NONRESPONSE FOLLOWUP: UNIT VS BLOCK SAMPLING

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1.0 Introduction

In the 1990 nonresponse followup (NRFU) operation, enumerators were sent to the field to collect data from every housing unit that did not return a questionnaire by mail. The increase in the number of housing units and the decrease in mail response rate made this one of the most costly operations in the 1990 Decennial Census. A major component of the 1995 Census Test design is to evaluate the operational feasibility of sampling for NRFU. The motivation for sampling nonrespondents is to reduce the cost of the census while maintaining high quality data.

An equally important objective of the 1995 Census Test is to evaluate the sampling element, the census block versus the housing unit. A sample design based on each of the two elements has advantages and disadvantages. From simulations using 1990 census data we know a unit sample design produces estimates with less bias and variance for small areas. The block sample may be easier to implement in conjunction with the integrated coverage measurement (ICM) operations, since the ICM uses a block sample.

To facilitate the evaluation of NRFU sampling, the design of the 1995 Census Test was a split panel design. Blocks were stratified based upon demographics and then assigned to one of two panels, the block sample (panel 1) or the unit sample (panel 2). From Table 1, panel 1 (block sample) consists of cells A, C, E, G and I. Panel 2 (unit sample) consists of cells B, D, F, H and J. The ICM sample was selected in such a way that approximately half of the sample was selected from each of the two panels. The ICM sample consists of cells G, H, I and J. The remaining blocks in panel 1 (cells A, C and E) formed the "NRFU block sampling universe." The remaining blocks in panel 2 (B, D and F) formed the "NRFU unit sampling universe." Note that all nonresponding housing units in the ICM sample (cells I and J) were in NRFU. Therefore, all the nonresponding housing units in cell J (unit sample) were sent to NRFU as if they were in the NRFU block sample. Similarly, all nonresponding housing units in cell I (block sample) were sent to NRFU.

Questionnaires were mailed to all housing units on March 1, 1995. We mailed reminder card to housing units for which we did not receive a return as of March 17, 1995. The replacement questionnaires were mailed on March 24, 1995. The identification of the NRFU universe was done on April 14, 1995. The mail return universe consisted of cells A, B, G and H. All housing units without a mail return which were not identified by the United States Postal Service (USPS) as vacant were eligible for NRFU, i.e., cells C, D, E, F, I and J. Housing units were determined to

be in the NRFU sample based on the sampling design. All nonresponding housing units which were not identified by the USPS as vacant in the ICM sample were sent to NRFU i.e., cells I and J. In the NRFU block sampling universe, the housing units eligible for NRFU consisted of cells C and E. The "NRFU block sample" was cell C. In the NRFU unit sampling universe, the housing units eligible for NRFU consisted of cells D and F. The "NRFU unit sample" was cell D.

Table 1: The Design			Block Sample (Panel 1)	Unit Sample (Panel 2)
NRFU Block/Unit Sampling Universe	Mail Returns		A	B
	Nonmail Returns	In NRFU Sample	C	D
		Out NRFU Sample	E	F
ICM Sample	Mail Returns		G	H
	Nonmail Returns	In NRFU Sample	I	J

This evaluation has six objectives:

1. To determine whether there is any difference in coverage between the NRFU block sample design and the NRFU unit sample design.

2. To determine whether there are other differences in the quality of estimates produced from a sample based on census blocks or housing units.

3. To collect cost data related to the implementation of NRFU block and NRFU unit sample designs. This objective is not covered in this report.

4. To identify refinements and enhancements to the methodology for sampling for NRFU, in a timely manner.

5. To examine the magnitude of NRFU adds and to provide information for the development of methods to handle the adds in estimation.

6. To assess the effects of late mail returns and Be Counted Forms (forms received after the cut for NRFU sampling) and the handling of other types of adds on the proposed NRFU design to use in the 2000 Census.

