

## Census 2000 Nonresponse Followup: Discrepancies in Enumerator Assigned Housing Unit Status\*

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### Abstract

One area of concern among census data users is the potential for misclassification of housing unit status by enumerators. The goal of this study is to determine what enumerator and other characteristics are associated with the questionable identification of housing unit status during Nonresponse Followup (NRFU). We compared the housing unit status during the NRFU operation with the status resulting from two followup operations, Coverage Improvement Followup (CIFU) and the Accuracy and Coverage Evaluation (A.C.E.). One of the main results that we found is that the NRFU operation was more likely to result in a discrepant housing unit status compared to CIFU than when compared to A.C.E. Perhaps the main reason for this finding is that the CIFU universe disproportionately included units identified as “vacant” or “delete” in NRFU (approximately 74 percent of the workload), and thus a larger percentage were likely to be converted to occupied status. The most important determinant of whether or not a housing unit status during NRFU will be different in the A.C.E. or CIFU is whether the NRFU respondent was a household member or a proxy.

**Keywords:** Nonresponse Followup, Census 2000, Enumerators, Housing Status

### 1. Background

In Census 2000, approximately 23 percent of Nonresponse Followup (NRFU) housing units were determined to be “vacant” and 14 percent of the universe had a status of “delete<sup>1</sup>” (Moul, 2002). One area of concern among census data users is the potential for misclassification of housing unit status by enumerators. Researchers are interested in identifying what enumerator

or other characteristics may be related to erroneous housing unit classifications.

To date, no known studies have been conducted to examine the relationship between enumerator characteristics and misclassification of housing unit status.

However, several studies have considered the impact of interviewer characteristics on data quality and survey results. Feldman *et. al.* (1951-52) found that interviewer experience was positively associated with more accurate data for some questions in a community survey. A study of interviewer effects on mental health interviews found that the interviewers’ characteristics such as age, experience, and number of interviews conducted could have a significant impact on the results of a survey (Cleary *et. al.*, 1981). Additionally, a phone survey found that less interviewer experience was associated with a higher refusal rate, but experience was not related to interviewer efficiency or accuracy in asking questions (Presser and Zhao, 1992).

With regards to census data, Burt (1986) examined the relationship between personality characteristics and enumerator job performance, as measured by supervisors, as part of the 1985 Test Census. That analysis found that some traits such as being organized, outgoing, responsible, persevering, intelligent, persuasive, conscientious, and confident were judged to be more associated with enumerator success than others.

This is the first known study of enumerator characteristics and the potential misclassification of housing unit status in a decennial census. This research study uses the Master Trace Sample (MTS) database as its data source. The MTS was a national representative systematic sample of approximately 600,000 housing units which links enumerator contact data with response data for research purposes.

### 2. Research objectives

The goal of this study is to determine what enumerator and other characteristics are associated with the questionable identification of housing unit status during NRFU. We compared the NRFU housing unit status with the status resulting from two followup operations. The first was Coverage Improvement Followup (CIFU). The second was the Accuracy and Coverage Evaluation

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<sup>1</sup> “Delete” means that the unit was demolished/ burned out, cannot locate, duplicate, nonresidential, or other (open to the elements, condemned, under construction) on Census Day (April 1, 2000).

(A.C.E.). For more information on CIFU and A.C.E., please see Sections 3.1.1 and 3.1.2.

A housing unit status was considered “questionable” if the enumerator-reported status was different between one operation and the other. For example, the status during NRFU was “vacant” and the status during CIFU was “occupied.” Note that all three operations used Census Day (April 1, 2000) as the reference date.

For the research hypotheses, we suspect that the following characteristics might be associated with fewer NRFU housing units having a questionable status compared to A.C.E. or CIFU.

1. Conducting interviews in fewer NRFU enumerator contacts;
2. More enumerator experience, as indicated by days of employment, full-time or part-time status, enumerator workload;
3. Increased enumerator education and higher test scores;
4. Using personal visit contact(s), as opposed to contact via the telephone;
5. Obtaining response from a household member (versus a proxy respondent).

