Administrative Records and Person Duplication in Census

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1. Executive Summary

In this study we used administrative records to evaluate and support research on duplicate enumerations in Census 2000. A duplicate enumeration occurs when one person is counted twice, in which case we refer to the two records for the person as duplicates. We used the results of a computer match between an administrative records file and a preliminary Census file, the Hundred Percent Unedited File (HCUF), to detect potential duplicates. Where one administrative records record is matched with two HCUF records, the two HCUF records appear to be duplicates.

We compared the results with results from a separate study of duplication, "Further Study of Census Duplication" (FSPD), which employed two methodologies to detect duplicates. One methodology, *statistical match modeling* considered how closely two records of people in different households matched, as well as how closely records of other people in the same two households matched. The second, *exact match modeling*, used frequencies of names and dates of birth, and other factors, to assign a probability that two closely matching records are duplicates. In addition, we used the results from a clerical review of a sample of linked pairs from administrative records and from FSPD.

Our primary findings are:

- **Administrative records can be a valuable tool for confirming and disconfirming potential duplicates.** We showed how administrative records can be used to confirm and disconfirm potential duplicates identified by other processes, and to assess probabilities those processes assigned. Clerical review results generally supported the administrative records confirmations and disconfirmations of FSPD links.
- **Administrative records can be useful for identifying a subset of duplicates missed by other processes.** We found that when administrative records had address information similar to that for both records in the pair, the links were confirmed at a much higher rate. Thus, we can use administrative records to identify with confidence *some* duplicates missed by other methods. These cases could then be used to learn something about duplicates that these processes miss.
- **Administrative records generally confirmed the two FSPD processes**. In general, administrative records supported the FSPD processes. They largely confirmed the statistical matching links that were judged to be duplicates, and agreed when statistical matching judged links not to be duplicates. The exact matching probabilities agreed to a large degree with estimates derived from administrative records.
- **Administrative records were less useful for estimating the number of duplicates missed by other processes.** The clerical review rejected a high percentage of pairs of records linked as duplicates using administrative records, but not by FSPD. While we might question the clerical judgments, the high percentage of links rejected throws doubt on those links. In addition, we expect that there are many duplicates not linked by either of the FSPD process or by administrative records.

2. Background

2.1 Administrative Records

For this project, we used two administrative records databases: the Census Numident and the Statistical Administrative Records System (StARS). The Census Numident is created from the Social Security Administration's Numerical Identification File (Numident), which contains effectively every Social Security Number (SSN) issued and a record for each transaction with the Social Security Administration. To create the Census Numident, Census Bureau staff edits the Numident and creates one record for each SSN, which includes a selection of the "best" demographic data for that person. The StARS database incorporates data from several national level administrative records files, including IRS files.

To detect person duplication, we used the results of a computer match of person records between a preliminary census file, the Census Hundred Percent Unedited File (HCUF), and the Census Numident. The matching process also used addresses from StARS for people on the Census Numident. The goal

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of this matching process was to link Census Numident records with HCUF records for the same person. When two HCUF person records were linked with the same Census Numident record, it appears that one person has two HCUF records. In this way, administrative records provide can provide strong evidence that a person was duplicated on the HCUF. Similarly, when two HCUF records were linked with different Census Numident records, that is strong evidence that the HCUF records really are of different people.

2.2 Previous Studies

This report follows several related studies.

Further Study of Census Duplication (FSPD). In Mule (2002) (also see Fenstermaker and Mule (2003)), a sample of census records was linked to HCUF records to find potential duplicates. FSPD used two processes for detecting duplicates: *statistical match modeling*, which used all of the potential duplicate links between two households to assess whether a potential duplicate is a duplicate; and *exact match modeling*, which used distributions of names and dates of birth, and other factors to produce a probability that a pair of records with the same name and date of birth represent a duplicate.

