RESPONSE RATES IN A DUAL-FRAME SAMPLE DESIGN CATI TEST

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1. INTRODUCTION

In 1987, the Bureau of Labor Statistics (BLS) contracted with the Census Bureau to conduct a telephone survey test of the Point of Purchase Survey (CPP). This experiment incorporated both the use of a dual-frame telephone survey methodology, and CATI. The purpose of the test was twofold. First, it was meant to determine if CPP could be conducted by telephone at a centralized CATI facility as opposed to its current method of personal interviewing. Second, the dual-frame design of Random Digit Dialing (RDD) supplemented with a list frame was used to see if such an approach to sampling was feasible for this survey.

This paper provides a description of why CATI and telephone sampling were considered for the CPP, maps out the analysis required to achieve the purposes of the test, and then reports some preliminary findings on response rates whichare needed along with other information to describe the success of the dual- frame design.

2. THE CPP SURVEY

The Census Bureau has conducted the CPP by personal visit interviewing since 1977, using a sample of about 5,700 households in approximately 18 Primary Sampling Units (PSUs) per year (approximately one-fifth of all sampled PSUs). Each sample household is interviewed only once. The respondent is asked to recall purchases of major commodities and services (such as vehicles, musical instruments, convalescent care) made by household members during the previous 5 years and purchases of other selected commodities anywhere from 2 years ago to 1 week ago, depending upon the commodity. In addition, they are asked to provide the name and address of each outlet where purchases were made, and the purchase price. Altogether, the respondent can report up to approximately 165 commodity purchases and their corresponding outlet names, locations and prices during the interview, which typically takes about 70 minutes to complete.

The information about what people buy and where they shop is collected, edited, tabulated, weighted, and delivered to the Bureau of Labor Statistics in 6 months. The data are used by the BLS to select the outlet sample for their pricing surveys. Information from those surveys is used as one measure to update the Consumer Price Index (CPI), a leading indicator of the cost of living in the United States.

3. THE USE OF CATI

The Census Bureau has conducted a considerable amount of research into CATI, especially since 1985 when it opened a telephone interview center in Hagerstown, Maryland. CATI development work has taken place on such surveys as the National Crime Survey, the Current Population Survey, the American Housing Survey, and numerous smaller ad hoc surveys. This work has shown that CATI offers several benefits over personal interviewing, including potentially lower interviewing costs due to elimination of travel time, greater quality control because of the centralized interviewing location, the ability to discern questionnaire wording and response problems through a level of monitoring which would not be possible in a personal interview situation, and the potential for more rapid data delivery.

4. THE USE OF TELEPHONE SAMPLING

Telephone sampling was considered for CPP since a main goal of the survey's use of the centralized CATI facility is the travel savings. Hence, phone numbers are the required sampling frame.

Outside of the Census Bureau, researchers have considered alternatives to deal with the productivity and response problems cited earlier with RDD sampling. One such method is to use a dual-frame design, wherein RDD sampling is used to ensure complete coverage of the universe of interest (telephone households) and a list sample of residential numbers with addresses is used to improve response rates and increase productivity of the calls (Lepkowski, 1988). This method was employed for the CPP-CATI test since the use of a dual-frame design allows for the testing of not only this design but of a list frame-only sample design and of an RDD-only sample design.

Another reason for using telephone sampling in this survey is that, based on the desired results of the survey, not representing nontelephone households may be acceptable. The purpose of the CPP survey is to obtain outlet names from which the BLS pricing survey samples are drawn. It is believed that households without telephones tend to report fewer purchases of commodities and services than those with telephones. There would be a bias in excluding nontelephone households if those households made purchases in outlets that telephone households do not report, or if their reported purchases were distributed differently across outlets than the telephone households' purchases. Because these biases are believed to be small, telephone sampling is an appropriate methodology for CPP.

To examine the success of using some form of telephone sampling (i.e., dual-frame design, list-only design, or RDD-only design), many factors need to be considered. The BLS is planning to perform cost modeling analysis to summarize the various costs associated with calling and interviewing respondents, as well as coding and processing the data. Three aspects of this analysis, namely population coverage, response rates, and in-scope rates, are discussed in Section 8 of this paper. The other aspects associated with making overall conclusions about

the uses of the various telephone sampling frames will be presented after future research is completed.

