Integrated Coverage Measurement Persons Not Matched in the Census 2000 Dress Rehearsal

Glenn Wolfgang, Danny Childers, Bureau of the Census
Glenn Wolfgang, Bureau of the Census, Washington, DC 20233[1]

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I. Introduction

Census 2000 procedures were rehearsed in three sites during 1998: Sacramento, California; Menominee county, Wisconsin, including the Menominee Indian Reservation; and Columbia, South Carolina with eleven surrounding counties. These sites provided responses to the initial census as well as to an independent second enumeration, the Integrated Coverage Measurement (ICM) survey, of sampled areas in these sites. (In South Carolina, the coverage measurement survey was designed as an evaluation not strictly integrated with the census. Yet, to simplify descriptions, this paper refers to all 1998 coverage measurement as ICM.)

The ICM involves two samples. Both are based on housing units found in blocks (or subsampled sections of large blocks) selected from census sites. The E-sample is comprised of persons reported in the census as Census Day residents in those housing units; it is used to count errors among those the census did count. The P-sample includes persons the survey found residing in housing units in the same areas on Census Day; it is used to determine who was missed in the census. Names of persons in the P-sample of the ICM are sought among census names. Persons found in both are matches.

The focus of this paper is on P-sample nonmatches, persons who were not found to be enumerated in the Census 2000 Dress Rehearsal. The aim is to identify characteristics that may be related to their being missed in census enumeration. The statistic used in this study is the nonmatch rate, the proportion of nonmatches among P-sample persons, computed within age, race, and other descriptive categories. The nonmatch rate is well related to (but less refined and more inflated than) the dual system adjustment factor used in census coverage evaluation. Errors and incomplete data estimated from the E-sample, as well as matches that may exist among census enumerations beyond areas searched, are refinements taken into account by dual system estimates but not nonmatch rates. Nonmatch rates are worthy of study independent of the effects of false or ambiguous enumerations, which are investigated by Feldpausch and Childers (1999) and by Jones and Childers (1999). Beaghen (1999) modeled both E-sample and P-sample data to gain insight into misses.

Several prior publications provide more background for this research. The procedures for both census and survey data collections in the Census 2000 Dress Rehearsal are described in Waite and Hogan (1998). Childers (1999) describes the ICM more completely. P-sample nonmatches were analyzed in the context of the 1990 census results by Moriarity and Childers (1993) using some of the same variables investigated in this research.

II. Limitations

This paper has a specific focus on P-sample nonmatches and the missed enumerations they represent. That excludes some other operational and theoretical concerns worthy of study. Other issues or errors beyond the scope of this paper include:

- Error in enumerations made by the census, measured with the E-sample,
- Imputation error in correcting ambiguity or inconsistency in census or survey data,
- Error in coding residence status or match status for the P-sample,
- Error due to whole-household nonresponse and the non-interview adjustment,
- Response error in reported characteristics,
- Correlation bias or lack of independence between census and survey enumerations, resulting in understated or overstated nonmatch rates,
- Lack of independence among groups compared or correlation due to the design,
- Incomplete representation of all areas of the United States during a decennial census. Three or so sites do not represent the variety in the nation. Dress rehearsal results also did not benefit from a full census publicity campaign.
- Interactions among variables within site.

[1]This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of research and to encourage discussion.

III. Methods

This study used final person-level data from the 1998 Dress Rehearsal for Census 2000. More detail on the processing of the data may be found in Waite and Hogan (1998). Here is a brief overview of the matching work. The P-sample people and the census people from the Census Unedited File (CUF) were computer matched within cluster. The computer matching involved first standardizing the name formats. Names and person characteristics of the P-sample people were compared to those of census people. A ranking score was assigned to each pair of person records and the optimal pairings were identified. Those pairs were reviewed to determine cutoffs in the scores taken to separate matches, possible matches, and nonmatches. Match cutoffs are assigned conservatively so there are virtually no false matches.

The possible matches and P-sample nonmatches were clerically reviewed using an automated match and review system. The names, age, race, Hispanic origin, sex, relationship, family composition, and address are displayed for review by the matching clerks, who matched some people the computer could not. After the matching, field follow-up was conducted to resolve or confirm coding of selected cases.