For the statistical match modeling, person records from the Accuracy and Coverage Evaluation (A.C.E.) sample of Census households were linked with HCUF records based on name and other person characteristics. Statistical match modeling applies when more than one person was linked between the same pair of households. In these cases, a score is calculated, based on the number of other links within the households, and the strength of the matches within the households. The strength of matches is reflected in the match scores that are produced by a computer matching algorithm. The underlying principle is that if more people there are within two households who appear to be similar, the less likely it is that the households contain completely different people. Links were judged to be duplicates or not based on whether the score is above a threshold.

Exact match modeling (Fay (2002) and Fenstermaker and Mule (2003)) required an exact match on name and date of birth. When two records were linked through this exact match, a probability that the link is a duplicate was assigned. The probability depends on the distribution of the names and dates of birth, geographical distance of the links, and whether the names were Hispanic names.

Census and Administrative Records Duplication Study (CARDS). Bean and Bauder (2002) calculated national level estimates of person duplication based on administrative records, using the Census Numident to HCUF match described in Section 2.1. They compared these estimates with estimates from the FSPD process. In general, the estimates were similar. The overall estimate from administrative records was somewhat higher, and more records were linked by the administrative records process that were geographically distant. However, a clerical review study judged that a fairly high percentage of geographically distant records linked through administrative records but not by FSPD were not actually duplicates.

Clerical Review of Census Duplicates. In Byrne, Beaghen, and Mulry (2002), a sample of potential duplicate links from the administrative records process and from FSPD were examined in a clerical review. The goal was to assess the quality of FSPD and administrative records duplicate links. The sample included approximately 19,000 links, of which about 10,000 were links between a record in the A.C.E. enumeration sample (E-sample) and another record. The present paper concerns only E-sample links. For the clerical review, analysts could examine all person records for the two households containing the linked persons, to assess whether the linked pair is truly a duplicate. Analysts could declare that a linked pair is a duplicate, deny that it is a duplicate, or record that they could not decide whether the pair is a duplicate.

In this study, we focus on how CARDS and FSPD results compare case-by-case, and on the clerical judgments for those cases.

3. Results

3.1 Confirmation and Disconfirmation of Statistical match modeling Links

Table 1 in the Appendix contains results for links for which FSPD statistical match modeling applied. We compare the FSPD judgment for these links with the result from administrative records. The administrative records process judges that: a link between Census records represents a *duplicate* when both records in the linked pair were matched to the same Census Numident record; the link is a *nonduplicate* when the records were linked with different Census Numident records; and the case *undetermined* if at least one of the two records was not matched at all to the Census Numident. We break out results by five geographic relations for the linked records: within the A.C.E. sample cluster, outside of the cluster but within the surrounding blocks, outside of the surrounding blocks but within the county, outside of the county but within the state,

and in different states. An A.C.E. sample cluster consists of a block or a geographically contiguous group of blocks and housing units. These clusters were the primary sampling unit for the A.C.E.

We refer to results using administrative records as AR outcomes. We found that:

- Overall, administrative records confirmed about 76% of the FSPD duplicates and disconfirmed about 2% of them.
- Of the links that FSPD judged not to be duplicates, AR agreed that they are not duplicates in about 71% of the cases. In only 0.2% of those cases did AR judge the link to be a duplicate.
- These confirmation and disconfirmation rates for the FSPD duplicates remained fairly consistent over the different geographic categories, except that within the A.C.E. cluster, AR confirmed more duplicates and disconfirmed fewer.
- For those that FSPD judged not to be duplicates, AR judged that more *were* duplicates in the closer geographic categories.

In addition, among the FSPD non-duplicates for the closer geographic categories, AR had a high percentage of unresolved cases. Recall that an unresolved case is one where at least one of the two HCUF records linked by FSPD did not get linked to the Census Numident. One likely explanation of the higher percentage of unresolved cases among the FSPD non-duplicates is that the cases FSPD judged not to be duplicates tend to be ones where the match score between the records was small. This is likely to happen when fields are missing – in which case the record is less likely to link to the Census Numident.

