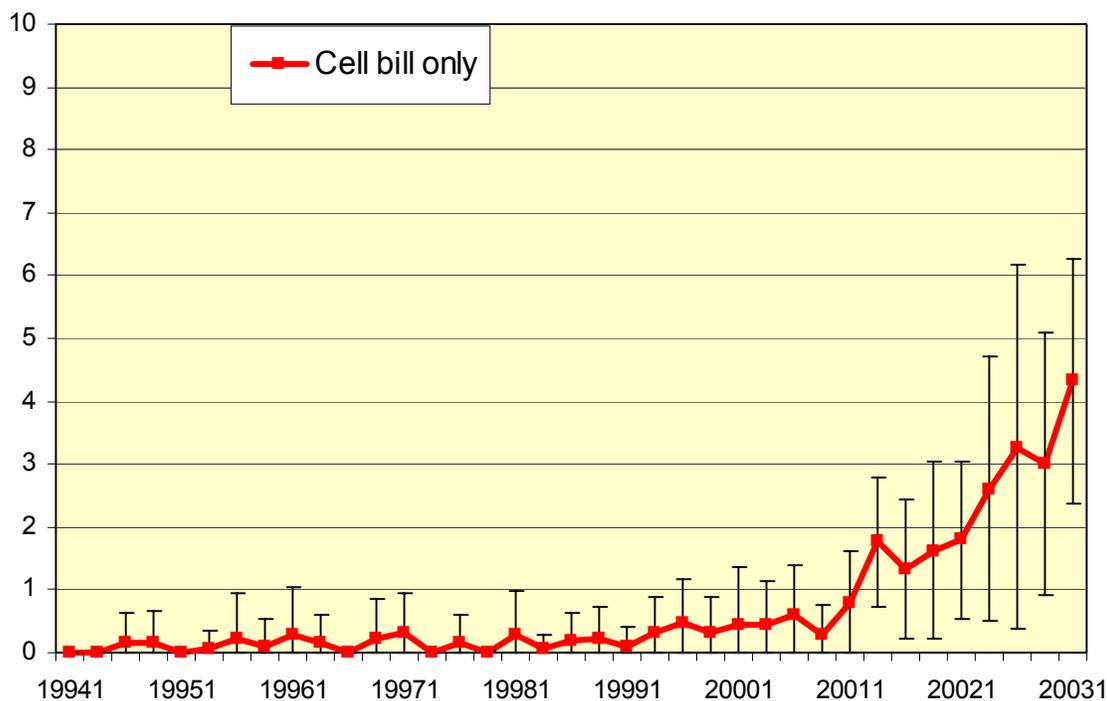
The percentage of households reporting a cell phone bill rose steadily from about two percent in the first quarter of 1994 to about 25 percent in the first quarter of 2001. At that point, the percentage began increasing at a much greater pace, and by the first quarter of 2003 approximately 47 percent of households received a cell phone bill. As shown in Figure 2, less than 1 percent of households received only a cell phone bill (no landline bill) through the first quarter of 2001. The percentage then rises, accompanying the aforementioned dramatic increases in cell phone bills. The percentage of households only receiving a cell phone bill increased dramatically from less than 1 percent to over 4 percent between the first quarter of 2001 and the first quarter of 2003.

We also tabulated the CEIS over time for various types of households, but do not show these tables here. Some of the highlights of the bivariate analyses are that cell-only households are more likely to be student housing units, rented households, single-person households, located in urban areas, and households that are not in the highest income quartile. These characteristics are consistent with the data collected in the CPS discussed below.



Source: Consumer Expenditure interview Survey, Bureau of Labor Statistics

Figure 1. Estimates of percentage of households reporting telephone service between 1994 and the first quarter of 2003, by type of service



Source: Consumer Expenditure Interview Survey, Bureau of Labor Statistics

Figure 2. Estimates of percentage of households reporting having expenditures only for Mobile telephone service between 1994 and the first quarter of 2003

### 3. CPS Supplement Questionnaire Development and Evaluation

The development of the items for the CPS supplement was initiated by a subgroup of attendees of the Cell Phone Summit meeting. The members included experts from government, academia, and the private sector. The work was coordinated by Clyde Tucker and Mike Brick. The group prepared a research agenda that identified the primary objective of the supplement was to classify households by the type of telephone service (landline only, landline and cell, cell only, and no service). A secondary goal was to classify members in households with landline and cell service by their type of usage. Since the items were to be in a supplement to the CPS, the length of the interview had to be very short, and could not exceed two minutes in total.

