

EVALUATION FOLLOW-UP FOR THE 1988 POST-ENUMERATION SURVEY

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1. Introduction

In the 1988 Dress Rehearsal, the U.S. Bureau of the Census conducted a Post-Enumeration Survey (PES) to evaluate the census coverage error. Currently, the Census Bureau plans to use the same methodology to evaluate the 1990 decennial census. This paper discusses the Evaluation Follow-up, which investigated misreporting of the Census Day address in the PES interview. The project was one of several evaluations of census coverage estimates. Similar studies are planned for the 1990 PES estimates of census coverage error.

The PES consisted of two samples. The E sample, which was a sample of census enumerations, and the P sample, which was a sample of the population independent of the census. The E sample and the P sample were overlapping, which means that the same blocks were selected for each sample. The E sample measured erroneous census enumerations in the census and the P sample measured census omissions. Together they were used in dual system estimation to produce an estimate of the census coverage error (Childers and Hogan, 1989).

The dual system estimator of the population size is defined as follows:

- CEN = the size of the original enumeration
- Π_1 = the number of persons imputed
- Π_2 = the weighted estimate of census enumerations with insufficient information for matching (missing name)
- EE = the weighted estimate of the number of erroneous enumerations in original enumeration
- $C = CEN - \Pi_1 - \Pi_2 - EE$
- N_p = the weighted estimate of the total population from the P sample
- M = the estimate of the number of people in the Census and the P sample

The dual system estimator then is given by

$$N = CN_p/M$$

Dual system estimation assumes among other things that the P sample respondents can be linked, or

matched, correctly to their census enumerations at their Census Day address (Wolter, 1986).

The Evaluation Follow-up measured address reporting and the error in the number of people matching a census enumeration due to address reporting error. In the 1988 Dress Rehearsal, Census Day was on March 20 and the PES was conducted in July. Thus, some of the respondents in the PES had moved between Census Day and their PES interview. However, in spite of extensive probes on the questionnaire, respondents may fail to report that they moved. This type of error may cause the matching operation to search the census in an area other than where the respondent was enumerated and to assign a nonmatch status to respondents who might have been enumerated. Previous work on the effect of inaccurate reporting of Census Day address on dual system estimation is described in Mulry and Spencer (1988) and Hogan and Wolter (1988).

The next section describes the Evaluation Follow-up, including the sampling design. The Evaluation Follow-up cases included only P sample cases who were not included in the production PES Follow-up. Section 3 contains the results of the study. The final section discusses the conclusions that can be drawn.

2. Study Design

2.1 Operations

The Evaluation Follow-up was conducted in November during the final days of the PES Follow-up. This way the same staff could be used without hindering progress on the PES Follow-up. Although the interviewers were temporary employees, many of them had the experience of being interviewers during the PES and the Census. The interviewers used the P sample section of the PES Follow-up questionnaire in the Evaluation Follow-up. Therefore, no additional training was needed, and the interviewers had a few weeks of experience with the questionnaire before using it in the Evaluation Follow-up.

The processing of the Evaluation Follow-up questionnaire was the same as for the PES Follow-up. When a mover address was given, the address was coded geographically, called geocoding. During the geocoding, the clerks determined whether the address was in the census test site. If the address was in the test site, the case was sent for mover matching. The mover matching operation then attempted to match the case at the mover address by accessing census records for the block in which the address was located. If a matching census enumeration was not located in the block, the clerks searched the surrounding blocks.

2.2 Sample Design and Selection

The sample for the Evaluation Follow-up was selected from the P sample respondents who reported that they did not move between Census Day and the PES interview, and did not match a census enumeration. The sample included both whole household nonmatches and partial household nonmatches. When a nonmatch was in a household that included matches, the matches also were interviewed as a control group.

The sample consisted of 602 households. There were 275 households in St. Louis, 226 in East Central Missouri and 101 in Washington State. The households represented 1,810 persons. The cases were divided into two strata: (1) households where all the members were nonmatches and (2) households where at least one of the members was a nonmatch. All the nonmatches who were not movers were selected for the sites in East Central Missouri and Washington State. In St. Louis, a sample of the nonmatches who were not movers were selected. Two-thirds of the households where all the members were nonmatches and one-third of the households where at least one of the members was a nonmatch were included in the sample. The sample allocation was proportional to the number of households in the PES strata. Table 2.2.1 shows the sample size for persons in the three district offices by type of nonmatch household.