Table 2 contains some results from the clerical review of FSPD links, conducted as part of the study, "Clerical Review of Census Duplicates" (Beaghen, Byrne, and Mulry 2002). Here, we compare the clerical judgments with the confirmations and disconfirmations by AR of FSPD links. We show comparisons between the clerical judgments for all FSPD cases of with those where AR agreed with FSPD and where AR disagreed with FSPD.

We see that the clerical results consistently confirm AR judgments of FSPD links.

For links within a state:

- The clerical review confirmed 94.2% of all of the FSPD duplicate links, but confirmed 98.2% when the link was confirmed by AR. The clerical review confirmed 88.7% of the links *not* confirmed by AR, and the difference between the 98.2% and the 88.7% is statistically significant, given the sample sizes of 893 links confirmed by AR and 462 not confirmed by AR.
- For FSPD duplicate links that AR *disconfirmed*, the clerical review agreed with AR that these were not duplicates in 63.3% of the cases.
- For FSPD non-duplicate links, the clerical review agreed that the linked pair was not a duplicate in 84.1% of the cases. But when AR agreed with FSPD that the linked pair was a duplicate, the clerical review agreed with AR and FSPD that they were not duplicates in 96.8% of the cases.
- For FSPD *non*-duplicate links, when AR had judged that the linked pair *is* a duplicate, the clerical review agreed with AR that the linked pair is a duplicate in 85.1% of the cases.

For links between different states:

- The clerical review confirmed 94.1% of all of the FSPD duplicate links (78% of those not confirmed by AR), but confirmed 98.2% of the FSPD duplicate links confirmed by AR. This difference is statistically significant, given sample sizes of 390 confirmed by AR and 100 not confirmed by AR.
- For FSPD duplicate links that AR *disconfirmed*, the clerical review agreed with AR that these were not duplicates in 83.3% of the cases.
- For FSPD non-duplicate links, the clerical review agreed that the linked pair were not duplicates in 95.2% of the cases. But when AR agreed with FSPD that the linked pair were not duplicates, the clerical review agreed with AR and FSPD that they were not duplicates in 98.7% of the cases.
- For FSPD *non*-duplicate links, when AR judged that they *are* duplicates the clerical review agreed with AR that the linked pair was a duplicate in 60.2% of the cases.

We see that in every case, when AR agreed with FSPD, the analysts were more likely to agree with the FSPD judgment. And when AR disagreed with FSPD, the analysts were more likely to agree with the AR judgment.

3.2 Comparison of FSPD exact matching probabilities with AR outcomes

The exact matching modeling procedure of FSPD applied when two records matched on name and date of birth. The procedure estimates a probability that such a linked pair is a duplicate. We compared the probabilities produced by exact match modeling with administrative records results by comparing estimates of odds. We created an AR estimate of the odds of a

link being a duplicate over a set of cases by taking the ratio of links judged to be duplicates by the AR process to those judged to be nonduplicates. We assessed the degree of agreement between AR and the FSPD exact matching process by considering intervals of FSPD probabilities, and comparing the odds calculated from the FSPD probabilities to the AR estimate. The AR results for the FSPD exact matching links are in Table 3.

These results show large agreement between AR and the FSPD exact matching process. For almost probability intervals in the table, the estimated odds from AR is within or close to the range of the FSPD odds ratios.

There is an important difference between the relationship between AR and FSPD statistical matching links, and exact matching processes. There is some dependence between the AR process and statistical matching. In both cases, whether records are linked depends partly on how closely the name and date of birth fields match. (The processes differ with regard to what else is used in deciding whether to link records, as well as some details about the name and date of birth matching.) In particular, both processes are likely to miss many of the same duplicates – ones where there are many missing fields, or where the reported names are very different.

On the other hand, the exact matching process is only applied to pairs that matched exactly on name and day and month of birth. *Within* this population of pairs, the exact matching process and AR are nearly independent. The exact matching process depends on distributions of names, geography, etc. The AR process depends on whether there is more than one record in the Numident with a similar name and date of birth, and on the addresses for people on those records. Because of the independence between these two processes, the amount of agreement between the exact matching odds ratios and the AR confirmation to disconfirmation ratio is especially impressive.

