CHARACTERISTICS OF COMMERCIAL RESIDENTIAL TELEPHONE LISTS AND DUAL FRAME DESIGNS

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1. Introduction

Given the high costs of conducting a survey using personal interviews, telephone surveys have become quite popular in recent years. In those cases involving the general population, a sample usually is drawn with Random Digit Dialing (RDD), often using the Mitofsky-Waksberg two-stage sampling procedure (Waksberg,1978). Unfortunately, between seven and eight percent of the U.S.population is still without a telephone. This under coverage is greatest in the South (10.4%) and lowest in the Northeast (4.5%). Generally speaking, households without telephone service are younger and poorer than those with telephones. Rural residents and blacks are less likely to have telephones than city dwellers and whites (Thornberry and Massey, 1988). The existence of under coverage will be more or less serious depending on the behavior being measured (Groves and Lepkowski, 1985).

To overcome the under coverage problem but retain the cost advantages of a telephone survey, a dual frame, mixed mode survey has been suggested. Hartley (1962) discussed the use of a dual frame design in the 1960 Survey of Agriculture. Hansen, Hurwitz and Madow (1953) described such a design used in a survey of retail stores. Although the designs described by Hartley in the 1962 paper and a later one (1974) do not involve mixing interviewing modes, the same principles apply. As in the Hartley designs, an inexpensive but incomplete frame (a telephone frame) is combined with a complete but more expensive frame (an address frame). Hartley gave a post-stratified estimator for population means assuming the incomplete frame is simply a subset of the complete one.

Over the past ten years a great amount of research has been undertaken to determine the characteristics of dual frame, mixed mode designs. Groves and Lepkowski (1985) evaluated administrative structures for dual frame designs. Casady, Snowden, and Sirken (1981) examined estimators for a dual frame, mixed mode design applied to the National Health Interview Survey and concluded that sampling errors would be smaller for this design than for one relying solely on an area/list frame. Following this, Sirken and Casady (1982) analyzed the effects of varying response rates in the telephone frame and found that the level of nonsampling error was such that a dual frame design would be advantageous only if the response rate in the telephone frame were above eighty percent. Biemer (1983) also reported that low response rates make the use of telephone surveys less attractive. Lepkowski and Groves (1986a) developed a mean squared error model and a cost model which indicated that the telephone frame could be used even when a bias existed (e.g.,nonresponse). Their results differed substantially from Biemer's because of differences in assumed per'unit costs for telephone interviews, and Lepkowski and Groves only considered biases as great as ten percent.

One method of improving the response rates in telephone surveys actually involves the use of a different type of dual frame design. This design combines information from a sample drawn from a commercial frame of residential numbers and a supplementary sample selected with a RDD procedure. Use of the commercial list can not only save time and money by reducing the number of calls necessary to identify a residence (Landenberger, Groves, and Lepkowski, 1984), but the list also can increase response rates if the sample residences drawn from the list are contacted by mail prior to the survey, at least in the United States (Brunner & Brunner, 1971; Dillman, Gallegos, and Frey,1976; Traugott, Groves, and Lepkowski, 1987; Drew, Choudry, and Hunter, 1988). The RDD supplement is needed to provide coverage for residential numbers not on the list frame. If coverage of non-telephone households is desired, an area/list frame can be added to have a multiple frame, mixed mode design.

Unfortunately, the effectiveness of such designs depends upon characteristics of the list frame which are often not available to the user. This paper addresses the problem by examining the characteristics of list frames for four primary sampling units (PSUs) in the Bureau of Labor Statistics (BLS) Current Point-of-Purchase Survey (CPP). These frames, purchased from commercial vendors, vary by size and geography.

The paper is divided into several sections. Section 2 describes the survey project for which the lists were purchased. Section 3 discusses the frame acquisition process, including location of and communication with vendors, timing of the purchase, price structures, and frame construction methodology. The fourth, and most important section, analyzes frame characteristics. Section 5 discusses the potential use of list frames for better designs. The final two sections review the findings and suggest a number of research questions still left unanswered.

