Determining the Probability of Selection for a Telephone Household in a Random Digit Dial Sample Design is Becoming more Difficult

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1. INTRODUCTION

Over the last 25 years, a lot of household telephone surveys have made use of a random digit dial (RDD) sample design (Waksberg 1978). During the early years of RDD sampling the vast majority of telephone households had only one telephone number. By 1988 just 2.7%[1] of telephone households had more than one non-cellular telephone number. This figure steadily increased and by the year 2000, 26.2%[1] of telephone households had more than one telephone number. Accounting for the rapid increase in multiple telephone line households are advancements in telecommunication technologies such as the Internet and fax machines as well as an increase in home businesses. However, since 2000 the trend has reversed causing a dip in the percentage of telephone households having more than one non-cellular phone number (or landline number). The drop may well be attributed to further telecommunication technology advancements whereby a single phone line can serve the multiple purposes of voice communication and Internet or fax machine connection simultaneously. Also contributing to the decline in multiple telephone number households may be the recent surge in cellular telephone purchases to replace additional household landlines.

Recent rapid changes in the telecommunications culture have created a challenge for survey researchers attempting to measure the number of household telephone numbers eligible for selection into a sample. Respondents may be unsure about what counts as a household telephone number if researchers fail to be specific in their definitions.

Today, more than a fifth of the US household telephone population maintains two or more telephone numbers. A proportion this large demands that survey researchers obtain reliable data about how many telephone numbers a household has that are part of the RDD sample frame and that are always or sometimes used for personal (non-business) conversations.

For many years, researchers using a RDD sample design could estimate the total number of residential telephone numbers in a household by simply asking one, sometimes two, and at most three questions. The 2002 National Survey of America's Families (NSAF) is a telephone survey that relies primarily on a large RDD sample design using over 400,000 telephone numbers. In previous rounds of the NSAF (1999 and 1997) a simple two-question approach was used to estimate a household's total number of sample eligible residential telephone numbers. For the 2002 study a more in depth set of questions was asked of each household, with the purpose of learning whether additional telephone numbers could be used for completing a survey. This paper compares the results of these questions with previous rounds of NSAF and looks at what other RDD studies are doing.

2. OTHER RDD SURVEYS

In reviewing what other RDD surveys are doing to determine the probability of a telephone household's selection it is encouraging to see that most surveys have modified their questions on telephone use in order to address changes in technology. *Figures 1 and 2* show the question wording used in all three rounds of the NSAF and in several recent large RDD surveys. What is troubling is that while the information surveys

[1] Federal Communications Commission's August 2003 report, "Trends in telephone Service".

Figure 1. NSAF Telephone Question Series 1997, 1999 and 2002

1997 & 1999 NSAF Questionnaire:

M14. Besides [TELEPHONE NUMBER], do you have other telephone numbers in your household?
Yes → *[Go to M15]* No → *[Go to next section]*

M15. How many of these additional telephone numbers are for home use?
NUMBER _____ → *[Go to next section]*

2002 NSAF Questionnaire:

M14. Besides [TELEPHONE NUMBER], do you have other telephone numbers in your household, not including cell phones?
Yes → *[Go to M15]* No → *[Go to next section]*
DK → *[Go to M18]*

M15. Including your computer and fax phone numbers, how many of these additional phone numbers are for home use?
NUMBER _____
M15=0 → *[Go to next section]*
M15=1 → *[Go to M16]*
M15>1 → *[Go to M17]*

M16. Is this additional phone number used for a computer or fax machine?
Yes → *[Go to M20]*
No → *[Go to next section]*

M17. Of these [NUMBER] additional home use phone numbers, how many are used for a computer or fax machine?
NUMBER _____
M17=0 → *[Go to next section]*
M17=1 → *[Go to M20]*
M17>1 → *[Go to 19]*

M18. Do you have any additional phone numbers for computer or fax machines?
Yes → *[Go to M20]*
No → *[Go to next section]*