Table 2.2.1 Sample Size of Nonmatched Persons by Type of Nonmatch Household

District Office	Type of Household		
	Partial	Whole	Total
St. Louis	313	524	837
E.C. Missouri	207	435	642
Wash. State	125	206	331

3. Results

The Evaluation Follow-up was designed to produce estimates of the rate of error in the reporting of mover status. This estimate, in turn, is used to produce an estimate of the error in the estimate of the number of P sample people matched to a census enumeration. Furthermore, the proportion of matches which change because respondents change their mind and report a new address, provides a measure of the quality of address reporting in the Evaluation Follow-up.

In the result section, the outcome of the interview is reported first (Section 3.1). The outcomes are discussed by district office, by sample strata and by type of nonmatch household. Next, the results of the Evaluation Follow-up are displayed (Section 3.2). These results are also shown by sample strata and type of nonmatch households. In section 3.3 the results of the match status of the new addresses are examined. Only if the new address was within the test site was it possible to search for a matching census enumeration. Section 3.4 provides the results for the weighted data with adjustment for noninterview. In section 3.5, the

impact on the estimated undercount is examined. Finally, section 3.6 discusses the possibility of fabrication in the PES data.

3.1 Outcome of Interview

Overall, 90 percent of the Evaluation Follow-up interviews were conducted with a household member as the respondent. Focusing on completed interviews with a nonhousehold member, Washington State shows the highest percentage of completed interviews with this type of respondent, namely 11 percent. St. Louis had 6 percent, and E.C. Missouri 8 percent completed interviews with a nonhousehold member respondent.

A total of 60 interviews or 3 percent of the data were noninterviews. (Refusal, not at home, away on vacation or similar situations are classified as noninterviews). In both St. Louis and Washington State less than 2 percent of the interviews fell in this category. In E. C. Missouri, the noninterview rate was 6 percent.

The distribution of outcome of interview is presented in Table 3.1.1. This table shows the outcome of interview by PES sampling strata.

Table 3.1.1. Frequency Distribution of Outcome of Interview by Stratum

Stratum	Outcome of Interview		
	Complete % (n)	Noninterview % (n)	s.e.
St. Louis:			
Black renter	99.2 (388)	0.8 (3)	8.9
Black owner	98.5 (324)	1.5 (5)	9.5
Non-blacks	94.0 (110)	6.0 (7)	15.5
E.C. Miss.:			
TAR	90.0 (189)	10.0 (21)	11.3
Prelist	91.5 (214)	7.7 (18)	10.9
Update/Leave	100.0(183)	0	0
Small blocks:			
TAR	100.0 (3)	0	0
Update/Leave	100.0 (12)	0	0
Wash. State:			
TAR	100.0(40)	0	0
Prelist	84.6 (33)	15.4 (6)	2.6
List/Enumerate	100.0(193)	0	0
Small blocks:			
TAR	100.0 (42)	0	0
Prelist	100.0 (7)	0	0

In St. Louis, the highest occurrence of noninterviews is found in the nonblack stratum (6 percent). In E.C. Missouri, tape address register areas (TAR) had 10 and prelist areas 8 percent of noninterviews, respectively. In Washington State, prelist areas had more than 15 percent noninterviews. Standard errors for the noninterviews are presented in the last column.

In St. Louis, the percentage of noninterviews was higher for whole household nonmatches (4 percent) than partial nonmatches (0.3 percent). In E.C. Missouri, whole household nonmatches accounted for 2 percent of the noninterviews and 8 percent of the

partial household nonmatches. In Washington State, all the noninterviews came from whole household nonmatches (4.8 percent).

3.2 Change in Mover Status

The results concerning reporting of a new Census Day address are presented in this section. The tables include results for the nonmatches selected for the sample for the Evaluation Follow-up and for the matches included in the Evaluation Follow-up because they were in households with the selected nonmatches.