2. The Current Point-of-Purchase Feasibility Test

The list frames were purchased as part of a study to determine if the Current Point-of-Purchase (CPP) Survey could be conducted more efficiently using Computer Assisted Telephone Interviewing (CATI). Data for the ongoing CPP survey has been collected only by personal interview. The Bureau of the Census conducts this survey for the BLS as part of the Consumer Price Index (CPI) program. Its purpose is to develop and maintain a timely list of retail, wholesale and service establishments at which people shop for specified consumer items. The list of establishments produced from the survey serves as a sampling frame for the BLS to update and maintain the sample of outlets it uses in pricing goods and services for the CPI.

The feasibility test has three main goals. First, it will ascertain if outlet and expenditure information of sufficient quality for use in the CPI can be collected by telephone. Second, it will determine if a response rate necessary for the production of representative data can be achieved by telephone. Third, it will specify the technology required to conduct a successful ongoing CPP survey with CATI. An important assumption underlying this research is that the coverage bias which would result from abandoning the personal interview mode is negligible. Although 8% of all households do not have telephones, the BLS estimates that this translates into a loss of only about 5% of the expenditures.

Conducting the CPP survey with CATI could offer several advantages, some of which were mentioned in the previous section. In the ongoing survey, the cost for a completed telephone interview should be less than that for a personal interview. Furthermore, supervisors can exercise greater quality control over the interviewing in a centralized CATI facility. Using telephone survey methodology, the survey can be conducted continuously covering all PSUs over a 1-year period rather than in a subset of the PSUs (generally about 20) during a 6-week period each year. This will reduce the cost of outlet initiation, the training of new field staff, and provide greater flexibility with respect to adding new commodities to the CPI. Finally, the burden for any single respondent would be less because each respondent will be asked about expenditures for only a portion of the commodity categories covered in the personal interview. This would necessitate an increase in sample size which hopefully will be more than offset by other cost savings, especially if the quality of data increases as a result of the substantial decline in respondent burden.

The feasibility test was carried out in September through November, 1988 in four of the PSUs in which the ongoing CPP survey was conducted in the spring of that year. A dual frame sampling design was adopted for the feasibility test consisting of an RDD sample (using the Mitofsky-Waksberg procedure) and a list sample drawn from frames of residential telephone numbers purchased from private vendors. To enhance the utility of the list sample, respondents selected for this sample were sent an advance letter explaining the purpose of the survey. As a means of testing the effects of different levels of respondent burden, two versions of the questionnaire were used -- one with approximately 20 commodity categories and another with about 40 categories. Table 1 provides a description of the CATI design and the associated sample sizes.

3. The List Frame Acquisition Process

The nineteen PSUs used in the 1988 ongoing CPP survey were classified into four groups according to size, and one PSU from each group was chosen for the test. As it happened, three regions of the country were represented. The four PSUs selected were Chicago, New Orleans, Tucson and the urban part of Halifax County, North Carolina. After these PSUs were selected, information was collected on the telephone system in these locations (e.g., the identification of valid area codes and NXX codes or exchanges). With this information, the RDD frame was constructed and programming specifications written.

At the same time the RDD frame was being constructed, specifications for the list frames were developed, and commercial vendors known to have residential telephone frames were identified. The names of vendors were gathered by contacting individuals who had purchased list frames or samples in the past. Robert Groves and James Lepkowski of the University of Michigan, under contract to BLS, provided most of the information about the vendors. To aid vendors in constructing accurate frames, all counties, zip codes, and known telephone prefixes (the first six digits of the number, including area code) were identified by Census personnel. It was unclear whether or not some zip codes and prefixes crossed PSU boundaries; therefore, the union of counties, zip

codes, and prefixes defined a PSU list frame. A geographic screening question in the survey eventually was used to exclude respondents living outside PSU boundaries.

Two firms provided the list frames. One provided the Chicago frame, and the other provided the frames for Tucson, New Orleans and Halifax County. All negotiations were done by mail or telephone, but it would have been possible, at least in the case of one firm, to visit the location where the lists were constructed. In hindsight, this might have been advisable. Negotiations were conducted with sales personnel, and a site visit would have allowed us to make our frame requirements clear to those actually doing the work. We also might have learned more about the characteristics of the lists.

Each firm's price was per thousand numbers purchased, and, for this price, the following data were provided: telephone number, name, address, and Census tract and enumeration district (ED). There were substantial differences between the prices quoted by the two firms for the same products. Other differences existed as well. One offered a discount on further orders during a twelve month period. Price, however, was not based on the size of the order, at least for the volume of numbers we purchased. Volume was a factor in the prices quoted by the other firm, and these prices were guaranteed for one year. Sketchy information concerning a third firm's price structure indicated that the same products would have cost substantially more than the other two firms.