The first draft of the questionnaire was developed using items from existing surveys, to the extent possible. Charlotte Steeh of Georgia State University and Ed Cohen of Arbitron provided questionnaires that had been used in earlier cell phone surveys so that items could be extracted from them. Initial drafts of the questionnaire were vetted by the group using email and an in-person meeting at BLS.

The initial draft of the instrument from this process was tested and refined using cognitive interviewing techniques. David Cantor and Tracy Hagerty-Heller of Westat conducted three rounds of concurrent and debriefing

interviews with individuals over the telephone. The interviews included some persons who only had cell phones. After each round, the items were revised based on observations from the interviews. The final draft of the instrument was also reviewed and approved by the initial group of experts.

The instrument was then sent to the Census Bureau, where it was formatted. A few minor revisions were also made to accommodate administration in the CPS. The appendix contains the wording for the items in the supplement. The skip patterns and detailed fills used in the computer administration of the interview are not shown in this layout.

James Esposito of BLS developed and implemented two methods to evaluate the items as they were administered in the CPS. One method was interviewer debriefings. Two interviewer debriefing sessions were conducted, each consisting of about 20 CPS telephone interviewers from the centralized facilities (one in Tucson, AZ and the other in Hagerstown, MD). Both English and Spanish speaking interviewers participated in the debriefings. The second evaluation method was behavior coding in the same two centralized telephone facilities. All the behavioral coding or interaction coding was done by Esposito while listening to production interviews. A complete report on the findings from the interviewer debriefings and the behavioral coding is available from BLS.

In the cognitive testing during questionnaire development and in the evaluation of the production of the interviews, some ideas and constructions were identified as being difficult for either the respondent or the interviewer. In particular, Q3 raised the most concerns. The lack of a specific reference period, not having a code for ‘half the time,’ and the difficulty in reporting for other members of the household were noted in all the development and evaluation work. These efforts show that the interview could be improved and should be considered if the items are used again. Nevertheless, we concluded from the evidence that households were usually able to answer the questions about telephone service reliably, especially the items that addressed the primary objective of classifying the household by type of telephone service.

#### 4. Current Population Survey Estimates

The development of the CPS Supplement was motivated by a desire to assess the potential for coverage bias in RDD surveys and to investigate procedures to reduce this bias. If survey designers exclude households that only have cell phones in an RDD study, then it will result in undercoverage. The bias due to that undercoverage can be estimated from the CPS Supplement. Even if cell-only households are excluded, the data from the supplement can help to inform the development of procedures for benchmarking statistics to reduce coverage bias.

Our initial examination of the data focuses on answering the following questions: How are cell-only households (and persons) different from households (and persons) who receive calls via landlines? Is the cell phone a personal device in which only one person is accessible by one cell phone number? How are selection probabilities (and therefore survey weights) affected by access to cell phones, such as the number of unique cell numbers in a household or the number of people who use the same cell number?

To address these questions, descriptive statistics from cross tabulations of supplement data are presented first. Next, logistic regressions to predict phone ownership from demographic variables and cluster analysis of cell-only households (and persons) are given to search for important groupings of cell-only households. Each of these analyses are discussed in turn. Although we have not yet computed sampling errors for the estimates from the supplement, a lower limit of those errors can be based on simple random sampling inflated to account for the expected design effect. The sample of 32,000 insures that the sampling errors of percentages are relatively small. For a 1 percent statistic, the standard error (s.e.) would be .06 percent, while a 25 percent item would have a s.e. of only .24 percent. Thus, differences between subgroups in excess of 1 percent are likely to be statistically significant. Even if the design effect increased the confidence interval width by 50 percent, far greater than its likely impact given the CPS design, the differences noted

below would be statistically significant. Due to instrument problems and other nonresponse, some cases are imputed. The distribution using the imputed values is believed to more accurately represent the population.

Across the entire sample in February 2004, the majority of households have both landline and cell phone service (51.7%). Six percent of the surveyed households have only cell phone service, while 37.2 percent have only a landline in their household. The remaining 5.1 percent have neither landline or cell phone service.

Table A presents some key household characteristics. The table indicates that the proportion of cell-only households is smaller in the Northeast (4.2%) than in the other three regions (6.0 - 6.7%), and that the proportion of cell-only households is larger in central cities (7.9%) than households outside of central cities (5.2 - 6.0%). Further, the percent of one-person households that are cell-only (8.7%) is greater than that of larger households (5.7-6.0%). The table shows that cell-only households constitute a much larger proportion of rented units (11.8%) than of owned units (3.7%) and, related to this, a much larger proportion of multi-unit dwellings (11.7%) than single unit dwellings (4.6%).