First, we consider the rate at which respondents changed their reported Census Day address from nonmover to mover in St. Louis. The results are also summarized in Table 3.2.1.

Table 3.2.1. Percent of Respondents who reported a Change in Mover Status. St. Louis.

Type of nonmatch household and stratum	Production Match Code		
	Nonmatch % (s.e.)	Match % (s.e.)	Overall % (s.e.)
<u>Partial</u>			
Nonblacks	40.0 (15.0)	7.7 (7.0)	22.5 (9.0)
Black owners	8.5 (5.0)	2.1 (2.0)	4.7 (2.0)
Black renters	24.0 (8.0)	7.4 (4.0)	14.7 (4.0)
<u>Whole</u>			
Nonblacks	8.7 (7.0)	-	8.7 (7.0)
Black owners	5.4 (4.0)	-	5.5 (4.0)
Black renters	6.9 (3.0)	-	6.9 (3.0)

In partial nonmatch households, the highest percentage of change occurred in the non-black stratum. Here, 40 percent of the nonmatches reported that they had moved between Census Day and the PES interview. Almost 8 percent of the matches stated that they had moved since Census Day. Combined, 22.5 percent of the sample reported that they had moved. For the black owner stratum close to 9 percent of the nonmatches, and 2 percent of the matches changed status. Combined, 5 percent of the black owners said that they moved since Census Day. The black renter stratum showed a similar pattern with 24 percent of the nonmatches and 7 percent of the matches changing their mind. Over all, in this stratum, almost 15 percent had a change in mover status.

In whole household nonmatches there is less variation across the sampling strata. The non-black stratum shows the highest percentage of change with almost 9 percent changing their Census Day address. The black owner and black renter strata are similar in

their responses with changes of 5.4 and 6.9 percent, respectively.

Table 3.2.2. Percent of Respondents who reported a Change in Mover Status. East Central Missouri.

Type of nonmatch household and stratum	Production Match Code		
	Nonmatch % (s.e.)	Match % (s.e.)	Overall % (s.e.)
<u>Partial</u>			
TAR	33.3 (9.0)	10.0 (6.0)	22.2 (6.0)
Prelist	22.0 (9.0)	0.01 (2.0)	11.3 (5.0)
Update/Leave	26.8 (10.0)	-	13.0 (5.0)
<u>Whole</u>			
TAR	7.1 (7.0)	-	7.1 (7.0)
Prelist	31.9 (9.0)	-	31.9 (9.0)
Update/Leave	23.5 (9.0)	-	23.5 (9.0)

Table 3.2.2 shows the results of the Evaluation Follow-up obtained in East Central Missouri. Again, the results are presented by sampling strata and type of nonmatch household. In East Central Missouri, there were five sampling strata. In two of these strata, small block TAR (n=3) and small block Update/Leave (n=12), there was no reported change in address. In the other three strata, the distribution of changes was uniform. In partial nonmatch households between 22 and 33 percent of the nonmatches reported that they moved since Census Day. In TAR areas almost 10 percent of the matches stated that they had moved since Census Day. In prelist areas, on the other hand, only 1 of the matches (.01 percent) reported a change. None of the matches in Update/Leave areas reported that they had moved.

In whole household nonmatches, 7 percent of the nonmatches reported a change in address in TAR areas. In prelist areas the percentage was higher. Here, almost a third, 31.9 percent, reported a new Census Day address. Finally, close to a fourth (23.5 percent) of the whole household nonmatches in Update/Leave areas reported that they moved since Census Day.

The Washington State results are shown in Tables 3.2.3. For partial nonmatch households in TAR areas, 15.4 percent of the nonmatches changed their mind. None of the matches reported an address change. This resulted in an overall percentage change of 6 percent for this area. Prelist areas show a very high percentage change among nonmatches, and no change among matches. Seventy percent of the nonmatches reported a new address for Census Day. Overall, there is a 23 percent change in prelist areas. In List/Enumerate areas, the matches reported more changes than the nonmatches, with 15 and 8 percent, respectively. The combined change was 12 percent. In the small blocks,

only the partial nonmatches in the TAR areas reported a new address. For this sample stratum, the percent change was 33.3 (n=6).