The final contracts were modified slightly. Both agreed to supply the data within ten working days according to the tape specifications contained in the original contract. This promise was kept in both cases. One firm provided documentation of counts by Census geocode within zip code; the other did not. Neither firm supplied counts of errors or missing data, but they agreed to respond to any questions we had concerning the data.

4. The Analysis of List Frame Characteristics

Table 2 provides information about the expected and actual list frame sizes. Although only the urbanized part of Halifax County comprises the PSU, both urban and total county figures are given. Some caution is advised when looking at the expected numbers. They are only estimates using projected numbers of households and approximate national averages for listing rate and telephone ownership rate. Large differences between the expected and actual numbers of listings, however, do probably indicate departures from the national averages in a PSU.

The most disturbing finding is that the actual frame size for Halifax is below the expected one. Even though the telephone ownership rate might be less than the national average, as is characteristic of rural areas, the listing rate was expected to be substantially greater than .65. The preliminary listing rate calculated from the RDD sample is .53 (Table 3). One factor which could help explain this discrepancy is that small, local telephone companies often operate in rural areas resulting in a number of directories, all of which might not have been used to construct the frame. One vendor (not the one providing the Halifax list), however, reports that this should not be the case. Furthermore, all expected zip codes and NXX codes are represented in the frame, and the problem seems to exist in both the urbanized area and the whole county. On the other hand, the same vendor explained that telephone subscribers with post office box addresses are usually excluded from a list because marketing firms historically have had little success with these customers. Post office box mailing addresses are common in rural areas, but they are not usually the addresses listed in telephone directories. In any case, it appears that RDD sampling may be as critical in rural settings as in large, urban areas.

Both Tucson and New Orleans have actual frame sizes that are larger than the expected ones. Part of the reason is that, as shown in Table 4, there are relatively large numbers of duplicates in these frames, especially in Tucson. This is not the case in Halifax County. The duplicates existing in Halifax, Tucson and New Orleans are the result of a misunderstanding between the BLS and the vendor as to the meaning of "duplicate." The BLS assumed that a duplicate meant matching numbers, but the vendor identified a duplicate only when name, address and number matched. Tucson undoubtedly has the highest duplicate rate because it has a large student population who share residences.

After the removal of duplicates in Tucson and New Orleans, the actual frame sizes are quite a bit closer to the expected ones. In addition, 1907 numbers in New Orleans and 3102 numbers in Tucson (and 82 numbers in Halifax) were eliminated from the frames because research indicated certain NXX codes were outside the PSU boundaries. The

three frame sizes were further reduced using the estimated nonresidential (business) rates from the feasibility test that are given in Table 5.

In addition to the nonresidential rates , the nonworking rates also are given in Table 5. Halifax County has the lowest, and Tucson the highest. Unfortunately, the lists were four months old before they were used so the nonworking (and, possibly, the nonresidential) rates might have been lower had the lists been used promptly. As it is, the nonworking rates are comparable to those reported by Landenberger, Groves and Lepkowski (1984). Information from one of the vendors and a telephone company official indicates that the listed numbers can be as much as a year out-of-date, and numbers which go out of use are not reassigned for 90 days. Nonresidential and nonworking numbers combine with duplicates to increase somewhat the effective per unit cost of list frames. The actual frame sizes must also be reduced by the proportions of nonworking numbers.

Once these numbers are deleted, the actual frame sizes can again be compared to the expected ones. If the .92 ownership rate were accurate, a figure which is probably too high for Halifax, the listing rates would be .54 for Halifax, .57 for Tucson and 55 for New Orleans. The figures for Halifax and Tucson are similar to those in Table 3, but the New Orleans figure is somewhat lower than the matchback rate.

In the case of Chicago, purchased from the other vendor, Table 2 shows that the initial actual size is already somewhat smaller than the expected size. About 5000 duplicates had to be eliminated from the frame (Table 4). This is a duplication rate which is less than those in the other PSUs. The vendor supplying the Chicago frame used the BLS definition, but duplicates were purged from supposedly separate parts of the frame that, when merged, had some overlap. Another purge was not done, leaving a number of duplicates. Thus, even when definitions agree, duplicates can still result from incorrect processing.