### 3. Methodology

#### 3.1 Sample universe

The study focuses on the NRFU universe (i.e., cases that did not return a census questionnaire by a specific date). The analysis was limited to short forms so that the results are applicable to the methodology planned for the 2010 Census. Cases that were conducted using NRFU closeout procedures, or that were in the “POP99” operation to obtain unit population counts, were eliminated from this study.

##### 3.1.1 Accuracy and Coverage Evaluation

The A.C.E. was an independent coverage survey to determine the number of people and housing units missed or incorrectly counted in Census 2000. Its primary objective was to evaluate census coverage and to assess the net undercount. A.C.E. was conducted with an initial interview of households, by telephone (April 24, 2000 - June 13, 2000) or by personal visit (June 18, 2000 - September 11, 2000) (Childers and Petroni, 2004). The A.C.E. included various stages of sampling. During the frame development phase, enumerators used personal visits to collect information on the Census Day housing unit status. However, the data collection procedures and instrument were not the same as that in NRFU. For instance, the housing unit status codes were somewhat

different. For more information on the A.C.E. refer to U.S. Census Bureau (2004).

##### 3.1.2 Coverage Improvement Followup

CIFU was conducted after Census 2000 NRFU and was designed to improve coverage of housing units in the mailout/mailback, update/leave, and urban update/leave areas. CIFU was conducted in three waves, from June 26, 2000 - August 23, 2000 (Moul, 2002). One of the CIFU enumerator’s primary objectives was to verify the status of cases identified as vacant or delete by NRFU enumerators; other cases were reviewed, including adds from the new construction operation, adds from update/leave<sup>2</sup> and urban update/leave, and blank mail returns. NRFU and CIFU enumeration procedures, data collection modes, and survey instrument were comparable. Most of the CIFU workload consisted of units classified as vacant or delete in NRFU.

### 3.2 Statistical analysis

#### 3.2.1 Pairwise comparisons

We addressed the hypotheses using a series of pairwise comparisons of questionable housing unit identification rates across the levels for each of several variables. We used Bonferroni’s Multiple Comparison procedure to assure that the family-wise error rate did not exceed the  $\alpha=0.10$  level. Since this was a housing unit-level analysis, and the primary sampling unit was the housing unit, variances and significance tests were computed assuming a simple random sample.

#### 3.2.2 Logistic regression models

To supplement the pairwise comparisons, we analyzed two logistic regression models to control for factors that may confound any relationship between enumeration characteristics and questionable housing unit status. One model regressed the questionable identification of NRFU units, as compared to A.C.E., on the various predictor variables. The second model regressed the questionable identification of NRFU units, as compared to CIFU, on the same set of predictor variables.

The predictor variables included enumerator experience, number of contact attempts, enumerator test scores, whether or not the enumerator indicated that they had knowledge of a language other than English, as well as

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<sup>2</sup> “Update leave” is a method of data collection in which enumerators canvass assignment areas to deliver a census questionnaire to each housing unit. The household is asked to complete and return the questionnaire by mail.

indicators of their workload and average daily travel distance. Also, we controlled for any differences from regional management by including regional office in the models. Only the information from the final enumerator contact attempt with each household was used in these models.

**4. Limitations**

For general limitations on the MTS Database, see Hill and Machowski (2003). Other limitations include:

- The Census 2000 record of contact data, which comes from enumerator reports, are often unreliable and inconsistent.
- Multiple enumerators may have worked a case, but data reflected on the file are the characteristics of the enumerator who last contacted the housing unit.
- The A.C.E. data collection procedures and instrument were different from NRFU and the housing unit status codes were not identical. In addition, the CIFU universe was, in part, dependent on the results from NRFU, as units with vacant or delete status in NRFU were more likely to be sent to CIFU. For these reasons, the NRFU versus CIFU and NRFU versus A.C.E. results are not intended to be directly compared.