If match status remained unresolved, match probability was imputed. When variables used for poststratification (age, sex, race, ethnicity, and tenure) were missing, values were imputed. Each record was given a sampling weight derived from the probability of selection of the block cluster and of the block segment within the block if it was very large. For households not successfully interviewed, a non-interview adjustment was applied to similar other households. Sampling weights and non-interview adjustments were applied in all analyses.

A nonmatch rate, the weighted number of nonmatches divided by the weighted number of P-sample persons, was computed for various groups within the P-sample. Identifying groups with unusually high nonmatch rates provides insights on conditions associated with missed census enumerations. For this purpose, P-sample persons are grouped using variables:

- Site -- The Dress Rehearsal for Census 2000 was conducted within three states. South Carolina was so diverse that it was useful to divide it into three parts and analyze each as if it were a separate site. The resulting five sites vary on urban -rural character and type of enumeration area (TEA). TEA= 1, mail-out/mail-back, is the method of data collection used when the census address is specific enough to ensure the form can be delivered to only one location. TEA= 2, update/leave, means each address in sample will be updated in the field and a census form left for mail return:
  - S, CA = Sacramento, CA -- Urban; TEA = 1,
  - C, SC = Columbia, SC -- Urban; TEA = 1,
  - O, SC = Other SC -- Mixed; TEA = 1,
  - R, SC = Rural SC -- Rural; TEA = 2,
  - M, WI = Menominee, WI -- Rural; TEA = 2.
- Race and ethnicity -- Respondents were asked to identify ethnicity (Hispanic or non-Hispanic) as well as any race that applied (Black, American Indian, Asian, Pacific Islander, White, or Other). A person with multiple race responses was assigned to the largest group, other than white, based on the site's 1990 census data. Groups were collapsed, as needed in a site, to form the poststrata used in final dual system estimates. Schindler (1999) describes race categories more fully. The Sacramento site had four:
  - Hispanic, American Indian, and Pacific Islander
  - Black (non-Hispanic)
  - Asian (non-Hispanic)
  - White (including "other"; non-Hispanic)

  In South Carolina and Menominee, Black, Hispanic, American Indian, Asian, and Pacific Islander groups were collapsed into one group, Blacks predominate in South Carolina; American Indians in Menominee.
- Sex (Male or Female)
- Age -- Categories of age over age 17 are usually split by gender forming seven age/sex poststrata. In this paper, only basic age groups are analyzed:
  - Under age 18
  - Age 18 to 29
  - Age 30 to 49
  - Age 50 or more
- Tenure (Home owner or Renter)
- Impute -- Was age, sex, race, ethnicity, or tenure imputed for the ICM? (Imputed or not)
- Proxy -- (Proxy respondent or household member)
- Mover -- Did the census day resident move from the sample address before the survey interview? (Mover or Nonmover)
- Household Size -- The number of non-imputed P-sample persons enumerated at the address:
  - One (enumerated on one census form)
  - 2-5 (all could be enumerated on one census form)
  - 6 or more (supplemental forms required)
- Household Structure -- Type of structure at the address:
  - Single dwelling
  - Multi-unit
  - Mobile home
- Address Style -- Addresses may be written in various styles. Some are more useful or, at any rate, easier than others in distinguishing one housing unit from another or pinpointing its location on a map.
  - Street -- House number and street name,
  - Rural route -- Rural route number or street name,

- PO Box -- Post office box number
- Subsampling -- Was there any subsampling within the block cluster (Subsampled or not)
- Growth -- Amount of growth in the number of addresses for the area (tract) since 1990
  - Less than 20%
  - 20% to 40%
  - 40% or more
- Relisting – To insure the quality of address lists in a sample block cluster, field staff sometimes revisited the area and recreated the listing. The conditions leading to relisting might be related to those causing census misses (Relisted or not)

The group nonmatch rates were compared using VPLX, software designed to estimate variances in complex sample surveys using replication methods. VPLX was developed by Bob Fay, Senior Mathematical Statistician at the U.S. Bureau of the Census, and described in Fay (1990). VPLX documentation and software are available at www.census.gov/sdms/www/vwelcome.html. Stratified Jackknife methods were used to compute variance estimates for the nonmatch rates. VPLX also generated t-tests among these rates.