Besides the duplicates, approximately 90,000 numbers judged to be outside the Chicago PSU were eliminated, and the frame was reduced by another 11.5% based on the nonresidential and nonworking rate information in Table 5. A comparison of the new frame size to the expected one indicates that, again assuming a .92 ownership rate, the listing rate is about .51. This rate is fairly comparable to that calculated from the feasibility test (Table 3). Survey Sampling, Inc. (Mathews, 1989) recently reported a .57 listing rate for metropolitan Chicago, 20% lower than a 1970 figure given by Sudman (1973) but still 6% higher than the highest found in the present study.

The two rates for Tucson, Halifax and Chicago are fairly similar given the possible inaccuracies in projected households, estimated listing, nonworking and nonresidential rates, and the use of an average telephone ownership rate. Also, the residential status of some numbers could not be determined during the feasibility test. These rates are, however, lower (much lower in Halifax) than expected. The somewhat greater discrepancy in New Orleans also could be the result of the above errors, but this is unclear.

Also in the study by Landenberger and his colleagues is an examination of duplicates in a sample of hundred banks purchased from Metromail Corporation. They found that a majority of the duplicates had the same address but different names. An examination of the duplicates in the four frames indicates that this type of duplication is the most common, but the patterns of duplicates do differ across the frames. Table 6 gives the characteristics of the duplicates in each frame. Most duplicate sets consist of only two records, but in Tucson and New Orleans there are between five and ten percent of the sets with more than two records. The single most extreme case occurs in New Orleans where one number appears on the frame 43 times.

The predominant types of duplication for each frame also are given in Table 6. Almost all of the Chicago duplicates were of the "same name-same address" variety, and the vast majority of the duplicates in New Orleans had different names but the same address. The duplicates in the other two PSUs were about equally divided between the two types indicated.

5. List Frames and Better Survey Design

Assuming timely lists without the problems noted above were available, what is their potential for improving survey design? One use of list frames would be to provide information for stratification. Waksberg (1986) discussed Westat's use of list frame information about the demographics of prefix areas to stratify. This information was obtained by associating prefix with zip codes using 1980 Census demographic tabulations by zipcode. Mohadjer (1988) reports that this information was useful for sampling blacks and Hispanics.

Table 7 indicates the amount of missing data in the geographic variables from the list frames. If these four PSUs are representative, matches of prefix to zip code should be no problem. Even though a small portion of the address information is missing, zip code is always present (although it may be imputed). In fact, only in Halifax County is the amount of missing tract information serious. This may result from the fact that some rural areas are not assigned tract numbers. ED is still present in many cases, but it could have been suppressed on occasion.

Although list frames may be adequate for some stratification purposes, the information on zip code by hundred bank tabulations presented in Table 8 demonstrates that problems still exist. In the three largest PSUs, 70 to 80% of the hundred banks contain households spread across at least three zip codes. In the study reported by Mohadjer, prefix level characteristics were produced by weighting each zip code according to the proportion of listed numbers in the prefix area which came from that zip code[1]. This procedure proved adequate for racial characteristics, but Mohadjer did not examine other characteristics. Furthermore, although Inglis, Groves and Heeringa (1985) report that cluster sizes larger than 100 are effective for selecting large numbers of black households, this may not be true for other demographics given the geographic spread of hundred banks. The location of the hundred banks may be a key factor here.

Of greater concern after examining the information in Table 8, however, is the accuracy of nonresponse adjustments done at the hundred bank or prefix level. Little is known about the characteristics of nonrespondents to telephone surveys, and Groves and Lyberg (1988) remark that questionable assumptions concerning the similarities between respondents and nonrespondents have to be made to carry out weighting adjustments for nonresponse. Certainly, adjustments by prefix or hundred bank are more accurate than at the PSU level (if the Ns are large enough), but the geographic spread indicated in Table 8 should be cause for concern.

Lepkowski and Groves (1986b) describe a more efficient telephone sampling method which they term a "Two Phase Probability Proportional to Size Design." In this design, hundred banks are divided into two strata, low and high density, based on the counts of the number of residential listings obtained from a list frame vendor. Lepkowski and Groves, in an implementation of this design within Michigan, assigned hundred banks with fewer than twenty listings (including those with none) to the low density stratum. Hundred banks with twenty or more listings were assigned to the high density stratum. This decision took into account the minimum cluster size needed and working residential rates in hundred banks with relatively few listed numbers.