2.0 Methodology - Compare NRFU Block Sample and ICM Sample

The first part of the evaluation involves comparing the NRFU block sample (cell C in Table 1) and the ICM sample in panel 1 (cell I in Table 1). If the samples are homogeneous then we will combine the samples. The combined sample will be used in the comparison with the

NRFU unit sample, i.e., cell D in Table 1. Combining the two samples increases the power of the statistical comparisons. The statistical hypothesis tests can then detect smaller differences between NRFU block sample estimates and NRFU unit sample estimates as significant.

To determine whether there is any difference in the coverage between the NRFU block sample and the ICM sample, we compared the mail response rate, the average household size of the nonmail returns and the vacancy rate of the nonmail returns for the two samples. The mail response rate is defined as the number of mailback questionnaires divided by the total number of questionnaires mailed or delivered by census enumerators (Treat, 1995). The average household size is defined as the total number of persons in occupied nonmail returns divided by the number of occupied nonmail returns. The vacancy rate is defined as the number of vacant nonmail returns divided by the number of nonmail returns. If these comparisons suggest a significant difference in coverage then the samples will not be combined.

1. Mail Response Rate

The central proposition that needs to be assessed is:

H_0: There is no difference in the mail response rate between the NRFU block sampling universe (cells A, C and E) and the ICM sample in panel 1 (cells G and I).

Estimates of the mail response rate (MRR) for the two samples are as follows :

$$MRR_B = \frac{\sum_{j=1}^{B} MR_j}{\sum_{j=1}^{B} MO_j} \quad and \quad MRR_{ICM} = \frac{\sum_{j=1}^{S} MR_j}{\sum_{j=1}^{S} MO_j}$$

where

B = is the number of blocks in the NRFU block sampling universe, cells A, C, and E. Note that this differs from cell B in Table 1.

S = is the number of blocks in the ICM sample in panel 1, cells G and I

MR_j = is the number of mail returns in the jth block

MO_j = is the number of mailout housing units in the jth block

2. Average Household Size

The central proposition that needs to be assessed is:

H_0: There is no difference in average household size of the nonmail returns between the NRFU block sample (cell C) and the ICM sample in panel 1 (cell I). Note that the average household size excludes vacant housing units and housing units were all the data was imputed.

Estimates of the average household size for the two samples are as follows:

$$\bar{y}_b = \frac{\sum_{j=1}^{b} x_j}{\sum_{j=1}^{b} onmr_j} \quad and \quad \bar{y}_{ICM} = \frac{\sum_{j=1}^{s} x_j}{\sum_{j=1}^{s} onmr_j}$$

where

b = is the number of blocks in the NRFU block sample, cell C

s = is the number of blocks in the ICM sample from panel 1, cell I

x_j = is the number of persons on nonmail returns in sample in the jth block

$onmr_j$ = is the number of occupied nonmail return housing units in sample in the jth block

3. Vacancy Rate

The central proposition that needs to be assessed is:

H_0: There is no difference in the vacancy rate of the nonmail returns between the NRFU block sample (cell C) and the ICM sample in panel 1 (cell I).

Estimates of the vacancy rate (VR) for the two samples are as follows:

$$VR_b = \frac{\sum_{j=1}^{b} vnmr_j}{\sum_{j=1}^{b} nmr_j} \quad and \quad VR_{ICM} = \frac{\sum_{j=1}^{s} vnmr_j}{\sum_{j=1}^{s} nmr_j}$$

where

$vnmr_j$ = is the number of vacant nonmail returns in sample in the jth block

nmr_j = is the number of nonmail returns in sample in the jth block, i.e., $onmr_j + vnmr_j$

B. Compare NRFU Block Sample and NRFU Unit Sample

The analysis outlined in this section assumes we are able to combine the NRFU block sample and ICM block sample in panel 1. Therefore, when referring to the NRFU block sampling universe it is the combined sample, i.e., cells A, C, E, G and I in Table 1. Similarly, when referring to the NRFU block sample it is the combined sample, i.e., cells C and I:

To determine whether there is any difference in coverage between the NRFU block sample and the NRFU unit sample designs, we compared the following:

• the mail response rates,

• the average household size of the nonmail returns (unweighted and weighted),

• the vacancy rate of the nonmail returns (unweighted and weighted),

• the whole household substitution rate of the nonmail returns (unweighted and weighted),

- the last resort rate of the nonmail returns (unweighted and weighted),
- the household size distribution of the nonmail returns, and
- the estimates of housing unit population.