Table A. Telephone service status of U.S. households

Group	Landline or both	Cell only	None
Total	88.8	6.0	5.1
Region			
Northeast	91.4	4.2	4.5
Midwest	89.6	6.1	4.3
South	87.2	6.7	6.0
West	88.5	6.3	4.9
Metropolitan			
Central city	84.6	7.9	6.9
MSA, non-Central city	90.9	5.2	4.0
Non-MSA	89.5	5.3	5.2
Household size			
1 Person	83.4	8.7	7.2
More than 1 person	89.5	5.7	4.8
Home ownership			
Own	93.6	3.7	3.1
Rent	77.2	11.8	10.0
Dwelling unit			
Single unit	91.7	4.6	3.9
Multi-unit	78.0	11.7	9.4

Table B gives some person level characteristics for adults 15 and older. It shows that while only 5.7 percent of adults live in cell-only households, 18 percent of persons 15-24 have cell phones only. Older persons have a much lower level of cell-only access (2.5 – 9.0%). Hispanics have the highest level of cell-only ownership (7.2%), followed by

Black, non-Hispanics (6.3%), and other races have the lowest level (5.4%). Not married adults have a notably higher cell-only ownership (10.5%) than the married (3.8%). Those with a masters or higher educational level have the lowest cell-only ownership (3.1%); whereas, those with less education range from 5.2 percent to 6.5 percent.

Table B. Telephone service status for adults 15 and over

	Both	Land only	Cell only	None
Total	51.6	37.9	5.7	4.7
Age				
15-24	41.1	29.6	18.0	9.6
23-34	53.5	30.2	9.6	6.1
35-54	60.4	31.0	5.0	3.9
55+	39.7	53.9	2.5	4.1
Race				
Hispanic	39.4	43.0	7.2	9.1
Black Non-Hispanic	42.1	43.5	6.3	7.9
Other	55.0	36.3	5.4	3.5
Marital status				
Married	55.9	37.1	3.8	3.5
Not married	41.1	39.9	10.5	7.6
Education level				
Less than high school	37.4	48.2	6.0	8.1
High school diploma	45.7	43.2	5.8	5.2
Some college	57.4	32.8	6.5	3.5
Bachelor's degree	65.0	27.3	5.2	2.6
Masters or more	65.5	29.4	3.1	2.3

The next tables deal with the issue that multiple phone numbers in a household create inefficiency in the sample design because a person can be reached by more than one unique number and their chances of selection are increased. Variation in survey weights due to these multiple selection chances gives rise to a design effect, which in this case will increase sampling errors for estimates. A common approximation is that the design effect is equal to the square of the coefficient of variation (cv) of the survey weights plus one. Thus, the questions about the number of unique phone numbers provides an estimate of the distribution of survey weights, their cv, and therefore the potential design effect. What is more, added complexity is required in the survey instrument to determine how many unique numbers are available and to which potential respondent. Survey quality is impacted by both the accuracy of the responses to probes about this topic and the added length of the required questions.

Table C gives a result consistent with most RDD surveys in our experience, showing that three to four percent of households have more than two unique land line phone numbers. This results in a modest design effect in RDD surveys of landlines.

Table C. Number of telephones in household, by type of service

Number of landlines	Land & cell	Land only
1	88.1	96.4
2	10.6	3.2
3+	1.4	0.3
Mean	1.14	1.04

Table D shows the situation arising from inclusion of cell phones, and suggests a much wider variation in survey weights and a much larger design effect. Only 41 percent of the household can be reached by a single cell number while 17 percent can be reached by three or more cell numbers. Of course, if each cell owner is the only user of their phone, then this issue does not arise because there is one-to-one link between the cell phone number and a particular adult (this statement assumes that the survey is of persons and not households where multiple cell phones would still create problems in having multiple chances of being selected).

Table D. Number of cell lines in household, by type of service

Number of cell lines	Land & cell	Cell only
1	41.1	56.3
2	42.1	32.1
3	11.4	9.5
4	4.3	1.7
5+	1.1	0.4
Mean	1.83	1.58

Table E indicates this is not the case. In most households where at least one person owns a cell, that cell is used by more than one person.