**5. Results**

**5.1 Summary information about the questionable identification of NRFU housing unit status**

We compared the housing unit status during NRFU with the status resulting from two followup operations, A.C.E. and CIFU. A housing unit status was considered “questionable” if, the enumerator-reported status was different between one operation and the other.

Table 1-A shows a cross-tabulation of sample sizes of NRFU housing unit status by CIFU housing unit status. Note that cases that had the same status in NRFU and in CIFU are along the diagonal and are in **bold**. The questionably identified cases are on the off-diagonals and are **highlighted**. The first interesting point is that the vast majority of NRFU cases in the MTS that were in the CIFU workload had a status of vacant or delete. Very few were occupied. However, as we can see in Table 1-A, a large number of the NRFU cases had a different status when compared to CIFU. In addition, close to half of all NRFU cases with a delete status were questionable (vacant or occupied) in CIFU. This suggests that whether or not a NRFU housing unit has a status of delete is a strong predictor of having a questionable identification based on

CIFU status.

**Table 1-A. Cross-tabulation of NRFU Housing Unit Status and CIFU Housing Unit Status**

NRFU Status	CIFU Status			Total
	Vacant	Delete	Occupied	
Vacant	<b>24,896</b>	<b>3,181</b>	<b>8,857</b>	36,934
Delete	<b>4,304</b>	<b>13,682</b>	<b>6,219</b>	24,205
Occupied	<b>1</b>	<b>1</b>	<b>64</b>	66
Total	29,201	16,864	15,140	61,205

Source: Census 2000 Master Trace Sample Database, unweighted

Table 1-B shows a tabulation of NRFU housing unit status against A.C.E. status, for units that were in the A.C.E. operation<sup>3</sup>. Note that the occupied category includes “other” for the A.C.E. housing unit status outcomes; this includes partial interviews and noninterviews. Overall there are not too many questionable cases between NRFU and A.C.E.

**Table 1-B. Cross-tabulation of NRFU Housing Unit Status and A.C.E. Housing Unit Status**

NRFU Status	A.C.E. Status		Total
	Vacant	Occupied	
Vacant	<b>4,638</b>	<b>1,871</b>	6,509
Occupied/Other	<b>1,033</b>	<b>18,767</b>	19,800
Total	5,671	20,638	26,309

Source: Census 2000 Master Trace Sample Database, unweighted

Perhaps the main reason for the large quantity of NRFU-to-CIFU questionable identifications is that the CIFU universe disproportionately included units identified as vacant or delete in NRFU (about 74 percent of the workload) (Moul, 2002). Since there were a large number of non-occupied units in CIFU, this meant that a larger percentage were likely to be converted to occupied status. In fact, these data are supported by Census 2000 CIFU figures that show that 32 percent of NRFU vacants were converted to occupied or delete status during CIFU (Moul, 2002). Additionally, 43 percent of NRFU deletes were changed to occupied or vacant (Moul, 2002). The A.C.E. used traditional sampling techniques and, thus, would be more likely than CIFU to include housing units that were occupied during NRFU.

<sup>3</sup> Note that A.C.E. deletes were not present in the MTS. Since NRFU deletes were only about 2 percent of the universe, the A.C.E. portion of the analysis focuses on vacant and occupied/other cases.

**5.2 Number of contacts and the questionable identification of NRFU housing unit status**

Table 2 shows the number of housing units in our universe that were questionably identified in Census 2000 NRFU compared to the A.C.E. and CIFU by the number of NRFU contact attempts at each unit. About 14 percent of those housing units that were enumerated after six contacts in NRFU had a different housing unit status in the A.C.E. We tested whether the percentage of questionable identifications for enumerations completed after 3 contacts were different from the percentages after 4, 5, and 6 contacts<sup>4</sup>. We found a statistically significant difference for units needing six contacts compared to those with three contacts (p-value = 0.0266).