The first three comparisons are similar to the comparisons discussed in Section II.A. The whole household substitution rate is defined as the total number of nonmail returns where all of the data for the housing unit is imputed from another housing unit divided by the number of nonmail returns. Note that even the housing unit status (occupied or vacant) is imputed. The last resort rate is defined as the total number of nonmail returns where the NRFU enumerator was unable to obtain complete person and housing unit data for the housing unit divided by the number of nonmail returns. The results of all seven comparisons will provide input into the decision of which NRFU sampling design (census block versus housing unit) should be used in Census 2000. In addition, we examined the number of reverse computer assisted telephone interviews (CATI) and the number of housing units added during NRFU by sample.

1. Mail Response Rate

The central proposition that needs to be assessed is:

H$_0$: There is no difference in the mail response rate between the NRFU block sampling universe (cells A, C, E, G and I) and the NRFU unit sampling universe (cells B, D and F).

$$MRR_B = \frac{\sum_{j=1}^{T_B} MR_j}{\sum_{j=1}^{T_B} MO_j} \quad and \quad MRR_U = \frac{\sum_{j=1}^{T_U} MR_j}{\sum_{j=1}^{T_U} MO_j}$$

Estimates of the mail response rate (MRR) for the two samples are as follows:

where

T_B = Is the number of blocks in the NRFU block sample universe, i.e., B + S, cells A, C, E, G and I

T_U = is the number of blocks in the NRFU unit sampleuniverse, cells B, D and F

2. Average Household Size

The central proposition that needs to be assessed is:

H$_0$: There is no difference in average household size (unweighted and weighted) of the nonmail returns between the NRFU block sample (cells C and I) and the NRFU unit sample (cell D).

Note that the average household size excludes vacant housing units and housing units where all the data was imputed.

Estimates of the unweighted average household size for the two samples are as follows:

$$\bar{y}_b = \frac{\sum_{j=1}^{t_B} x_j}{\sum_{j=1}^{t_B} onmr_j} \quad and \quad \bar{y}_u = \frac{\sum_{i=1}^{onmr_u} y_i}{onmr_u}$$

where

t_B = is the number of blocks in the NRFU block sample, i.e., b + s, cells C and I;

y_i = is the number of persons in the ith nonmail return household in the NRFU unit sample;

$onmr_u$ = is the number of occupied nonmail return households in sample in the NRFU unit sample.

Estimates of the weighted average household size for the two samples were also calculated and compared.

3. Vacancy Rate

The central proposition that needs to be assessed is:

H$_0$: There is no difference in the vacancy rate (unweighted and weighted) of the nonmail returns between the NRFU block sample (cells C and I) and the NRFU unit sample (cell D).

Estimates of the unweighted vacancy rate (VR) for the two samples are as follows:

$$VR_b = \frac{\sum_{j=1}^{t_B} vnmr_j}{\sum vnmr_i} \quad and \quad VR_u = \frac{vnmr_u}{nmr_u}$$

where

$vnmr_u$ = is the number of vacant nonmail returns in the NRFU unit sample

nmr_u = is the number of nonmail returns in the NRFU unit sample

Estimates of the weighted vacancy rate for the two samples were also produced.

4. Whole Household Substitution Rate

The central proposition that needs to be assessed is:

H$_0$: There is no difference in the whole household substitution rate (unweighted and weighted) of the nonmail returns between the NRFU block sample (cells C and I) and the NRFU unit sample (cell D).