M19. How many of these [NUMBER OF PHONE NUMBERS] phone numbers used for computers or faxes are ever answered for talking?
NUMBER _____
M19=0 → *[Go to next section]*
M19=1 → *[Go to M21]*
M19>1 → *[Go to M22]*

M20. Is it ever answered for talking?
Yes → *[Go to M21]*
No → *[Go to next section]*

M21. Is this phone number used for a computer or fax line answered for:
Personal calls
Business calls
Both?
→ *[Go to next section]*

M22. Of these [NUMBER OF PHONE NUMBERS THAT ARE ANSWERED], how many are answered for non–business related calls?
NUMBER _____ → *[Go to next section]*

Figure 2. Telephone Question Series from other Major RDD Surveys

California Workforce Study 2001/2002:

Tel1. Next, how many telephones do you have in your home – counting extensions, but not counting cellular phones?
Tel2. Do [all/both] the telephones have the same number?
Tel3. How many different numbers are there?

[Tel4 & Tel5: ASK ONLY OF RESPONDENTS WHO HAVE MORE THAN 1 TELEPHONE NUMBER]

Tel4. Are any of those numbers used *exclusively* for computers of fax machines?
IF YES: How many?
Tel5. How many of those lines are used for making or receiving calls for personal or business purposes?

Behavioral Risk Factor Social Survey 2001 & 2002:

Q1. Do you have more than one telephone number in your household? Do not include cell phones or numbers that are only used by a computer or fax machine.
Q2. How many of these are residential?

Behavioral Risk Factor Social Survey 1999 & 2000:

Q1. Do you have more than one telephone number in your household?
Q2. How many residential phone numbers do you have?

Community Tracking Survey 1998/1999:

H30. Do you have any other telephone numbers in you household besides [FILL IN PHONE NUMBER]?
[IF YES]: How many?
H31. (Is this/Are these) other phone numbers for…
Home use
Business and home
Business use

need to obtain is the same, the approaches different surveys are using to get this information are quite varied. Therefore, it is not easy to compare estimates across studies of reported additional residential telephone numbers that require a weighting adjustment.

Survey researchers agree that obtaining correct estimates of residential phone numbers is needed for RDD surveys. Carefully crafted questions with a specific definition for the term 'residential telephone number' will aid in accurate measurement. However, as we adopt new procedures it is important that we investigate the effects of new questions on the weighting adjustment associated with multiple residential telephone numbers.

3. NSAF METHODOLGY

Westat collected the data for all three rounds of the NSAF: 1997, 1999 and 2002. The purpose of the NSAF survey is to assess the impact of recent changes in the administration of a number of assistance programs for children and the poor. The sample is based on two different frames, the largest of which is a RDD[2] frame representing households with telephones. The second is an area frame from which non-telephone households are selected. All interviews are administered by telephone (interviews in the area frame are conducted through cellular telephones supplied to respondents). The NSAF sample is designed to generalize to 13 specific states, as well as the nation as a whole. The design also includes an over sample of households estimated to be under

[2] Over 500,000 phone numbers were selected for the 2002 NSAF.

200% of the federal poverty level as well as households with children.

The NSAF consists of both a screening and an extended interview. The screening interview is designed to assess household eligibility and select a respondent for the extended interview when a household is eligible. Household eligibility for the extended interview is determined by residence of persons less than 65 years of age and by family poverty as compared to 200% of the federal poverty level. The extended interview is between 30 and 50 minutes in length and covers a wide range of topics, including health, education, child care, income, and receipt of social services.