One of the purposes of defining the two density strata is to increase the efficiency of the design by reducing the number of calls that must be made and, thus, the costs. The dividing line between the two strata in the Michigan study was empirically derived and could be different depending on the geographical area in which a survey was being conducted. Table 9 provides information on the hundred-bank densities in the four PSUs. These densities are slightly understated because of the inclusion of the hundred banks believed to be outside the PSU boundaries. Most of these latter hundred banks have very low densities, some with only one number. It is quite likely that some are the result of keying errors in the NXX code field.

The proportions of hundred banks with fewer than twenty listings in Tucson, Chicago and the urban portion of Halifax are similar to that for Detroit and its suburbs reported by Lepkowski and Groves (about half). When the rural part is included, however, the hundred bank density for Halifax drops significantly. If other rural areas are similar, a large portion of hundred banks will fall in the low density stratum. Moreover, many of these hundred banks will have listed densities between one and nine numbers. They have the potential of screening in the sample, but cluster sizes may have to be small, necessitating the screening of a large number of hundred banks. The proportion of hundred banks in New Orleans with less than twenty numbers is smaller than in the other areas--35%. If the boundary between the strata is kept at twenty, fewer hundred banks would have to be screened than in the Michigan study or, for that matter, in Tucson and Chicago.

Traugott, Groves and Lepkowski (1987) and others have demonstrated that one advantage of using a list frame is that advance letters can be sent to potential respondents. These letters have often improved response rates to the survey; however, not all letters are delivered. Table 10 shows the number of returned letters from the feasibility test in each PSU. Few were returned in Chicago, but the proportions were more substantial in the other PSUs. Halifax County had the highest return rate. Many of the returned letters in the Halifax sample included

only name and rural route without the rural route box number. A discussion with postal employees in Halifax revealed that unless the carrier happened to know the box number, the letter would not be delivered. Although regular carriers might have some of this knowledge (a portion of the letters with just the route number were delivered), substitute carriers could not be expected to have this information. Some of the "insufficient address" / "address not known" problems in the other PSUs may have been the result of missing apartment numbers. Tucson probably has a relatively greater letter forwarding problem because of the large number of transient university students.

Another problem affecting the potential utility of list frames to improve designs is that, according to one vendor, records with post office box numbers and addresses identified as college housing are often excluded from the lists. The exclusion of addresses with post office box numbers, as mentioned earlier, could be a significant problem in rural areas. Exclusion of college housing is a problem for the CPP Survey because these residences are considered in scope. This may have affected the survey in Tucson.

6. Discussion

Both positive and negative findings have emerged from this research. On the positive side, the amount of missing data is fairly insignificant, and the nonworking rates are certainly no worse than those reported in other studies, especially given that the lists were several months old before they were used. Nonresidential rates for these PSUs are about the level expected. Although the extent of duplication in New Orleans and Tucson is unsatisfactory, clearer specifications should improve these figures. Finally, the hundred bank densities for the three largest PSUs, especially New Orleans, indicate that a two phase probability design in these areas would be at least as efficient as the one conducted in Michigan.

As for the negative findings, even with clear specifications, duplicates and businesses may remain on a list. Unfortunately, these problems probably will not be apparent when only a sample is purchased. The hundred bank density information demonstrates that design efficiency is likely to be dependent on place size. The geographic distribution of numbers within hundred banks may not affect the sampling of some population subgroups, but it does call into question the accuracy of certain methods for nonresponse adjustment. The proportions of returned letters in three of the PSUs point to limitations on the utility of advance letters for improving response rates. This may be particularly true in rural areas.

One of the most discouraging results has to do with the inability to easily define PSU frames. Telephone service boundaries do not necessarily follow PSU boundaries, and the universe of valid NXX codes is not easily identified. This task is further complicated when a rural PSU only comprises the urbanized part of a county. Ultimately some judgments must be made.

In addition to the boundary problem, it is difficult, even with the purchase of a frame, to know whether the frame has been properly constructed. Two methods were used to calculate coverage, and the estimates largely agreed. On the other hand,the rates were lower than expected. Some portion of each frame could be missing since all expected zip codes and NXX codes are not represented (although most are).