**Table 2. Number of Contacts by NRFU Questionable Identification**

Number of Contacts	Compared to A.C.E. (%)	Compared to CIFU (%)
1	10.1	35.6
2	10.5	35.9
3	11.8	37.5
4	12.2	40.3
5	11.7	41.0
6	14.0	47.1

Source: Census 2000 Master Trace Sample Database

Similarly, the rates of NRFU questionable identification based on CIFU housing units were from 38 percent for three NRFU contacts, and 47 percent for six contacts. The percentage after contacts 4, 5, and 6 was significantly higher than the percentage at three contacts. The increasing trend was likely due to the desperation and last chance efforts by NRFU enumerators at the sixth contact, leading to possible housing unit status identification errors.

Both regression models showed that there was a slight significant positive relationship between the number of contact attempts and the likelihood of having a questionable housing unit status. This means that more contacts tended to be associated with a greater percentage of questionable identifications in NRFU compared to either A.C.E. or CIFU. Note, though, that the logistic regression models take into account all six NRFU contacts, whereas we only statistically compared contacts 3 through 6 in Table 2.

**5.3 Enumerator experience and the questionable identification of NRFU housing unit status**

<sup>4</sup> The intent was to compare later contacts (i.e., 4, 5, and 6) to earlier (i.e., 3) contacts.

We also analyzed the percentage of questionable housing unit status identifications by the number of days that an enumerator worked during NRFU up until the time of the NRFU interview completion. The days were collapsed into meaningful categories by week (1 week, 2 weeks, etc.). The left side of Table 3 examines the number of workdays by the NRFU questionable identifications based on A.C.E. units. We see that the percentage is lowest at about 10 percent for enumerators with a week or less of Census 2000 NRFU experience.

The rates of questionable identification for NRFU compared to A.C.E. were significantly higher for 1-2 weeks (p-value = 0.0098), 2-3 weeks (p = 0.0097), 3-4 weeks (p = 0.0002), and 5 weeks or more (p < 0.0001), compared to the baseline category of one week or less. The regression results for this model also suggested that there was a mild association between the number of days during NRFU that an enumerator has worked and the odds of having questionable housing unit identifications, when controlling for other factors. In the model, all four of the previously mentioned categories were statistically higher compared to 1 week or less except for the 1-2 weeks category, all other things being equal.

**Table 3. Number of Workdays by NRFU Questionable Identification**

Number of Workdays	Compared to A.C.E. (%)	Compared to CIFU (%)
0-7 (1 wk or less)	9.8	35.0
8-14 (1-2 wks)	11.4	35.5
15-21 (2-3 wks)	11.5	38.1
22-28 (3-4 wks)	12.5	38.2
29-35 (4-5 wks)	11.2	41.7
36+ (5 wks or more)	14.1	42.4

Source: Census 2000 Master Trace Sample Database

Also shown in Table 3, we examined the relationship between the number of NRFU workdays and the questionable housing unit identification based on CIFU housing units. There was an increasing trend from 35 percent at 1 week or less to 42 percent at 5 weeks or more.

All percents were significantly higher (p < 0.0001) than 1 week or less, except for 1-2 weeks. In the regression model only the 3-4 weeks, 4-5 weeks, and 5 weeks or more categories were significantly higher than the percentage for 1 week or less.

Next we compared the percentage of questionable NRFU housing unit identifications based on A.C.E. between enumerators employed a total of 80 hours or less throughout the NRFU operation and those employed more than 80 hours (as an indicator of employment status). As shown in Table 4, enumerators who worked more than 80 hours had an average of 11.4 percent questionable

identifications compared to A.C.E. results. This was higher than the 10.4 percent for those who worked less than 80 hours total (p-value = 0.0210). Further, in the logistic regression model we found a positive relationship between the total number of hours worked during NRFU and the number of questionable housing unit identifications compared to the A.C.E. (all other things being equal). The model showed that the odds of being questionably identified between NRFU and A.C.E. were 13 percent higher for cases worked by enumerators with more than 80 hours of NRFU experience.