The tests were conducted at a 90% level of confidence, using a multiple comparison of means technique with a Bonferroni criterion, as described by Games (1971). It controls the probability of Type I error for a family of tests. In the context of this paper, a family of tests is defined as all tests conducted between groups of cases that together comprise the whole site or, when comparing sites, the whole sample. For example, when comparing the four race groups within the Sacramento site, six pairs of nonmatch rates were tested. To control the chance of Type I error at $\alpha = 0.10$ for all six tests combined, we used an adjusted criterion t-value associated with the probability of one of six two-tailed tests that have a joint error probability equal to 0.10. In addition, tests with groups based on less than 100 person records were avoided, either through collapsing with other groups or simply by dropping the group from that family of tests.

IV. Results

In general, results are presented in tables displaying group names (and group numbers among groups being compared, usually within site) nonmatch rates (rate), the stratified jackknife standard error (s. e.), the number of persons contributing data to the analysis (n), and a list of the numbers of groups with which a significant difference was found (*). Criterion t-values (e.g., $|t| > 1.65$) vary, as described above, with the number of comparisons being made in the family of tests. They are displayed below each table. The groups are arranged by nonmatch rate from lowest to highest to help display data patterns.

Overall, the nonmatch rates in these dress rehearsal sites are higher than a corresponding rate based on dual system estimates qualified by erroneous enumerations and insufficient information. They are also higher than 1990 rates. That is partly due to differences in how often and how far into blocks surrounding the sample block the search for census matches and counterbalancing erroneous enumerations was extended. In 1990, the search area was one ring of surrounding blocks in urban areas and two rings of blocks in rural areas. In dress rehearsal, the search area was the sample block cluster, except in a small number of clusters. The dress rehearsal did not have all the coverage improvement activities of a decennial census, such as coverage edit follow-up and block canvassing. Such efforts increase coverage.

The first table shows that the sites, picked to test a variety of census collection conditions in the U.S., did indeed differ from each other, but not when grouped by TEA, which usually yields differing nonmatch rates (Moriarity and Childers, 1993).

Table 1: Nonmatch Rates by Census 2000 Dress Rehearsal Site

SITE	rate	*	s. e.	n
1. C, SC	0.154	3-5	0.007	17810
2. M, WI	0.171	3-5	0.015	1271
3. S, CA	0.218	all	0.004	36336
4. R, SC	0.255	1-3	0.012	5359
5. O, SC	0.280	1-3	0.008	12751

* groups differing at $|t| > 2.57$

The results of other analyses are presented separately within sites. Tables 2, 3, 4, and 5 show comparisons of groups defined by major poststratification variables, which historically yield differences in coverage rates, thus making the poststratification useful in improving the dual system estimates. Poststratum groups compared below differ in a few instances from those used in official dual system estimates, mainly in order to arrange comparison groups with sample sizes greater than 100.

Table 2: Nonmatch Rates by Site and Tenure

SITE	TENURE	rate	*	s. e.	n
S, CA	1. Owner	0.161	2	0.004	19613
	2. Renter	0.284	1	0.006	16723
C, SC	1. Owner	0.121	2	0.005	8459
	2. Renter	0.174	1	0.011	9351
O, SC	1. Owner	0.261	2	0.009	9436
	2. Renter	0.333	1	0.018	3315
R, SC	1. Owner	0.243	2	0.013	4549
	2. Renter	0.316	1	0.032	810
M, WI	1. Owner	0.162	.	0.019	903
	2. Renter	0.187	.	0.023	368

* groups differing at $|t| > 1.65$

These poststrata results were consistent with 1990. Nonmatch rates for renters were higher than for owners, except in Menominee. Whites generally had the lowest nonmatch rates. Asian and Hispanic race/ethnicity groups shared nearly equal, moderate rates in Sacramento. Those age 50 or over, and next those aged 30-49, had the lowest rates and young adults (aged 18-29) the highest, except in Menominee. Females often had lower nonmatch rates than males. Although the trends were generally consistent from site to site, significant differences tended to appear more in sites with larger sample sizes.