The results from Halifax County are particularly troubling. This frame is the one most likely to be incomplete even though there appear to be no missing zip codes and NXX codes in this case. The forecaster for the telephone company servicing Halifax County indicated that, while the ownership rate in the county may be as low as 75%, the number of telephone households still should be approximately 15,000. It is unlikely that the listing rate would be low enough to produce only about 10,000 listings. Along with the other problems in Halifax (boundary definition, hundred bank density and letter return rate), one wonders about the use of list frames in rural areas. In a PSU oriented survey, such as CPP, concerns about survey operations in rural areas are magnified. For surveys over larger geographic areas, the problems described above may be less severe.

7. Further Research

There are a host of questions left unanswered by this research. Clearly, a more exacting method will be needed for defining the telephone service boundaries of PSUs. Perhaps, a visit to a vendor's production facility would be useful for defining boundaries as well as for communicating specifications and gaining more information about frame characteristics. The identification and evaluation of the products from other vendors should be undertaken; and, in conjunction, the same frame should be purchased from more than one company. One of the shortcomings of the present study is that

the two firms could not be compared directly because they provided different frames. At the same time that more frames are investigated, information about price structures and characteristics of samples from these frames should be gathered. In a production survey involving almost one hundred PSUs, it would be impossible to purchase all frames.

More research is needed into the characteristics of rural frames. There likely will be a good deal of variance here, and the results from Halifax County have been, at best, inconclusive. Greater knowledge of the particular rural PSU or PSUs probably is needed before the frame(s) can be adequately evaluated; and, in fact, Halifax will continue to be studied.

Further analysis of the geographic spread of hundred banks should be done, especially by location (e.g., central city versus suburbs and urban versus rural). The use of prefix area to stratify for demographics other than race needs to be examined. One might begin by looking at the variation in these characteristics among the zip codes within a prefix area.

Finally, there are some important questions to be answered about the bias in surveys using RDD and/or list frames. For which types of behaviors does the failure to cover non-telephone households matter? Are listed residences representative in someplaces and not others? What is the relationship between bias and nonresponse? How does this relationship vary with survey content?

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1 I am indebted to Joe Waksberg for this information

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Table 1. Treatment Assignments in the Feasibility Test (N=3600)

	Short Questionnaire (.67)[1]	Long Questionnaire (.33)
RDD	.333	.167
List (with letter)	.333	.167

[1] Proportion of the sample. The short questionnaire was allocated twice the sample size so the number of respondents per commodity category was the same as with the long questionnaire.

Table 2. Expected and Actual List Frame Sizes

	Expected[1]	Actual
Halifax County		
Urban	4822	4653[2]
Total	11,960	11,030
Tucson	150,397	171,571
New Orleans	297,710	306,338
Chicago	1,752,360	1,663,135

[1] These counts were determined by (1) projecting 1985 Census county household counts (U.S. Bureau of the Census, 1988) to July 1, 1988, (2) assuming 92% of these households have telephones, and (3) assuming 65% of households with telephones are listed(the approximate national rate). The estimate of the number of households in the urban part of Halifax county was based on a projection from the 1980 Census household count in the urbanized area.

[2] The number of actual listings in the urban part was calculated by multiplying the total number of possible urban listings (9249) by .503 (the proportion of the sample of urban listings that actually screened in during the feasibility test).

Table 3. Preliminary Listing Rates (and Standard Errors) Based on the Match of RDD Residential Numbers to the List Frames

	Halifax[2] County	Tucson	New Orleans	Chicago
Total Residences	672	520	760	776
No. of Matches	354	288	467	372
Listing Rate[1]	.53 (.019)	.55 (.022)	.61 (.018)	.48 (.018)

[1] Standard errors assume simple random sampling.
[2] Including only the four urban NEX codes.

Table 4. The Proportion of Duplicates in the List Frames

	Total N	N Excluding Duplication [1]	Duplicate Proportion of Total N
Halifax County			
Urban	9249	9158	1.0%
Total	11,030	10,926	0.9
Tucson	171,571	157,955	7.9
New Orleans	306,338	294,779	3.8
Chicago	1,663,135	1,657,137	0.4

[1] One duplicate number in each set was retained at random and included in these N's.