5. TEST DESIGN OVERVIEW

Due to the interest in examining many aspects of telephone sampling and CATI, there were a number of design variables built into the CPP-CATI test. The survey was conducted in 4 BLS CPI PSUs of varying population size, as shown in Attachment A. The dual-frame design, consisting of two methodologies of sampling (list and RDD) was employed in order to take advantage of the unique qualities of each system, as described earlier in this paper. Once selected, in order for a unit to be eligible for interview it had to meet two criteria - to be within specific geographical boundaries, and to be residential. Twelve separate questionnaire versions were designed: 4 "long versions" which each contained up to 45 commodity categories, and 8 shorter versions which each consisted of a different subset of the longer "parent" version. These version lengths will be examined in later analysis of the data to determine the optimal questionnaire length.

6. SAMPLING

The 4 PSUs were selected based on population size. Three of them (Chicago, Illinois; New Orleans, Louisiana; and Tucson, Arizona) were defined at the county level but the fourth PSU (Halifax, North Carolina) was defined at the place level so that only households within the urban areas of that PSU were in sample. The sampling methodology differed for these 2 types of PSUs, as well as for the generation of list versus RDD numbers.

In order to create the list sample universe, Census researched possible telephone prefixes (defined as the first 6 digits of an area code-telephone number combination) in the PSUs of interest. A list of these prefixes, along with a list of state-county codes and ZIP codes, was provided to a private contractor which then supplied all of the listed telephone numbers in the PSUs. For the county level PSUs, the contractor provided telephone number combinations of state-county-ZIP code-prefixes. For the place level PSU, the contractor provided combinations of state-county-ZIP code-100 banks. A 100-bank is defined as the first 8 digits of an area code-telephone number combination (i.e., groups of 100 telephone numbers).

For the RDD frame, however, the methodology was quite a bit more complex. The Census Bureau employed the Mitofsky-Waksberg (Waksberg, 1978) two-stage RDD sampling procedure. The first stage of sampling (primary screening) was designed to reduce the number of telephone calls to nonresidences during the interviewing (secondary screening) phase of the survey. Essentially, for each PSU at primary screening, a single telephone number within each 100-bank was generated at random. That phone number was called by a CATI interviewer and if contact was made, a series of questions was asked to determine whether the unit in which that phone was located was actually residential and inside the geographical boundaries defined by the PSU. If so, the 100-bank was "screened in" and became part of the RDD sample universe from which numbers would be randomly generated during the interviewing phase.

If the geographical boundaries AND residence status of the unit containing the number dialed at primary screening could not be determined, or the unit was determined not to meet the geography condition, then that entire 100-bank (containing 100 separate telephone numbers, all with the same area code, 3-digit telephone exchange, and first 2 digits of the remaining part of the phone number) was "screened out" and not given a chance of selection during the interviewing phase. If the residential condition was met but the geography condition was not determined (due to refusal or inability or unwillingness of respondent to provide geographic information), the 100-bank was screened in at the primary stage. Most of the 100-banks screened in during the primary screening stage comprised the RDD sample.

7. SURVEY OPERATIONS

Addresses were obtained for all cases included in the list sample. Addresses could also have been obtained for RDD cases that matched to the list universe; however, this was not done in order that a pure RDD design could be compared to a pure list design. Where addresses were obtained, letters were mailed to notify households that an interviewer would be telephoning them. Unfortunately, the start of CATI interviewing was delayed by almost a month and when asked if they had received the letter, most respondents did not remember. (The actual number of such cases is not available yet.) The CATI interviewing phase was conducted over 11 weeks. Altogether, 4,691 RDD secondary phase screened-in cases and 2,668 list cases were attempted, for a total of 7,359 attempted interviews. Staff from Census and BLS monitored interviewing in Hagerstown at least once per interviewing week. At the conclusion of the CPP-CATI interviewing phase, the CATI interviewers were brought together for a debriefing session, and they were also asked to complete a debriefing questionnaire, the results of which were tabulated and summarized (Giesbrecht, 1989).