Table E. Percent of households with cell phones in which at least one cell is answered by more than one person, by number of cells in household

Number of cell phones	Land & cell	Cell only
1	79.9	59.4
2	64.4	53.9
3	48.4	47.7
4+	45.9	43.1

To explore possible approaches to reduce coverage bias, logistic regressions were run to predict phone ownership from demographic characteristics. The variables that predict phone ownership categories may also be useful for determining which ones are appropriate for benchmarking survey weights. The results of the regression models, as expected, supported the descriptive results given above. These analyses are weighted and scaled to the sample size, but this does not fully reflect the sample design in the estimation of standard errors. Nevertheless, given the large sample size, it is expected that estimated coefficients are statistically significant.

The analysis shows that the type of units (single, multi-unit), family type, tenure and region are good predictors of household phone ownership. Age, race, marital status, education, employment and an interaction between age and education and between race and employment are good predictors of phone ownership for adults.

Lastly, a cluster analysis of cell-only households was undertaken to determine if any subgroups of interest could be identified within this population. Where the logistic modeling was valuable to search for main effects and direct interactions that predicted categories of phone ownership, cluster analysis was used to identify subgroups within the cell-only population. Five distinct groups of households with cell phones only were identified. These groups and the percent of the total population of cell phone households are: (1) Households in the N.E. or Mid-west with children (9.3%); (2) Households in the N.E. or Midwest without children (7.4%); (3) Households in the South or West, in central cities OR not in central cities but with children and in rented units (44.2%); (4) Households in the South or West, not in central cities in rented units and had no children (3.0%); and (5) Households in the South or West, outside of MSAs OR in owned units and were not in central cities (36.2%). Further analysis is needed to determine if these exploratory findings are confirmed.

## 5. Discussion

These results provide a glimpse into the likely future of telephone surveys. The collection of data in 2004 was timely because it is likely that this is the first time in history in which the percentage of households that have only cell phone service is greater than those with no phone service. In fact, these two groups of households are diverging, with those without service continuing to shrink, perhaps because households that formerly had no service are acquiring cell phones, and those with cell-only service are continuing to grow. As the CEIS indicates, the number of cell-only households is increasing at a quick pace. Of course, it's likely that the number will reach a plateau, but there is no indication that plateau is near-at-hand.

As noted in the article, data from some households were unintentionally excluded from the February CPS supplement. Data from the excluded types of households is planned for data collection in December 2004. Once these data are combined with the already collected data from February, a final report will be produced and is expected to be released in early 2005. The trends from the CEIS also will continue to be monitored.

The results from these surveys indicate that survey researchers planning future studies will need to develop methods to include cell-only households in their samples to combat the potential bias due to undercoverage. In addition to developing new sampling methodologies, operational methods for actually contacting cell phone owners and convincing them to participate are needed. Some work on these new procedures has already begun (e.g., Steeh 2004), and more will follow.

An expanded group of researchers will meet once again in January 2005 in New York to review what has been learned, and to map out future directions needed to incorporate cell phones into telephone surveys.

## 6. References

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**Appendix. Telephone Service Questionnaire**

Q1. First I would like to ask about any regular, landline telephone numbers in your household. These numbers are for phones plugged into the wall of your home and they can be used for different reasons, including making or receiving calls, for computer lines or for a fax machine.

How many different landline telephone numbers does your household have?

VER1. I'd like to verify the information you just provided. I believe you indicated that your household has NO LANDLINE TELEPHONE service for incoming and outgoing calls: Is that correct?

VER2. I just want to verify that your household has (Q1) distinct telephone NUMBERS: Is that correct?

Q1a. Excluding any numbers used only for faxes and computers, how many of these (Q1) landline telephone numbers are used for incoming calls?

Q1b. Excluding a number used only for a fax or computer, do you or any other member of your

household take incoming calls on a landline number?

Q2. {Excluding students living away at school,} Do you or any other members of your household have a working cellular phone number?

Q2a. {Excluding students living away at school,} How many different cell phone numbers do the members of your household have?

Q2b. How many of the (Q2a) cell phone numbers do you or any other members of your household use regularly?

Q2c. How many of the (Q2a) cell phone numbers are answered by more than one household member?

Q2d. Do you regularly answer this cell phone number?

Q2e. Is this cell phone number answered by more than one household member?

Q3. Of all the phone calls that you or any other members of your household receive, about how many are received on a cell phone? Would you say...

- All or almost all calls, 1
- More than half, 2
- Less than half, or 3
- Very few or none? 4