Table 6. Characteristics of Duplicates in the List Frame

	Halifax [1] County (urban=88[2] total=101)	Tucson (12,388)[2]	New Orleans (10,715)[2]	Chicago (5998)[2]
Number in Duplicate Set				
2	98.00%	91.96%	94.51%	100.00%
3	1.00	6.80	4.50	-
4	1.00	0.91	0.70	
5	-	0.19	0.15	-
6	-	0.04	0.03	-
7	-	0.05	0.02	-
8	-	0.03	0.01	-
9	-	0.02	0.01	-
10+	-	-	0.07	-

Type of Duplication	Halifax County	Tucson	New Orleans	Chicago
Same Name-Same Address				X
Different Name-Same Address	X	X	X	
Same Name-Different Address	X			
Different Name-Different Address		X		

[1] Characteristics the same for urban and whole county.
[2] Number of duplicate sets

Table 5. Sample Estimates of Nonworking and Nonresidential Rates (and Standard Errors)[1]

	Sample N	Nonworking Rate	Nonresidential Rate[3]
Halifax County	1128[2]	5.6% (0.7)	3.1% (0.5)
Tucson	795	13.3 (1.2)	1.9 (0.5)
New Orleans	1332	11.9 (0.9)	2.5 (0.4)
Chicago	1178	9.6 (0.9)	1.9 (0.4)

[1] These data include the sample from the list frame and those numbers from the RDD sample that were successfully matched to the list frame. There were only very small differences in the rates from these two parts. Standard errors assume simple random samplings.

[2] Sample only from four valid NEX codes.

[3] Nonresidential numbers are defined here to be those that are businesses.

Table 7. Percentages of Missing Data in the List Frames [1]

Variable	Halifax County Urban (9249)	Halifax County Total (11,030)	Tucson (171,571)	New Orleans (306,338)	Chicago (1,663,135)
State Code	--	--	--	--	--
County Code	--	--	--	--	--
Zip Code	--	--	--	--	--
City	--	--	--	--	--
Address Number and Street	1.49	2.84	0.22	0.52	0.06
Name	--	--	--	--	--
Tract	32.31	33.67	--	1.78	--
ED	2.97	10.99	2.17	9.05	--

[1] All duplicates included

Table 8. Distribution of the Number of Zip Codes Found in the Hundred-Banks on the List Frames.

	Halifax County Urban	Halifax County Total	Tucson	New Orleans	Chicago
Number of Zip Codes					
1	85.8%	83.7%	5.1%	13.2%	13.9%
2	0.9	3.3	12.0	8.1	18.7
3	7.1	10.0	7.9	25.7	23.3
4	6.2	3.0	25.8	27.0	23.1
5 +	-	-	49.2	26.0	21.0
Number of Hundred-Banks Appearing on List	211	428	3828	8249	50,179

Table 9. Densities of Listed Numbers in Hundred-Banks Appearing on the List Frames [1].

	Halifax County Urban [2]	Halifax County Total	Tucson	New Orleans	Chicago
Mean Density of 100-Banks on List	43.4	25.5	41.3	35.7	33.0
Frequency Classes					
1-9	3.8%	43.9%	3.1%	10.6%	6.7%
10-19	8.5	6.5	4.7	8.7	10.7
20-29	8.5	6.8	9.8	11.1	21.9
30-39	18.0	11.0	21.1	22.0	26.3
40-49	19.4	11.2	33.5	25.6	22.4
50-59	22.4	11.0	21.6	17.3	9.3
60-69	16.6	8.2	4.3	4.1	2.2
70-79	2.8	1.4	1.6	0.5	0.4
80-89	-	-	0.3	0.1	0.1
90+	-	-	-	-	-
Hundred-Banks on List	211	428	3828	8249	50,179
Estimated Total Possible Hundred Banks in Frame	400	1028	7418	10366	83,200

[1] One duplicate from each set retained.
[2] Including four valid NEX codes.

Table 10. Returned Letters From the List Samples

Type	Halifax County	Tucson	New Orleans	Chicago
Forwarding Time Expired	6	18	17	7
No Forwarding Address	5	11	7	3
No Such Numbers	4	1	8	6
Address Not Known	77	10	11	5
Insufficient Address	18	11	33	1
Other	3	3	5	1
Total Returned	113	54	81	23
Total Sent	708	440	760	760