8. RESPONSE RATE ANALYSIS

In a telephone survey, one can consider many measurements of response (Groves and Lyberg, 1988). There are various purposes for response rates in telephone surveys such as measuring respondent cooperation, ability to contact respondents and proportion of cases that are in-scope. There are also, at times, various methods of measuring the same thing. For example, to measure the proportion of in-scope cases from all attempted cases, one could consider ring-no-answers as being in-scope, out-of-scope, or some fraction of both. With various measurements to choose from, it is important to know what is of interest. For CPP/CATI, several of these measurements are of interest.

List Frame and RDD Frame Response Rates

The use of a dual-frame design was to ensure complete coverage and at the same time minimize cost. One assumption made in the use of this design is that response rates will be higher in the list frame because an advance letter was sent to the list frame respondents. This has been shown to improve response rates (Groves and

Lyberg, 1988). The effect is examined by comparing the response rates of the list frame with the listed cases of the RDD frame. Although the list frame is expected to yield higher response rates, use of a list frame alone results in undercoverage because the frame excludes unlisted phone numbers. By matching the RDD sample to the list universe, a list coverage estimate of 50-60 percent was made. That is to say, based on this comparison, the list sample actually represented between 50 and 60 percent of the total possible numbers in this test. Further details in the coverage of the list frame are presented in Tucker, 1989.

To measure the overall response rate for this test, one would examine the proportion of all in-scope cases that were completed interviews. Two different rates were calculated based on different definitions of what is an in-scope case. Response Rate I includes in the denominator all cases that were determined to be in-scope as a result of contact with the respondent or with a recording or a telephone business office. Response Rate II includes in the denominator all cases that could conceivably be in-scope including those cases that make up Response Rate I plus cases whose in-scope status were not determined. The numerator of both response rates includes all completed and partial interviews. A partial interview is defined to include at least one reported commodity purchased at one outlet.

The overall response rates for the list and RDD frames are shown in Table 1.

The comparison shows that for each response rate method, the list frame had a significantly higher response rate than the RDD frame in the Chicago and Halifax PSUs and in all four PSUs combined (TOTAL). All 4 individual PSUs, plus the TOTAL, had significantly higher response rates in the list frame for Response Rate II. Thus, the use of a list frame to reduce nonresponse is helpful.

To further explain the difference between the list and RDD frames, the RDD cases were divided into listed and unlisted telephone numbers by matching the RDD cases to the list frame universe. This was done only for Response Rate I, because listed and unlisted data are not yet available for Response Rate II. The response rates are presented in Table 2.

By comparing RDD-listed to RDD-unlisted, differences in response rates for people with listed telephone numbers versus unlisted telephone numbers are seen. The difference in the Chicago and New Orelans PSUs are statistically significant, as is the difference for all four PSUs combined. These comparisons suggest that the difference observed between the list and RDD frame may be due to the inclusion of unlisted numbers in the RDD frame.

The other aspect in the comparison of the list and RDD frame response rates is the use of an advance letter in the list frame. The effect of the letter is measured by comparing the response rate of the list frame with the response rate of the listed numbers in the RDD frame, thus removing the effect of the unlisted telephone numbers in the RDD frame. These response rates are in Table 3.

There is no significant difference between the list frame and the listed portion of the RDD frame, leading to the conclusion that the advance letter had no significant effect in response rates in this test. As mentioned earlier, an advance letter has been shown in other surveys to improve response rates. It is important to note that, in this survey, because of a delay in the start-up of the test, the advance letters were mailed to respondents one month prior to the start of interviewing. By the time respondents were contacted, they may not have recalled receiving the letter, and the potential effect of the letter on response rates may have been lost. So, although advance letters can be helpful, their timeliness is critical.

List Frame and RDD Frame In-scope Rates

Another assumption made to justify this dual-frame design is that the list frame sample is more productive as measured by the proportion of all cases attempted that are in-scope (Lepkowski, 1988). Similar to response rates, to give a range of measures, the two different definitions of in-scope cases are used. In this case, the two definitions of in-scope make up the numerators and the total number of attempted cases (in-scope and out-of-scope) make up the denominator of both rates. The in-scope rates are presented in Table 4.