In whole household nonmatches there was a 25 percent change among the nonmatches in TAR areas. In List/Enumerate areas the change was smaller. Here, 8 percent of the nonmatches changed their mind.

Table 3.2.3. Percent of Respondents who reported a Change in Mover Status. Washington State.

Type of nonmatch household and stratum	Production Match Code		
	Nonmatch % (s.e.)	Match % (s.e.)	Overall % (s.e.)
Partial			
TAR	15.4 (17.0)	-	5.9 (7.0)
Prelist	70.0 (25.0)	-	22.6 (13.0)
List/Enumerate	8.5 (6.0)	15.2 (2.0)	12.0 (5.0)
Small block-Tar	33.3 (33.0)	-	33.3 (33.0)
Whole			
TAR	-	-	-
Prelist	25.0 (27.0)	-	25.5 (27.0)
List/Enumerate	7.5 (6.0)	-	7.5 (6.0)

3.3 Match Rate of New Addresses

This section turns to the results of the match rate at the newly reported Census Day addresses. As previously stated, only if the newly reported address was within a test site could an attempt be made to match an address.

In St. Louis, match of new address within the site is found for only responses in the non-black stratum in partial nonmatch households. Here, 20 percent of the nonmatches who moved within the test site (n=10) matched a census enumeration.

In East Central Missouri, address matches are found in three strata: TAR, prelist and Update/Leave in partial nonmatch household. In TAR areas, 9.5 percent of the new addresses matched. In prelist areas, the percentage was much higher. Thirty eight percent of the nonmatches matched census enumerations at the new address. Finally, in Update/Leave areas, 13 percent of the nonmatches who moved within the East Central Missouri test site matched at a new address.

In Washington State, new addresses were reported in TAR areas, small blocks, partial nonmatch households. Here, two new addresses were reported. Both addresses matched addresses within the Washington State test site, yielding a new address match rate of 100 percent.

For all three district offices, for all sampling strata, none of the respondents who matched at their initial

address also matched at their new address. Also, there were no new address matches reported in whole household nonmatches.

3.4 Weighted Results

The weighted results including adjustments for nonresponse are presented in Table 3.4.1.

Table 3.4.1. Percent Change in Address Reporting by District Office (Weighted w/Noninterview Adjustment)

District Office	Status of Address			
	New (% of sample)	Within Site (% of new)	Match (% of within site)	Address Error (% of entire site)
St. Louis	35.3	56.6	27.0	2.6
s.e.	(2.9)	(11.9)	(10.7)	(1.0)
E.C. Missouri	19.9	70.9	45.5	1.1
s.e.	(2.8)	(8.5)	(9.4)	(0.7)
Wash State	15.2	28.0	18.6	1.3
s.e.	(3.4)	(25.9)	(23.3)	(1.1)

As seen in Table 3.4.1, the largest proportion of new addresses was reported in St. Louis. However, the largest proportion of new addresses within the site was reported for E.C. Missouri. Here, almost 71% of the new addresses were within the site. Of those cases, 46 percent matched. In St. Louis, only 27 percent matched. In Washington State, 19 percent matched. Finally, the address error, calculated as a percentage of the entire site, is highest in St. Louis, 2.6 percent, and lowest in E.C. Missouri, 1.1 percent.

3.5 Change in Estimated Undercount Rate

The last step in the analysis of the data involves calculating the implications of the results obtained in The Evaluation Follow-up on the dual system estimator estimate of undercount within the three district offices. Because the Dress Rehearsal was restricted geographically to particular sites, there are differences between how movers were treated in the Dress Rehearsal and how they will be treated in 1990. We will evaluate the Dress Rehearsal in two ways, one with a narrow focus on the Dress Rehearsal as a census of each of the three sites, and one with a broader focus on the Dress Rehearsal as a pretest of the 1990 census. (For a more comprehensive discussion of the differences, see Mulry and Spencer (1990)).

For the narrow focus, the into site movers are declared out of scope. For the broad focus, it is assumed the net difference between the number of into scope (into site) and the out of scope (out of the site) movers is zero and that they have the same match rate.

The narrow focus results are presented first (Table 3.5.1). The data are weighted, with adjustment for noninterview, but with no post-stratification.