Estimates of the unweighted whole household substitution rate (WHHSR) for the two samples are as follows:

$$WHHSR_b = \frac{\sum_{j=1}^{l_B} snmr_j}{\sum_{j=1}^{l_B} nmr_j} \quad and \quad WHHSR_u = \frac{snmr_u}{nmr_u}$$

where

$snmr_j$ = is the number of whole household substitution nonmail returns in sample in the jth block

$snmr_u$ = is the number of whole household substitution in the NRFU unit sample.

In addition, estimates of the weighted whole household substitution rate (WHHSR) for the two samples were calculated and compare.

5. Last Resort Rate

The central proposition that needs to be assessed is:

H_0: There is no ifference in the last resort rate (unweighted and weighted) of the nonmail returns between the NRFU block sample (cells C and I) and the NRFU unit sample (cell D).

Estimates of the unweighted last resort rate (LRR) for the two samples are as follows:

$$LRR_b = \frac{\sum_{j=1}^{l_B} lnmr_j}{\sum_{j=1}^{l_B} nmr_j} \quad and \quad LRR_u = \frac{lnmr_u}{nmr_u}$$

where

$lnmr_j$ = is the number of last resort nonmail returns in sample in the jth block

$lnmr_u$ = is the number of last resort nonmail returns in the NRFU unit sample.

In addition, estimates of the weighted last resort rate (LRR) for the two samples were calculated.

6. Household Size Distribution

The distribution of the nonmail return's household size will be reported by sample, NRFU block sample versus NRFU unit sample. In addition, a chi-square test will be performed on the distribution to test for independence between the two samples.

7. Estimates of Population

The central proposition that needs to be assessed is:

H_0: There is no difference in the site level population estimate between the NRFU block sampling design and the NRFU unit sampling design.

Estimates of the site level population for the two samples are as follows:

$$\hat{Y}_B = 2(Y_{NMRB} + Y_{MRB}) + Y_{UUE} \quad and \quad \hat{Y}_U = 2(Y_{NMRU} + Y_{MRU}) + Y_{UUE}$$

where

Y_{NMRB} = is the estimated population from the housing units which did not return their questionnaires by mail in the NRFU block sampling universe, cells C, E and I.

Y_{NMRU} = is the estimated population from the housing units which did not return their questionnaires by mail in the NRFU unit sampling universe, cells D, F and J.

Y_{MRB} = is the population from the housing units which returned their questionnaires by mail in the NRFU block sampling universe (constant), cells A and G.

Y_{MRU} = is the population from the housing units which returned their questionnaires by mail in the NRFU unit sampling universe (constant), cells B and H.

Y_{UUE} = is the population from the housing units in the Urban Update/Enumerate areas (constant).

The variance of the site level population estimates for the two samples are as follows:

$$Var(\hat{Y}_B) = 4 \; Var(Y_{NMRB}) \quad and \quad Var(\hat{Y}_U) = 4 \; Var(Y_{NMRU})$$

C. Statistical Inference

A series of statistical tests were implemented to compare the NRFU block sample and NRFU unit sample designs. The statistical tests were performed independently for each characteristic and each of the four ICM sampling strata. The four ICM sampling strata are Black, Hispanic, Asian Pacific Islander (API) and Other. The variances of all estimates and the differences were calculated using jackknife estimators and VPLX software (Fay, 1990).

The analysis was performed so that the confidence level of all statistical tests simultaneously is greater than or equal to 90 percent. The significance level of each test individually is α/k, where α is the overall significance level (10 percent) and k is the number of statistical tests (3 and 7). While this procedure requires that larger differences must exist between samples to be declared significant, we are able to control the familywise error in the decision process. When several differences are declared significant, we are at least 90 percent confident that all such decisions are correct, simultaneously. The statistical tests were based on the Bonferroni t intervals (Miller, 1981).

For the comparison between the NRFU block sample and the ICM sample three statistics were examined representing three comparisons. Based on the Bonferroni method a multiplier of 2.13 was applied when determining the confidence levels. The P values are compared to 0.0333 instead of 0.1000 to determined if there was a difference between the sample estimates at the 90 percent confidence level.