Again, using either measurement, the rate of in-scope cases is higher for the list frame sample than for the RDD frame sample for all PSU's and the total. This difference in in-scope rates is one of the most important justifications for a dual-frame design. The extremely low in-scope rate for the Halifax PSU is attributed to the survey's geographical requirement for being in-scope. The restricted PSU definition for Halifax (urban areas only) led to many cases being screened as out-of-scope.

List Frame and RDD Frame Out-of-Scope Cases

Examining the out-of-scope cases in more detail, one can look at the proportion of all cases that are nonworking or nonresidential. These are the two main components of the out-of-scope cases. These rates are presented in Table 5.

Comparing these two components shows that nonworking numbers are more frequently experienced than nonresidential numbers. This is consistent with earlier work (Groves, 1979).

Another reason for cases being screened as out-of-scope was that they were not inside the geographic bounds of the survey. This accounted 9.6 percent of the list sample and 8.1 percent of the RDD sample. The list sample had a higher proportion of cases that were outside of the geographic bounds, mostly due to some prefixes that were erroneously included. The primary screening operation associated with the RDD frame removed these prefixes. There is no such mechanism for removing erroneous prefixes in the list frame. Had the list of prefixes been much less accurate, the geographic screen-outs in the list frame would have most likely been intolerable. Another important aspect of the geographic screen-outs is that the Halifax PSU had an unusually high rate of such cases. Over 30 percent of the Halifax cases were screened out-of-scope for geography reasons. This is attributed to the restricted geographic rules in

the Halifax PSU. Since in this test's PSUs the telephone prefixes are somewhat ill-defined within county, a PSU definition that includes only part of a county (in this case, the urban part) will yield a high out-of-scope rate relative to the other out-of-scope categories. The other three PSUs, defined at the county level, have much lower percents out-of-scope for geography reasons.

Primary and Secondary Results

The use of the Mitofsky-Waksberg two-stage RDD sampling procedure is meant to reduce the inefficiency of calling nonresidential and nonworking numbers (Waksberg, 1978). To examine the success of this procedure, one can look at the proportion of cases attempted in the primary screening that were out-of-scope and compare that to the proportion of cases attempted in the secondary screening that were out-of-scope given the 100-banks that were screened in-scope at the primary screening (Table 6). Besides nonworking and nonresidential numbers, cases that were not inside the basic geography were examined. Note that "not inside the basic geography" is equivalent to saying outside of a county of interest.

In the case of nonworking numbers, the desire to use two-stage sampling is clear. The percent of nonworking numbers is greatly reduced at the second stage of sampling given that a 100-bank was screened in-scope during the primary stage. This is the case for all 4 PSUs as well as the total.

The gain in efficiency of secondary screening for nonresidential numbers was significant in the Tucson and Chicago PSUs and significant for the total as well. The lack of improvement at the second stage in the New Orleans and Halifax PSUs may be related to the fact that some areas of the country do not assign specific exchanges to residences or businesses exclusively.

The comparison between primary and secondary basic geography screen-outs does not show an overall improvement in efficiency. The New Orleans PSU is the only one which has a lower rate of basic geography out-of-scopes at the secondary stage. The Chicago and Tucson PSUs showed no significant difference. We anticipated telephone prefixes in the Chicago PSU that bordered counties outside the PSU definition. Perhaps the numbers in those prefixes had an equal probability of being on either side of a county border. We have no explanation for the lack of improvement made in the Tucson PSU. We also do not know why the Halifax PSU had fewer basic geography screen-outs at the primary stage than at the secondary stage. This is currently being researched.

9. CONCLUSIONS AND FUTURE ANALYSIS

Item and cost data from the CPP-CATI feasibility test will not be available until later this year, and analysis of those data will likely take months. It is premature, therefore, to offer any conclusions as to the adequacy of telephone sampling or of CATI for the CPP. However, the response rate information provided in this paper can serve as a foundation for discussion about the success of the dual-frame sample design.