3.3 The effect of address similarities on the quality of AR duplicate links

In the original CARDS study (Bean and Bauder, 2002), we found that AR linked many more pairs of records at large distances – different states, for example – than did FSPD. However, the clerical review did not confirm a high percentage of links found by AR but not by FSPD. In addition, the clerical review did not confirm a large percentage of AR links at larger geographic distances. In Table 4 below, we report clerical review results for AR links by whether FSPD judged them duplicates, and by whether the links were within a state or between states. We refer to record pairs linked by AR but not by FSPD as "AR only" links.

We see that:

- Overall, the clerical review confirmed about 64% of the AR links, and rejected about 25%.
- For links between states, the clerical review confirmed about 37% confirmed and rejected about 49% .
- For AR only cases, the clerical review confirmed about 33% and rejected about 52%.
- For AR only links between different states, only about 10% were confirmed.

However, in some cases, administrative records had address information that could help place one person two addresses in the Census. We investigated whether, by looking at when there is address information linking a person to two places, we could find AR links that are more reliable.

Computer record linkage is typically done in multiple "passes." In each pass, some fields are specified as blocking fields and some as matching fields. Blocking fields are fields in which two records must agree in order to be compared at all. When records are compared, a score is computed based on agreements or disagreements in the matching fields. Multiple passes are used so that records that are not compared in one pass because they disagree in the blocking fields might be compared in other passes.

The HCUF to Numident matching was done in two phases, each of which contained several passes. In the first phase, called the Geokey Search, address fields were used as blocking fields. Thus, when records were linked in the Geokey Search, there is some similarity between the address for the HCUF record and one of the addresses in the Geokey Numident for the person. HCUF records that were not linked to Numident records in the Geokey Search were then involved in the second phase of matching, the Name Search. In the Name Search, the blocking fields involved only person data, such as name and date of birth. In both phases, the matching fields included names or parts of names, date of birth fields, and sex.

Each AR link involves two HCUF-Numident links to the same Numident person. When both HCUF-Numident links were found in the Geokey Search, then there is StARS address data that is similar to the HCUF addresses for each of the two HCUF records. In these cases, we have the strongest evidence from administrative records that there is a Census duplicate. Table 5 below contains the clerical review results for the AR links, by how many of the two HCUF-Numident links were found in the Geokey Search.

There is a striking difference in the confirmation rates between when both links were found in the

Geokey Search and when one or more were found in the Name Search. The difference is especially notable for links between different states. When both links were found in the Geokey search, the clerical review confirmed about 75% of the links, while it confirmed only about 31% of the links where at least one of the HCUF-Numident links were found without use of the Geokey. We should note that the clerical staff did not use the StARS addresses in making their judgments. If they had, we might expect that even more of these links could have been confirmed.

4. Conclusions

The results above support the following conclusions:

- **Administrative records can be a valuable tool for confirming and disconfirming potential duplicates.** In this report, we showed how administrative records can be used to confirm and disconfirm potential duplicates identified by other processes, and to assess probabilities those processes assigned. The results in Table 2 are of particular interest. They show that when AR confirmed the FSPD judgment, the clerical review was more likely to agree with FSPD. And when AR disagreed with FSPD, the clerical review was more likely to agree with AR than with FSPD. Thus, the AR confirmations and disconfirmations contain substantial information.
- **Administrative records can be useful for identifying a subset of duplicates missed by other processes.** Links where both HCUF-Numident links were found in the Geokey search were confirmed at a much higher rate – 75% for AR links between states. Thus, while the procedure used here with administrative records might not be adequate for estimating the *number* of duplicates missed by other process, it can with confidence identify *some* of these duplicates. These cases could then be used to learn something about duplicates that these processes miss.
- **Administrative records generally confirmed the two FSPD processes**. In general, the AR results supported the FSPD processes. AR largely confirmed the statistical matching links that were judged to be duplicates, and agreed when statistical matching judged links not to be duplicates. The exact matching probabilities agreed to a large degree with estimates derived from administrative records. These results are particularly interesting because of the independence between the exact matching procedure from FSPD and the AR procedure.
- **We were less successful in using administrative records to estimate the number of duplicates missed by other processes.** The clerical review rejected a high percentage of pairs of records linked as duplicates using administrative records, but not by FSPD**.** The high percentage of AR Only links rejected throws doubt on those links. In addition, we expect that there are many duplicates not linked by either of the FSPD process or AR. If there were significant differences in reporting of names, or missing fields in two HCUF records for one person, AR is not likely to link both records unless it could do so in the Geokey search (because when there was address similarity, a less exact match on person characteristics could be tolerated). But for AR to make both links in the Geokey search, StARS would generally have to have both addresses for the person. This would require there being administrative records for the person at both addresses. This could easily not happen.