For the comparison between the NRFU block sample and the NRFU unit sample seven statistics were examined representing seven comparisons. Based on the Bonferroni method a multiplier of 2.45 was applied when determining the confidence levels. The P values are compared to 0.0143 instead of 0.1000 to determined if there was a

difference between the sample estimates at the 90 percent confidence level.

III. Results

A. Compare NRFU Block Sample and ICM Sample

For the mail response rate, the average household size, and the vacancy rate, comparisons were made at the total and the four ICM sampling strata levels. The comparisons were performed at the 90 percent confidence level.

1. Mail Response Rate

The mail response rate for the NRFU block sampling universe and the ICM sample in panel 1 is 53.0 percent and 55.3 percent, respectively. The difference of -2.3 percent is not statistically significant. The difference of -16.8 percent for the API stratum is statistically significant at the 90 percent confidence level. For the remaining comparisons, there is no evidence of a significant difference between the mail response rates.

2. Average Household Size

The average household size for the NRFU block sample and the ICM sample in panel 1 is 2.505 and 2.549, respectively. For all the comparisons, there is no evidence of a significant difference between the average household size.

3. Vacancy Rate

The vacancy rate for the NRFU block sample and the ICM sample in panel 1 is 20.3 percent and 17.1 percent, respectively. The difference of 7.0 percent for the Hispanic stratum is statistically significant at the 90 percent confidence level. For the remaining comparisons, there is no evidence of a significant difference between the vacancy rates

B. Compare NRFU Block Sample and NRFU Unit Sample

The comparisons between the NRFU block sample and the ICM sample in panel 1 provided the following results. First, the comparison of the mail response rates in the API sampling stratum was statistically significant at the 90 percent confidence level. In addition, the comparison of vacancy rates in the Hispanic sampling stratum was statistically significant at the 90 percent confidence level. For the overall comparisons of the mail response rate, average household size and vacancy rate, there was no evidence of a significant difference between the two samples. Therefore, based on these results, the NRFU block sample and the ICM sample in panel 1 were combined. Thus, when referring to the NRFU block sampling universe it is the combined sample, i.e., cells A, C, E, G and I in Table 1. Similarly, when referring to the NRFU block sample it is the combined sample, i.e., cells C and I.

For the seven statistics, comparisons were made at the total level. For six of the seven statistics, comparisons were made for each of the ICM sampling strata. The analysis of the household size distribution was not performed at the ICM sampling strata level. All the comparisons were performed at the 90 percent confidence level.

1. Mail Response Rate

The mail response rate for the NRFU block sampling universe and the NRFU unit sampling universe is 53.1 percent and 53.8 percent, respectively. For all the comparisons, there is no evidence of a significant difference between the mail response rate.

2. Average Household Size

The unweighted average household size for the NRFU block sample and the NRFU unit sample is 2.514 and 2.569, respectively. For all the comparisons, there is no evidence of a significant difference between the unweighted average household size.

3. Vacancy Rate

The unweighted vacancy rate for the NRFU block sample and the NRFU unit sample is 19.7 percent and 19.2 percent, respectively. The difference of -4.8 percent for the Other stratum is statistically significant at the 90 percent confidence level. For the remaining comparisons, there is no evidence of a significant difference between the unweighted vacancy rates.

Comparisons using the weighted vacancy rate data are similar to the comparisons using the unweighted data. For the Other stratum, the difference is statistically significant at the 90 percent confidence level. For the remaining comparisons, there is no evidence of a significant difference between the weighted vacancy rates. Attachment B contains the weighted vacancy rates for the NRFU block and the NRFU unit samples, along with the comparisons.

4. Whole Household Substitution Rate

The unweighted whole household substitution rate for the NRFU block sample and the NRFU unit sample is 1.3 percent and 1.2 percent, respectively. For all the comparisons, there is no evidence of a significant difference between the unweighted whole household substitution rates.

Results on a comparisons using the weighted data are similar to the comparisons using the unweighted data for all characteristics.