**Table 4. Employment Status by NRFU Questionable Identification**

NRFU Employment Status	Compared to A.C.E. (%)	Compared to CIFU (%)
More than 80 hours	11.4	36.7
80 hours or less	10.4	37.3

Source: Census 2000 Master Trace Sample Database

The employment status by NRFU questionable housing unit status identification based on CIFU units was also studied. Unlike the results for NRFU compared to A.C.E., the percentage for those with more than 80 hours was slightly less (36.7 percent compared to 37.3 percent) than for cases worked by enumerators with 80 hours or less during NRFU. The pairwise comparison was not significant and was also not significant in the corresponding regression model.

We also examined the relationship between enumerator workload (i.e., number of NRFU cases worked per hour) and questionable housing unit status. For NRFU compared to A.C.E., as shown in Table 5, there was a slight increasing trend in the percentage of questionable NRFU cases from about 10 percent for enumerators with less than half a case per hour worked to 12 percent for those with 2 or more cases per hour. We compared the percentage of questionable cases for less than 0.5 cases per hour to the other three levels, but there were no significant differences. This finding was replicated in the regression data, as none of the levels of cases worked per hour was significantly different from those with less than 0.5 cases per hour.

**Table 5. Enumerator Workload by NRFU Questionable Identification**

Enumerator Workload	Compared to A.C.E. (%)	Compared to CIFU (%)
0 - 0.49 cases/hour	10.3	41.8
0.5 - 0.99 cases/hour	10.7	37.1
1 - 1.99 cases/hour	11.2	36.1
2 or more cases/hour	11.7	36.2

Source: Census 2000 Master Trace Sample Database

On the right side of Table 5, we show the NRFU questionable identification based on CIFU comparison for the levels of enumerator workloads per hour. Here the highest rate of questionable identifications (42 percent) was for cases worked by enumerators with 0.49 or less cases per hour worked. This figure was significantly higher than the percentage at each of the other three enumerator-workload ranges (p-value < 0.0001). This result was not wholly repeated in the logistic regression model, as the 2 or more cases per hour category was not significant, taking into account the other confounding variables.

**5.4 Enumerator education level and the NRFU questionable identification of NRFU housing unit status**

We also compared the percentage of questionable NRFU housing unit status based on A.C.E. by enumerator education level. NRFU interviews completed by an enumerator with less than high school education resulted in, on average, 11 percent different housing unit status classifications compared to A.C.E. The percentage of questionable cases was also about 11 percent for enumerators with high school or some college education and for those with a Bachelor’s Degree or higher (see Table 6). Using pairwise t-tests and regression modeling, we found that none of these percentages were statistically different.

**Table 6. Education Level by NRFU Questionable Identification**

Education Level	Compared to A.C.E. (%)	Compared to CIFU (%)
Less than HS	11.3	42.4
HS or Some College	11.3	37.3
Bachelor’s Degree	10.5	35.2

Source: Census 2000 Master Trace Sample Database

Table 6 also shows the percentage of NRFU cases, by enumerator education level, that were questionably identified based on the CIFU comparison. The percentage of questionable cases for enumerators with less than high school education (42 percent) was significantly higher than the percent for each of the other two education levels (p-value < 0.0001). This was significant in the regression model and supports the research hypothesis that cases worked by enumerators with more education may be less likely to have questionable housing unit status identifications than cases worked by enumerators with less education.

**5.5 Mode of enumeration and the questionable identification of NRFU housing unit status**

Next, we compared the percentage of questionable identifications by mode of enumeration (personal visit or telephone) for the final contact attempt. Table 7 first shows the questionable ID of A.C.E. units by NRFU mode. About 11 percent of housing units enumerated by personal visit were questionably identified compared to the A.C.E. and about 12 percent by telephone were questionable. Using a t-test and regression model, we found no difference by mode.

**Table 7. Mode of Enumeration by NRFU Questionable Identification**

Mode of Enumeration	Compared to A.C.E. (%)	Compared to CIFU (%)
Personal Visit	11.0	36.7
Telephone	11.8	33.2

Source: Census 2000 Master Trace Sample Database

Thirty-seven percent of NRFU personal visits had a different housing unit status than in CIFU. This was significantly higher than the 33 percent by telephone (p-value < 0.0001), and was also significant in the regression on the questionable identification of CIFU cases compared to NRFU.