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Appendix: Tables

Table 1. Administrative Records (AR) Status of FSPD Statistical Matching Links

Geographic Relation	FSPD Result	TOTAL	AR Result: Duplicate		Nonduplicate		Undetermined	
All Cases	Duplicate	26,574	19,625	73.9%	478	1.8%	6,471	24.4%
	Non-dup.	462,238	730	0.2%	330,274	71.5%	131,234	28.4%
Within A.C.E. Block Cluster[1]	Duplicate	12,001	9,059	75.5%	84	0.7%	2,858	23.8%
	Non-dup.	0	0	N/A	0	N/A	0	N/A
Outside cluster, w/in surrounding blocks	Duplicate	5,901	4,226	71.6%	112	1.9%	1,563	26.5%
	Non-dup.	74	9	12.2%	31	41.9%	34	45.9%
Outside surr. blocks, w/in county	Duplicate	4,362	3,268	74.9%	100	2.3%	994	22.8%
	Non-dup.	8,208	248	3.0%	3,874	47.2%	4,086	49.8%
Outside of county, within state	Duplicate	1,982	1,513	76.3%	104	5.2%	365	18.4%
	Non-dup.	41,692	162	0.4%	26,267	63.0%	15,263	36.6%
Different states	Duplicate	2,328	1,559	67.0%	78	3.4%	691	29.7%
	Non-dup.	412,264	311	0.1%	300,102	72.8%	111,851	27.1%

[1] A block cluster consists of a block or a geographically contiguous group of blocks and housing units. Block clusters were the primary sampling unit for the A.C.E.

Table 2. Clerical Review Results by AR Status for links judged by FSPD statistical matching

Geographic Relation	Statistical matching decision	AR Status	TOTAL	CLERICAL REVIEW RESULT: Duplicate		Nonduplicate		Undetermined	
Same State	Duplicate	All Cases	1,355	1,277	94.2%	56	4.1%	22	1.6%
		Duplicate	893	877	98.2%	3	0.3%	13	1.5%
		Non-dup.	60	22	36.7%	38	63.3%	0	0.0%
		Unresolved	402	378	94.0%	15	3.7%	9	2.2%
	Non-Duplicate	All Cases	1,803	233	12.9%	1,517	84.1%	53	2.9%
		Duplicate	101	86	85.1%	10	9.9%	5	5.0%
		Non-dup.	1,215	21	1.7%	1,176	96.8%	18	1.5%
		Unresolved	487	126	25.9%	331	68.0%	30	6.2%
Different State	Duplicate	All Cases	490	461	94.1%	24	4.9%	5	1.0%
		Duplicate	390	383	98.2%	3	0.8%	4	1.0%
		Non-dup.	12	2	16.7%	10	83.3%	0	0.0%
		Unresolved	88	76	86.4%	11	12.5%	1	1.1%
	Non-Duplicate	All Cases	3,081	99	3.2%	2,934	95.2%	48	1.6%
		Duplicate	88	53	60.2%	30	34.1%	5	5.7%
		Non-dup.	2,513	9	0.4%	2,480	98.7%	24	1.0%
		Unresolved	480	37	7.7%	424	88.3%	19	4.0%

Table 3. AR Status of FSPD Exact Matching Links, by FSPD Exact Matching Probability