5. Last Resort Rate

The unweighted last resort rate for the NRFU block sample and the NRFU unit sample is 22.2 percent and 21.2 percent, respectively. For all the comparisons, there is no evidence of a significant difference between the unweighted last resort rates.

Comparisons using the weighted last resort rate data are similar to the comparisons using the unweighted data. For all the comparisons, there is no evidence of a significant difference between the weighted last resort rates. .

6. Household Size Distribution

The NRFU block sample contained 10,697 housing units, of which 2,103 (19.7 percent) were vacant. Similarly, the NRFU unit sample contained 8,422 housing units, of which 1,621 (19.2 percent) were vacant. The

reason for the larger number of housing units in the NRFU block sample is due to the combining of the original NRFU block sample with the ICM sample in panel 1. A review of the percent rows indicates that the distribution of the household size is similar for both samples. The chi-square test between the distribution of household size and the two samples produced a P value of 0.690. Therefore, there is no evidence of a significant difference between the distribution of household size.

7. Estimates of Housing Unit Population

The population estimate for the NRFU block sample design and the NRFU unit sample design is 330,412 persons and 329,662 persons, respectively. For all the comparisons, there is no evidence of a significant difference between the population estimates.

8. Additional Analysis

As part of the additional analysis we determined the number of reverse CATI interviews by sampling universe.

For the NRFU block sampling universe, there were 231 reverse CATI interviews. There were 195 reverse CATI interviews in the NRFU unit sampling universe. For both samples, the number of reverse CATI interviews represented 0.3 percent of their respective universes. Since the percent of reverse CATI interviews is the same for both universes, this supports the conclusion that sampling design does not affect the respondent's ability/desire to complete their interview over the telephone.

We determined the number of NRFU adds by sampling universe. There was a relatively small number of NRFU adds in both samples. For the NRFU block sampling universe, there were 39 housing units added during NRFU. This represented 0.4 percent of the housing units in the NRFU block sample. There were 14 housing units added during NRFU in the NRFU unit sampling universe. This represented 0.2 percent of the housing units in the NRFU unit sample. Even though the percent of NRFU adds is different between the two samples, the number of NRFU adds is small. Therefore, if there is a difference between the two sampling universes the effect would be small (0.2 percent). In addition, the NRFU block sampling universe had more NRFU adds than the NRFU unit sampling universe.

IV. Conclusions/Recommendations

Statistical tests were performed for the total sample and for each of the four major ICM sampling strata; Black, Hispanic, API, and Other. Table 12 summarizes the results of the comparisons by the seven characteristics and the ICM sampling strata. One of the 31 comparisons were statistically significant at the 90 percent confidence level. The comparison was the vacancy rate for the Other strata. For the remaining comparisons, none were statistically significant at the 90 percent confidence level. Based on the results we conclude that there is little to no difference

between the NRFU block sample design and the NRFU unit sample design. Based on this analysis we recommend the use of the NRFU unit sample design since there is no significant difference in coverage and the unit design produces population estimates with less bias and variance for small areas than the block design.

V. Future Analysis

A. To refine the NRFU methodology for implementation in Census 2000 we will analyze quality assurance and operational data. The analysis of these data will identify potential areas of improvement in the NRFU operations.

- We will compare data collected in NRFU with the ICM data for the same units in the ICM sample blocks. This comparison will be carried out to assess the quality of the data collected during NRFU. The comparison will be made based on failed-edit and item nonresponse rates.

- We will compare data collected in NRFU with data in mail returns arriving after the cut for NRFU. Results of this comparison will be used to formulate a recommendation on the use of late mail-returns in estimation.

B. Perform similar analysis in conjunction with the targeting database. The analysis using the targeting database classified tracts from hard to enumerate to easy to enumerate. Using this analysis we can compare the mail response rates, the average household size (mail and nonmail), the vacancy rates (mail and nonmail), the whole household substitution rates (nonmail), the last resort rates (nonmail) and the household size distribution (mail and nonmail) by type of area. This will provide insight into both the NRFU sample designs as well as providing additional information into the many uses of the targeting database.

VI. References

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