Table 3: Nonmatch Rates by Site and Race/Ethnicity

SITE	RACE	rate	*	s. e.	n
S, CA	1. White	0.185	all	0.005	17038
	2. Asian	0.229	1,4	0.012	5668
	3. Hisp.,	0.233	1,4	0.007	8105
	4. Black	0.286	all	0.010	5525
C, SC	1. White	0.116	2	0.006	9563
	2. Black	0.192	1	0.010	8247
O, SC	1. White	0.246	2	0.008	7329
	2. Black	0.325	1	0.015	5422
R, SC	1. White	0.197	2	0.011	3330
	2. Black	0.352	1	0.024	2029
M, WI	1. White	0.105	2	0.030	269
	2.Am.Ind.	0.184	1	0.015	1002

* groups differing at $|t| > 2.39$ in S, CA
or $|t| > 1.65$ elsewhere

Table 4: Nonmatch Rates by Site and Age

SITE	AGE	rate	*	s. e.	n
S, CA	1. 50 +	0.152	all	0.007	9090
	2. 30-49	0.195	all	0.005	11156
	3. 1-17	0.265	1,2	0.009	9852
	4. 18-29	0.279	1,2	0.008	6238
C, SC	1. 50 +	0.104	all	0.007	4246
	2. 30-49	0.154	1	0.009	5721
	3. 1-17	0.171	1	0.023	4143
	4. 18-29	0.182	1	0.011	3700
O, SC	1. 50 +	0.233	3,4	0.012	3592
	2. 30-49	0.269	4	0.011	3919
	3. 1-17	0.310	1	0.023	3239
	4. 18-29	0.338	1,2	0.016	2001
R, SC	1. 50 +	0.193	3,4	0.017	1467
	2. 30-49	0.249	.	0.019	1722
	3. 1-17	0.278	1	0.029	1360
	4. 18-29	0.337	1	0.033	810
M, WI	1. 50 +	0.098	4	0.022	372
	2. 30-49	0.166	.	0.024	311
	3. 18-29	0.199	.	0.039	161
	4. 1-17	0.216	1	0.025	427

* groups differing at $|t| > 2.39$

Table 5: Nonmatch Rates by Site and Sex

SITE	SEX	rate	*	s. e.	n
S, CA	1. Female	0.210	2	0.005	18823
	2. Male	0.226	1	0.005	17513
C, SC	1. Female	0.141	2	0.008	9608
	2. Male	0.170	1	0.008	8202
O, SC	1. Female	0.279	.	0.010	6790
	2. Male	0.281	.	0.010	5961
R, SC	1. Female	0.245	.	0.015	2833
	2. Male	0.266	.	0.016	2526
M, WI	1. Female	0.164	.	0.021	654
	2.Male	0.179	.	0.020	617

* groups differing at $|t| > 1.65$

There was little imputation of poststratification variables, but when there was enough to test, imputed data had higher nonmatch rates. Households with proxy respondents yielded higher nonmatch rates than those with household member respondents (HHR), as in 1990.

Table 6: Nonmatch Rates by Site and Imputation

SITE	IMPUTED	rate	*	s. e.	n
S, CA	1. No imp.	0.217	2	0.004	35719
	2 Imputed	0.280	1	0.019	617
C, SC	1. No imp.	0.153	2	0.007	17539
	2 Imputed	0.230	1	0.034	271
O, SC	1. No imp.	0.279	2	0.008	12560
	2 Imputed	0.376	1	0.042	191