Table 3.5.1 Weighted Results by District Office
Address Reporting Error - Narrow Focus

Result	District Office		
	St. Louis	E.C. Miss	Wash. State
DSE	424,238	449,322	275,613
Undercount	0.0578	0.0469	0.0683
N _p	366,595	352,619	245,644
Correction s.e.	-4,555 585	-1,179 354	-2,307 564
Corrected N _p	362,040	351,440	243,337
M	321,581	321,339	219,760
Correction s.e.	1,396 325	1,305 378	166 152
Corrected M	322,977	322,644	219,926
Corrected DSE	417,216	446,016	271,412
Corr. Undercount	0.0419	0.0399	0.0539
Change in Undercount	-0.0159	-0.0070	-0.0144

With the narrow focus, the estimated corrections to N_p ranges from -4,555 in St. Louis to -1,179 in E.C. Missouri. The estimated correction to M ranges from 1,396 in St. Louis to 166 in Washington State. The corrected undercount rate is lowered by 1.59 percent in St. Louis, 0.7 percent in E.C. Missouri, and 1.44 percent in Washington State. This represented a 27 percent change in the undercount rate in St. Louis, a 15 percent change in E.C. Missouri, and a 21 percent change in Washington State.

The broad focus results are presented in Table 3.5.2 below. The data are weighted, with adjustment for noninterview, but with no post-stratification.

Table 3.5.2 Weighted Results by District Office
Address Reporting Error - Broad Focus

Result	District Office		
	St. Louis	E.C. Miss	Wash. State
DSE	424,238	449,322	275,613
Undercount	0.0578	0.0469	0.0683
M	321,581	321,339	219,594
Correction s.e.	2,626 445	1,841 444	596 286
Corrected M	324,207	322,180	220,190
Corrected DSE	420,802	448,156	274,867
Corr. Undercount	0.0501	0.0444	0.0658

Change in Undercount	-0.0077	-0.0024	-0.0015
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With the broad focus, the estimated correction to M for address reporting ranges from 2,626 in St. Louis to 596 in Washington State. Overall, the resulting change in the estimated undercount is small. The difference between the estimated undercount and the corrected undercount is .0077 or .77 percent in St. Louis. In East Central Missouri, the correction amounts to .0024 or .24 percent. Finally, in Washington State, the undercount was reduced by .0015 or .15 percent.

3.6 Fabrication

In any data collecting, the possibility exists that the interviewers fabricate the data. In the PES, quality control procedures have been developed to detect and correct for fabrication. The Evaluation Follow-up provides an alternative estimate of the level of fabrication in the P sample. The estimate also provides an assessment of the adequacy of the quality control operation in detecting fabrication.

In the Evaluation Follow-up, no fictitious cases were found in Washington State. In St. Louis, the fabrication error for the entire site was .02 percent (weighted data). For Columbia, it was .23 percent (weighted data).

To examine the impact of fabrication on the estimated undercount, the following results were generated (Table 3.6.1):

Table 3.6.1 Weighted Results by District Office -
Fabrication in the Data

Result	District Office	
	St. Louis	E.C. Miss
DSE	424,238	449,329
Undercount	0.0578	0.0469
M	321,581	321,339
Correction s.e.	52 62	731 234
Corrected M	321,633	322,070
Corrected DSE	424,169	448,309
Corr. Undercount	0.0576	0.0448
Change in Undercount	-0.0002	-0.0021

The estimated number of corrections for fabrication was 52 in St. Louis and 731 in E.C. Missouri. This correction implies a .0002 or .02 percent reduction in the estimated undercount for the St. Louis data. In E.C. Missouri, the undercount is reduced by .0021 or .21 percent.

4. Discussion and Conclusion

Misreporting of Census Day address in the PES interview was examined in this paper. The analysis was conducted for the three Dress Rehearsal sites. Within these sites, the data were classified by sampling stratum, type of nonmatch household and production match code.

It was found that differences in reporting occurred in all strata, in both types of households and at all three sites. The data, weighted including nonresponse weights, show that a third of the nonmatches not sent to PES Follow-up in St. Louis, a fifth in E.C. Missouri, and a sixth of the cases in Washington State, reported a new address. Not all of the reported addresses were within the site. Of the cases within site, between a fifth (18.6 percent) in Washington State and almost a half (45.5 percent) in St. Louis matched. This results in an overall address reporting error of between 1.1 and 2.6 percent for the three test sites.