Overall, the list frame yielded higher response rates than the RDD frame, regardless of the method of measurement. However, this was found to be due only to the inclusion of unlisted numbers in the RDD frame. The effect of the letter was negligible. To obtain the list frame entailed purchasing it from a private contractor. But the time lag between frame purchase and interviewing may have affected the accuracy of the frame itself. The mechanics of using the list frame were relatively simple. Once it was purchased, a basic "start with-take every" scheme produced the list sample. Since there was no need to go through a primary screening or a number replacement operation for the list sample, there were probably some savings of programming and interviewing time, as well as operational costs. The major drawback seen thus far with the list frame is the undercoverage of the telephone population by 35 percent.

For RDD, there was no need to purchase the sampling frame because every telephone number had a chance of selection at the primary screening phase. And the time span between the primary screening operation and the secondary (interviewing) phase was short and likely did not affect the accuracy of the telephone number status; that is, numbers which were residential during primary were probably not reassigned to nonresidences during the time between the two phases. On the other hand, because entire 100-banks were screened in during the primary phase, encountering a nonresidence or a residence out of the geographical boundaries at the secondary screening stage, although minimized, still occurred and resulted in replacement of numbers. And the additional programming required for both the primary screening operation and for number replacement at the interviewing stage was complex.

Because of the unique characteristics of each frame, using a dual-frame design may very well be the best way to ensure complete coverage and at the same time minimize cost. However, it is clear that further analysis is required on this issue, particularly with regard to the cost factors. Again, the success of using CATI has not been measured yet. This analysis hinges on the accuracy of the commodity and outlet information. Both the Census Bureau and the Bureau of Labor Statistics will analyze future data from the CPP-CATI Feasibility Test. They will investigate such issues as: the accuracy with which outlet and commodity data can be collected from a centralized location; response burden differences between personal and CATI interviewing; component costs of the dual-frame design; selected data item analysis by questionnaire version; and interview time analysis.

10. A SECOND CPP-CATI TEST

Census and the Bureau of Labor Statistics have begun discussions to plan for a second CPP-CATI test to study some variables which were not included in the first test. New study variables may include interviewing additional consumer units (CUs) within households. It is estimated that about two percent of all households actually contain more than one CU. The first test made no attempt to interview more than one CU. Another possibility for a future test is to conduct it concurrently with the Point of Purchase field production work so that comparisons may be drawn between personal visit and telephone interviewing.

If analysis of the current test indicates a questionnaire length beyond which accuracy of obtaining outlet reports for commodity categories is questionable, future testing may limit the questionnaire length. Instead of conducting the CPP over about a 6-week time period as is now done, future CATI work may be carried out continuously. And instead of contacting one-fifth of the PSUs each year, CATI may enable all PSUs to be included each year.

There are still many questions about the future of computer-assisted interviewing for the Point of Purchase Survey. Analysis of the current test, plus introduction of some different variables for future testing, may provide the answers we need.

ATTACHMENT A
CPP-CATI Feasibility Test Areas

PSU NAME	STATE	COUNTY
Chicago-Gary-Lake County (IL-IN-WI CMSA)	Illinois	Cook DuPage Grundy Kane Kendall Lake McHenry Will
	Indiana	Lake Porter
	Wisconsin	Kenosha
Halifax (part)	North Carolina	Halifax: -Enfield town -Roanoke Rapids city -Scotland Neck town
New Orleans (LA MSA)	Louisiana	Jefferson Orleans St. Bernard St. Charles St. John the Baptist St. Tammany
Tucson, (AZ MSA)	Arizona	Pima

Table 1: Comparison of List and RDD Response Rates

	Response Rate I			Response Rate II		
	List (n)	RDD (n)	Difference	List (n)	RDD (n)	Difference
Chicago	76.2 (635)	72.2 (748)	4.0*	75.1 (644)	68.6 (787)	6.5*
New Orleans	74.8 (628)	71.9 (747)	2.9	73.0 (644)	68.1 (789)	4.9*
Tucson	78.0 (360)	74.6 (504)	3.4	76.6 (367)	71.3 (527)	5.3*
Halifax	85.6 (425)	80.8 (339)	4.8*	83.9 (434)	73.1 (375)	10.8*
TOTAL	78.1 (2048)	73.9 (2338)	4.2*	76.5 (2089)	69.7 (2478)	6.8*

*Significant at the .10 level.