* groups differing at $|t| > 1.65$

Table 7: Nonmatch Rates by Site and Proxy Status

SITE	PROXY	rate	*	s. e.	n
S, CA	1. HHR	0.214	2	0.004	34581
	2. Proxy	0.296	1	0.013	1755
C, SC	1. HHR	0.150	2	0.007	16787
	2. Proxy	0.200	1	0.016	1023
O, SC	1. HHR	0.276	2	0.008	12146
	2. Proxy	0.377	1	0.027	605
R, SC	1. HHR	0.252	2	0.012	5196
	2. Proxy	0.364	1	0.041	163

* groups differing at $|t| > 1.65$

Movers and people with unresolved mover status had higher nonmatch rates than nonmovers. Those living in households large enough to require additional, supplemental census forms (to list the persons who did not fit on the first form) had higher nonmatch rates than those in smaller households, much as in 1990. Except in Columbia, SC, residents of single unit dwellings had lower nonmatch rates than respondents in multiple housing unit structures (buildings) or mobile homes, again, as in 1990.

Table 8: Nonmatch Rates by Site and Mover Status

SITE	MOVER	rate	*	s. e.	n
S, CA	1 Nonmover	0.209	all	0.004	34090
	2. Unresolv	0.353	1	0.022	634
	3. Mover	0.371	1	0.015	1612
C, SC	1.Nonmover	0.144	all	0.007	16478
	2. Mover	0.254	1	0.017	1064
	3. Unresolv	0.327	1	0.037	268
O, SC	1 Nonmover	0.276	all	0.008	12114
	2. Unresolv	0.364	1	0.038	209
	3. Mover	0.365	1	0.026	428
R, SC	1. Nonmover	0.251	2	0.012	5204
	2. Mover	0.431	1	0.070	139

* groups differing at $|t| > 2.13$ (or 1.65 in R,SC)

Table 9: Nonmatch Rates by Site and Household Size

SITE	SIZE	rate	*	s. e.	n
S,CA	1. 2-5	0.201	3	0.004	25072
	2. 1	0.215	3	0.008	5229
	3. 6 +	0.289	1,2	0.010	6035
C, SC	1. 1	0.147	3	0.008	1046
	2. 2-5	0.148	3	0.007	13540
	3. 6 +	0.257	1,2	0.025	3224
O, SC	1. 2-5	0.266	3	0.008	10230
	2. 1	0.299	3	0.016	1518
	3. 6 +	0.389	1,2	0.027	1003
R, SC	1. 2-5	0.238	3	0.013	4470
	2. 1	0.284	3	0.030	467
	3. 6 +	0.413	1,2	0.035	422
M, WI	1. 6 +	0.151	.	0.026	343
	2. 2-5	0.179	.	0.021	844

* groups differing at $|t| > 2.13$ (or 1.65 in M,WI)

Table 10: Nonmatch Rates by Site and Type of Structure

SITE	Structure	rate	*	s. e.	n
S,CA	1. Single	0.193	all	0.004	30034
	2. Multi	0.319	all	0.011	6111
	3.Mobile	0.597	all	0.073	184
C,SC	1.Single	0.144	.	0.005	12207
	2.Multi	0.165	.	0.013	5540
O,SC	1. Single	0.253	all	0.008	9852
	2.Multi	0.326	1	0.032	1078
	3.Mobile	0.387	1	0.024	1811
R,SC	1.Single	0.215	2	0.012	3663
	2.Mobile	0.344	1	0.021	1664
M,WI	1.Single	0.152	2	0.016	1012
	2.Mobile	0.264	1	0.028	241

* groups differing at $|t| > 2.13$ in S,CA & O,SC or $|t| > 1.65$ elsewhere

Address style groups seldom had sufficient data for a good comparison. Those in Rural S.C. with a full street address, including house number, had a lower nonmatch rate. Having a P.O. box did not differ from having no P.O. box, whether or not other addresses were given.