Questions about the number and use of residential telephone numbers are asked towards the end of the extended interview. *Figure 1* shows how the telephone assessment questions were asked on the 1997 and 1999 questionnaire compared to the 2002 version. While the total number of questions and the wording of questions M14 and M15 changed from 1997 and 1999 to 2002, the intent of these questions remained the same: to determine the number of sample eligible telephone numbers in a household. In the 2002 questionnaire it was considered necessary to explicitly ask respondents *not to include* cellular telephone numbers due to the rapid increase in cell phone usage. The 1997 and 1999 questionnaires included this as an on-line interviewer instruction that was only read at the respondent's request. Likewise, question M15 of the 2002 NSAF explicitly instructed respondents to include home computer and fax numbers only if they were also used for voice communication. The 1997 and 1999 NSAF surveys again relied on an interviewer instruction. Therefore, while the questions used between rounds of the NSAF were different, the goal of estimating total residential telephone numbers also used for voice communication remained.

In addition to changes in question wording, the 2002 NSAF also includes a series of questions asked of multi-telephone households to assess whether or not supplemental telephone numbers were sample eligible. Many people purchase additional telephone numbers for their home computer or fax machine. In some households telephone numbers used by a computer or fax machine are never answered or voice communication while in other households the opposite is true. Regardless of their household use these telephone numbers are included in the sampling fame. We felt the need, on the 2002 NSAF, to ask a set of usage questions to determine whether additional household telephone numbers were available for completing a survey.

4. RESULTS FROM CHANGING THE NSAF PHONE NUMBER ITEMS

Since the NSAF telephone questions are asked towards the end of the first extended interview, telephone information was only collected for households that were selected into the study. To analyze the 2002 NSAF telephone question series, we use a household weight adjustment that controls for the probability of a household's selection. This weight adjustment does not include the multiple telephone line adjustment. The weight is an accurate assessment of telephone information for households with a resident 18 to 64 years old. Since we do not collect information from elderly households, where all household members are 65 or older, our data presumably varies somewhat from household surveys that include all telephone households. *Table 1* displays estimates of the percent of NSAF multiple telephone households for all three rounds using the adjusted household weight described.

Table1. NSAF 1997-2002: Percent of households with multiple residential telephone numbers (excluding cell phones)

NSAF		
1997	**1999**	**2002**
14.0%	**18.3%**	**11.7%**

Timeline data from the Federal Communications Commission's August 2003 *Trends in Telephone Service* show increasing numbers of US households acquiring multiple telephone numbers during the 1990s (see *Table 2*). These figures exclude cellular telephones but do include telephone numbers purchased only for home business use. The four-point increase in the

percentage of households with multiple telephone numbers (14.0% in 1997 vs. 18.3% in 1999 – *Table 1*) from 1997 to 1999 on the NSAF is consistent with the five- point FCC increase. The slightly higher increase in FCC numbers can be explained by possible over reporting of telephone lines due to respondent inclusion of cell phones and/or computer, fax or home business lines not used for personal conversations. In support of this argument we look to the 1999 adult special study supplement to the National Household Education Survey (NHES)[3]. The NHES found that 41% of households in 1999 owned at least one cellular telephone. Of these households, 4% admittedly included their cellular telephones in their count of additional residential telephone numbers (Roth, Montaquila, and Brick 1999). Likewise, it is probable that some of the 1999 NSAF respondents living in households owning cellular telephones also included them in their count of residential telephone lines. Cellular telephone inclusion likely had less impact on 1997 NSAF telephone line estimates since, according to the Cellular Telecommunications and Internet Association (CTIA), there were 60% fewer cellular subscribers in 1997 than in 1999.

Since reaching a peak in 2000, the percentage of households having more than one landline telephone number has dropped, as reported by the FCC. NSAF estimates for the same period show a similar decline: between 1999 and 2002 a 6½ point drop in households with multiple residential telephone numbers is evident (18.3% to 11.7% respectively – see *Table 1*). Using the NHES 1999 estimates of households owning a cellular telephone and respondents who included cellular telephones in their count of residential telephone numbers we can approximate those figures for the 1999 NSAF. Assuming that 4% of the roughly 41million 1999 NSAF cellular owning telephone households erroneously reported a cellular telephone as an additional residential telephone number, we feel that 1½ to 2 points of the overall 6½ point drop were respondents who included cellular telephones in their count of additional household telephone numbers (4% of 41 million). The remaining 4½ to 5 point decline in multiple telephone households from the 1999 to the 2002 NSAF is plausibly the result of both changing telephone technology and reduced demand for more than one household landline.