Table 2. Comparison of the RDD-Listed and RDD-Unlisted Response Rates for Response Rate I

	RDD-Listed (n)	RDD-Unlisted (n)	Difference
Chicago	77.7 (346)	67.4 (402)	10.3*
New Orleans	74.6 (456)	67.6 (291)	7.0*
Tucson	75.2 (278)	73.9 (226)	1.3
Halifax	83.2 (190)	77.8 (149)	5.4
TOTAL	76.8 (1270)	70.3 (1068)	6.5*

*Significant at the .10 level.

Table 3. Comparison of List and RDD-Listed Response Rates for Response Rate I

	List (n)	RDD-Listed (n)	Difference
Chicago	76.2 (635)	77.7 (346)	- 1.5
New Orleans	74.8 (628)	74.6 (456)	0.2
Tucson	78.0 (360)	75.2 (278)	2.8
Halifax	85.6 (425)	83.2 (190)	2.4
TOTAL	78.1 (2048)	76.8 (1270)	1.3

Table 4. Comparison of the List and RDD In-scope Rates

	In-Scope Rate I			In-Scope Rate II		
	List (n)	RDD (n)	Difference	List (n)	RDD (n)	Difference
Chicago	83.5 (760)	56.6 (1322)	26.9*	84.7 (760)	59.5 (1322)	25.2*
New Orleans	82.6 (760)	51.1 (1462)	31.5*	84.7 (760)	54.0 (1462)	30.7*
Tucson	81.8 (440)	60.7 (830)	21.1*	83.4 (440)	63.5 (830)	19.9*
Halifax	60.0 (708)	31.5 (1077)	28.5*	61.3 (708)	34.8 (1077)	26.5*
TOTAL	76.8 (2668)	49.8 (4691)	27.0*	78.3 (2668)	52.8 (4691)	25.5*

*Significant at the .10 level.

Table 5. Comparison of the List and RDD Nonworking and Nonresidential Numbers

	Percent Nonworking Numbers			Percent Nonresidential Numbers		
	List (n)	RDD (n)	Difference	List (n)	RDD (n)	Difference
Chicago	9.9 (760)	24.9 (1322)	-15.0*	2.5 (760)	13.1 (1322)	-10.6*
New Orleans	12.1 (760)	24.8 (1462)	-12.7*	2.6 (760)	20.2 (1462)	-17.6*
Tucson	13.4 (440)	21.1 (830)	- 7.7*	1.8 (440)	13.1 (830)	-11.3*
Halifax	5.5 (708)	17.9 (1077)	-12.4*	0.6 (708)	15.7 (1077)	-15.1*
TOTAL	9.9 (2668)	22.6 (4691)	-12.7*	1.9 (2668)	15.9 (4691)	-14.0*

*Significant at the .10 level.

Table 6. Comparison of Primary and Secondary Screening

	Percent Nonworking Numbers			Percent Nonresidential Numbers		
	RDD Prim. (n)	RDD Sec. (n)	Difference	RDD Prim. (n)	RDD Sec. (n)	Difference
Chicago	40.2 (517)	24.9 (1322)	15.3*	24.9 (517)	13.1 (1322)	11.8*
New Orleans	52.4 (634)	24.8 (1462)	27.6*	18.1 (634)	20.2 (1462)	- 2.1
Tucson	45.3 (344)	21.1 (830)	24.2*	18.0 (344)	13.1 (830)	4.9*
Halifax	47.1 (193)	17.9 (1077)	29.2*	17.6 (193)	15.7 (1077)	1.9
TOTAL	46.6 (1688)	22.6 (4691)	24.0*	20.1 (1688)	15.9 (4691)	4.2*

	Percent Basic Geography		
	RDD Prim. (n)	RDD Sec. (n)	Difference
Chicago	1.9 (517)	2.0 (1322)	- 0.1
New Orleans	1.6 (634)	0.7 (1462)	0.9*
Tucson	1.2 (344)	1.1 (830)	0.1
Halifax	3.1 (193)	7.1 (1077)	- 4.0*
TOTAL	1.8 (1688)	2.6 (4691)	- 0.8*

*Significant at the .10 level.

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