Table 11: Nonmatch Rates by Site and Address Style: Full Street Address vs Part or None

SITE	Street	rate	*	s. e.	n
R, SC	1.Full	0.235	2	0.012	3499
	2.Part	0.289	1	0.024	1755
M, WI	1.Part	0.152	.	0.021	427
	2.Full	0.184	.	0.019	844

* groups differing at $|t| > 1.65$

Table 12: Nonmatch Rates by Site and Address Style: P.O. Box Address vs No P.O. Box

SITE	P.O. Box	rate	*	s. e.	n
R, SC	1. Have	0.237	.	0.033	324
	2. None	0.256	.	0.021	4930
M, WI	1. Have	0.153	.	0.021	650
	2. None	0.196	.	0.024	621

* groups differing at $|t| > 1.65$

Lower nonmatch rates were found in two sites for persons living in blocks with so many residents that the block was subsampled. The two city sites did not agree.

Table 13: Nonmatch Rates by Site and Whether Subsampled:

SITE	Subsam	rate	*	s. e.	n
S, CA	1. Yes	0.204	2	0.007	93081
	2. No	0.222	1	0.005	26678
C, SC	1. No	0.151	.	0.005	12948
	2. Yes	0.158	.	0.013	4760
O, SC	1. Yes	0.249	2	0.019	2705
	2. No	0.291	1	0.009	10016
R, SC	1. No	0.250	.	0.013	4705
	2. Yes	0.287	.	0.018	616

* groups differing at $|t| > 1.65$

Results concerning blocks that had high rates of housing construction or growth were also inconsistent. It may be that low growth areas are associated with higher nonmatch rates, but that needs further study.

Table 14: Nonmatch Rates by Site and Locality's Level of Growth:

SITE	Growth	rate	*	s. e.	n
C,SC	1.20-40%	0.143	.	0.015	3105
	2. Low	0.158	.	0.007	14681
O,SC	1.20-40%	0.222	all	0.024	711
	2.Low	0.281	1	0.009	10962
	3.> 40%	0.308	1	0.023	1078
R,SC	1. >40%	0.188	3	0.029	254
	2.20-40%	0.206	3	0.018	990
	3.Low	0.270	all	0.015	4115

* groups differing at $|t| > 2.13$ (or 1.65 for C,SC)

Relisted blocks had higher nonmatch rates even though there were not many blocks on which to base the comparisons.

Table 15: Nonmatch Rates by Site and Whether Relisted:

SITE	Relisted	rate	*	s. e.	n
C SC	1. No	0.152	2	0.007	17447
	2. Yes	0.278	1	0.038	363
O SC	1. No	0.271	2	0.008	12385
	2. Yes	0.526	1	0.081	366

* groups differing at $|t| > 1.65$

V. Conclusions and Recommendations

The Integrated Coverage Measurement of the Census 2000 Dress Rehearsal yielded many significant differences between rates of persons not matched. This crude statistic of the number of persons missed among census enumerations overestimates the miscount, since it does not take into account erroneous enumerations and census imputations. But nonmatch rates show, without distraction from those other errors, when census enumerations are less likely to be missed. Owners and whites and persons over 30 years old, especially those over 50, have lower nonmatch rates. Among variables used for poststratification, only sex seemed to get weak confirmation of its importance. Several other groups were also found to have lower nonmatch rates: persons not imputed; those reported by household members rather than proxy; nonmovers; those in households small enough to need only one census form; those living in single family dwellings; and those not living in areas where address listing was so confusing that field interviewers had to redo the work. Those findings were confirmation of prior findings or expectations.

It was also useful to see, despite prior findings or expectations, what variable groups were not discriminated by nonmatch rates: type of enumeration area, address style (i.e. the presence or absence of a full street address or of a P.O. box address), whether or not a block was large and thus subsampled, and how much the area's percent of housing units increased since 1990.

Of course most of these variables are merely related to, rather than causes of, nonmatches, and, even if they could be controlled, there is no guarantee that would improve match rates. But in designing and conducting a census, important characteristics should be kept in mind, aiming to continue questionnaire design, interviewer training, and data processing with care and insight aimed at improving estimates. Evaluation of the poststrata variables is part of getting the most precise and accurate dual system estimate. Knowing that proxy respondents generally give more nonmatch data motivates the push for finding a household member whenever possible. Monitoring trends in how such variables relate to nonmatch rates over the decades is also part of understanding and interpreting census data. A final recommendation then is to follow this research with Census 2000 investigations of similar and additional variables.

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