FSPD Probability*	Total	FSPD Odds	Administrative Records Status: AR Ratio: dup./ nondup.	Duplicate		Not a duplicate		Undetermined	
0.00-0.10	197	**0 - .11**	**0.14**	22	11.2%	152	77.2%	23	11.7%
0.10-0.20	491	**.11 - .25**	**0.22**	82	16.7%	375	76.4%	34	6.9%
0.20-0.30	459	**.25 - .43**	**0.35**	109	23.7%	315	68.6%	35	7.6%
0.30-0.40	392	**.43 - .67**	**0.62**	138	35.2%	224	57.1%	30	7.7%
0.40-0.50	399	**.67 - 1.0**	**1.2**	190	47.6%	159	39.8%	50	12.5%
0.50-0.60	472	**1.0 - 1.7**	**1.3**	232	49.2%	175	37.1%	65	13.8%
0.60-0.70	351	**1.7 - 2.3**	**1.6**	194	55.3%	124	35.3%	33	9.4%
0.70-0.80	461	**2.3 - 4.0**	**3.0**	303	65.7%	101	21.9%	57	12.4%
0.80-0.90	720	**4.0 - 9.0**	**5.7**	557	77.4%	97	13.5%	66	9.2%
0.90-0.93	648	**9.0 - 13**	**13.**	554	85.5%	44	6.8%	50	7.7%
0.93-0.95	351	**13 - 19**	**24.**	312	88.9%	13	3.7%	26	7.4%
0.95-0.97	814	**19 - 32**	**35.**	725	89.1%	21	2.6%	68	8.4%
0.97-0.98	491	**32 - 49**	**30.**	453	92.3%	15	3.1%	23	4.7%
0.98-0.99	1,097	**49 - 99**	**56.**	1006	91.7%	18	1.6%	73	6.7%
0.99-1.00	16,290	**99 - ∞**	**208.**	15,357	94.3%	74	0.5%	859	5.3%

* Only links assigned a probability greater than 0 are included.

Table 4. Clerical Review Results for AR Links

Type of AR Link	Geographic Relation	TOTAL	CLERICAL REVIEW RESULT: Duplicate		Not a duplicate		Undetermined	
All Links	All Links	4477	2,875	64.2%	1,142	25.5%	460	10.3%
	Different State	1,875	698	37.2%	921	49.1%	256	13.7%
	Same State	2,602	2,177	83.7%	221	8.5%	204	7.8%
AR Only	All Links	1,852	606	32.7%	970	52.4%	276	14.9%
	Different State	1,048	108	10.3%	786	75.0%	154	14.7%
	Same State	804	498	61.9%	184	22.9%	122	15.2%
Not AR Only	All Links	2,625	2,269	86.4%	172	6.6%	184	7.0%
	Different State	827	590	71.3%	135	16.3%	102	12.3%
	Same State	1,798	1,679	93.4%	37	2.1%	82	4.6%

Table 5. Clerical Review Results for AR Links, by Phase of HCUF-Numident Match

Geographic Relation	# of HCUF-Numident Links found in Geokey Search	TOTAL	CLERICAL REVIEW RESULT					
			Duplicate		Not a duplicate		Undetermined	
All Links	All Cases	4,477	2,875	64.2%	1,142	25.5%	460	10.3%
	Both	1,817	1,544	85.0%	120	6.6%	153	8.4%
	One	2,230	1,098	49.2%	880	39.5%	252	11.3%
	None	430	233	54.2%	142	33.0%	55	12.8%
Links Between Different States	All Cases	1,875	698	37.2%	921	49.1%	256	13.7%
	Both	255	191	74.9%	27	10.6%	37	14.5%
	One	1,392	445	32.0%	769	55.2%	178	12.8%
	None	228	62	27.2%	125	54.8%	41	18.0%
Links Within a State	All Cases	2,602	2,177	83.7%	221	8.5%	204	7.9%
	Both	1,562	1,353	86.6%	93	6.0%	116	7.4%
	One	838	653	77.9%	111	13.2%	74	8.8%
	None	202	171	84.7%	17	8.4%	14	6.9%