Other recent RDD surveys also show a decline in households with multiple landlines. Despite some measurement differences, the proportional decline of multiple telephone line households for the period from 1999 to 2002 is relatively similar for the NSAF and BRFSS studies. NSAF data show a 36% decline from 1999 to 2002. However, by making the 1½ to 2 point adjustment to the 1999

Table2. US Households with Additional Residential Telephone Numbers[4] (Data in Millions)

Year	Households w/Telephone Service	Additional Residential Lines	%Additional Lines for HHs w/ Telephones
1988	85.4	2.3	2.7%
1989	87.4	2.6	3.0
1990	88.4	3.9	4.4
1991	89.4	6.5	7.3
1992	91.0	8.3	9.1
1993	93.0	8.8	9.4
1994	93.7	11.4	12.2
1995	94.2	13.9	14.7
1996	95.1	16.0	16.8
1997	96.5	18.2	18.9
1998	98.0	19.1	19.5
1999	99.1	23.6	23.8
2000	100.2	26.2	26.2
2001	102.2	25.1	24.6
2002[5]	104.0	18.7	18.0

[3] The adult special study supplement to the National Household Education Survey (NHES) was conducted by Westat to gather information on telephone technologies that could affect survey response rates or weighting procedures.

[4] Table 3 is adapted from table 7.4 from the FCC's August 2003 release of "Trends in Telephone Service". Table 7.4-*Additional Residential Lines for Households with Telephone Service (End-of-Year Data in Millions).*

[5] The 2002 estimate of households with additional telephone lines is an unpublished and preliminary estimated obtained from the FCC.

NSAF figure we find that the decline drops to 30% as compared to the BRFSS data which show a 29% decline for the same period. The decline in household demand for supplemental landline numbers is the result of consumer response to advancements in the telecommunications industry. As the percentage of multiple landline households has fallen in recent years the popularity of cellular telephones and digital subscriber lines (DSL) has surged (CTIA, 2003). The purchase of cellular telephones may be replacing the purchase of additional landlines in some households. Moreover, DSL Internet connections render the need for supplemental landline Internet numbers unnecessary since they allow for simultaneous voice and Internet communication on a single landline. Comparing the 1999 NHES adult special survey to the 2002 NSAF we found that 15% more NSAF respondents than NHES respondents say they would answer a telephone number used for computer or fax machine connections (35% vs. 50%, respectively). This change over time can be attributed to increased availability of landline numbers that provide Internet, fax and voice communication simultaneously

5. SUMMARY

As a result of increasing telecommunication options, it has become more difficult to determine a households' chance of selection from a RDD sampling frame. A simple one or two question approach no longer yields the necessary information. Use of an expanded question series to navigate the respondent through the inclusion of cellular telephones lines and landlines used exclusively for purposes other than voice communication is necessary in today's confusing and rapidly changing telecommunications culture. The series of questions asked on the 2002 NSAF survey seems to address these issues, but for how long? In just three years we have seen a 15 percentage point increase in the number of people reporting that they would answer and talk on a telephone number that is also used for computer or fax connections. This demonstrates how rapidly people are changing their telecommunication habits. As the telecommunication world changes it is important to readdress the series of household telephone number questions, keeping in mind that the primary objective is to determine household probability of selection.

Major RDD surveys administered over the past five years have obtained varying estimates of the percentage of multiple telephone number households. Ideally, all telephone surveys would benefit from the development of a set of questions that could become the industry standard. However, this will be a difficult objective to accomplish given the fast paced nature of telecommunication technologies.

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