**5.6 Respondent type and the questionable identification of NRFU housing unit status**

Lastly, we examined the relationship between respondent type<sup>5</sup> (proxy or household member) and questionable housing unit identification, as shown in Table 8. Greater than 17 percent of NRFU cases with a proxy respondent were assigned a different housing unit status during the A.C.E. This was significantly higher than the 6 percent of questionable identifications from householder respondents (p-value < 0.0001). Moreover, the regression results indicate that with all other things being equal, for householder respondents the odds of finding a difference in the housing unit status between A.C.E. and NRFU are about 70 percent less than the odds for proxy respondents.

This suggests that NRFU housing unit status information from household members is much more reliable than with proxies.

<sup>5</sup> Note that out of the NRFU cases in the MTS, about 23 percent did not make it into the final census files. Of these, almost two-thirds had a missing value for respondent type. These were assigned to the proxy category since the majority were NRFU delete or vacant housing units and would likely have been verified by a proxy respondent. We also analyzed the data by including “missing” as a separate category, and the conclusions were similar.

**Table 8. Respondent Type by NRFU Questionable Identification**

Respondent Type	Compared to A.C.E. (%)	Compared to CIFU (%)
Proxy (In-mover or other)	17.5	29.7
Household member	6.0	95.7

Source: Census 2000 Master Trace Sample Database

Table 8 also provides information on the percentage of questionable NRFU housing unit status cases, based on CIFU, by respondent type. Here, about 30 percent of NRFU proxy data later had questionable housing unit status during CIFU. In contrast, greater than 95 percent of NRFU cases with householder responses were later deemed to have a different housing unit status. This is statistically significant (p-value < 0.0001) and is also significant in the regression model. The regression model also finds that the odds of a questionable NRFU housing unit status based on CIFU comparison are much greater for household members than for proxy respondents.

The counter-intuitive results seen with the CIFU cases in Table 8 may not be too unexpected. For one, as noted before, the CIFU workload included a substantial number of vacant and deleted units from NRFU. Clearly, if a household member can respond than a housing unit is almost certainly occupied - exceptions being recording errors by enumerators. Therefore, only about 10 percent of the CIFU cases had household member respondents in NRFU. We found that most of these cases had a status of “delete” during NRFU, and NRFU deletes tended to either be vacant or occupied in the followup operation, as we previously stated in Section 5.1. It might then be reasonable to assume that these units were special cases that were included in CIFU for some valid reason and were probably more susceptible to having their housing unit status changed.

**6. Summary and recommendations**

We found somewhat mixed results in this analysis, with regards to the original research hypotheses outlined in Section 2. Overall, housing units with a NRFU status of “delete” were likely to have a different status when compared to CIFU. In addition, the NRFU respondent type is a major predictor of whether or not the unit will have a questionable status. For the NRFU to A.C.E. comparison, proxy responses were more likely to be questionably identified. For the NRFU to CIFU comparison, household member responses were found to have a higher questionable identification percentage. Further, there were moderate trends for the number of contacts (more contacts associated with higher percentage of questionable identifications), the number of enumerator workdays (more days associated with higher percentages),

and the education level of the NRFU enumerator compared to CIFU outcomes (more education associated with lower percentages).

In general, we hope that the results in this report will be informative and useful to Census 2010 planners. We believe that the relatively high questionable identification percentages should be carefully considered during the planning stages. There are several possible uses for this information, including implementing additional quality check procedures for vacant or delete classifications such as recording the contact person's (i.e., proxy) name and telephone number for verification.

In addition, we recommend that any future endeavor into this area of work attempt to control for more household characteristics that may be related to the difficulty in accurately depicting housing unit status. It may also be useful to consider not just whether the status was different between two operations, but the direction of the differences.

## 7. References

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