These findings can be compared with the results from the Research Follow-up conducted after the PES in the 1986 test census in East Central Los Angeles. Although the Research Follow-up included other types of nonmatches who were not movers, a comparison is still productive. The Research Follow-up found that 15 percent of the nonmatches reported that they had moved since Census Day. Similarly, the estimate of the proportion of nonmatches who reported a new Census Day address which matched was one-third (weighted data). The misreporting rate was estimated to be 3.1 percent (Hogan and Wolter, 1988). Thus, compared with previously obtained estimates, the estimates produced by the Evaluation Follow-up appear plausible.

The type of respondents who provided the new information was examined in this study. Most information was provided by members of the household. For all three sites combined, 6 percent of the new addresses were given by nonhousehold member respondents. However, in the cases where a nonhousehold member provided a new address, the address was never matched. These findings stress the value of making contact with a household member, when requesting specific information.

The rate of noninterview in the Evaluation Follow-up was 2 percent for St. Louis and Washington State and 6 percent for E.C. Missouri. In the PES Follow-up, the noninterview was 6 percent for both St. Louis and E.C. Missouri and 2 percent for Washington State. Thus, the rate for St. Louis is lower than expected. The fact that the Evaluation Follow-up employed more experienced interviewers may account for the better outcome in St. Louis. A similar outcome was not obtained in E. C. Missouri, perhaps due to the higher percentage of movers here, 11.2 percent in E.C. Missouri versus 6.4 percent in St. Louis (Childers and Hogan, 1990).

Further analysis by stratum indicates that the highest noninterview rate in St. Louis occurred in the non-black stratum (6 percent). In comparison, the black renter stratum had 0.8 percent and the black owner stratum 1.5 percent, respectively. The same pattern is revealed by the PES Follow-up noninterview data. The non-black stratum had the highest noninterview rate. This is a finding contrary to expectation. However, given the large standard error on the result (s.e.=15.5

percent), the data do not allow for further interpretation.

The results obtained in the Evaluation Follow-up further showed that new addresses provided for whole household nonmatches did not match at the new address. Similarly, new addresses provided for matches in partial nonmatch households, did not yield new addresses that matched. These results appear to confirm that the response variability on this question is high.

Finally, the level of fabrication in the PES P sample data was estimated in the Evaluation Follow-up. Fabrication was found in two of the three sites, ranging from .02 to .23 percent. In the 1986 test census, the Research Follow-up estimated that 1.2 percent of the interviews were fabricated. Compared to this estimates, the 1988 results look plausible.

In conclusion, accurate reporting of Census Day address is one of the fundamental assumptions of dual system estimation. The results of the Evaluation Follow-up indicate that address misreporting occurred in the PES. The effect of address reporting error on the DSE is greater in the analysis under the narrow Dress Rehearsal focus than under the 1990 broad focus. Both analyses indicate that address reporting error is a potential major source of error in the 1990 PES.

References

Childers, D. and Hogan, H. (1990). "Results of the 1988 Dress Rehearsal Post Enumeration Survey". Paper presented at the Joint Statistical Meetings in Anaheim, California, August 6-9, 1990.

_____ (1989). "The 1988 Post-Enumeration Survey Methods and Design". Paper presented at the Joint Statistical Meetings in Washington, D.C., August 6-10, 1989.

Hogan, H. and Wolter, K. (1988). "Measuring Accuracy in a Post Enumeration Survey", Survey Methodology, 14.

Mulry, M. and Spencer, B. (1990). "Total Error in PES Estimates of Population: The 1988 Dress Rehearsal", Proceedings of the Sixth Annual Research Conference, Bureau of the Census, Washington, D.C., 326-331.

_____ (1988). "Total Error in the Dual System Estimator: The 1986 Census of Central Los Angeles County", Survey Methodology, 14, 241-263.

Wolter, K. (1986). "Some Coverage Error Models for Census Data" - Journal of the American Statistical Association, 81, 338-346.

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