

Chronologic Overview of the Census 2000 Adjustment Decision

David C. Whitford

Bureau of the Census, Decennial Statistical Studies Division, Washington, DC 20233

Key Words: Census 2000; Accuracy and Coverage Evaluation; census adjustment

What does this article discuss?

In Census 2000 the U.S. Census Bureau conducted a coverage survey called the Accuracy and Coverage Evaluation (A.C.E.). It was completed by the end of the census year 2000. Immediately, the Census Bureau engaged in an extensive evaluation program of the survey, and as a result, decided March of 2001 that the A.C.E. survey should not be used to adjust the apportionment counts: “The Executive Steering Committee for A.C.E. Policy (ESCAP) is unable to conclude, based on the information available at this time, that the adjusted Census 2000 data are more accurate for redistricting.” Further, the committee decided to “continue to investigate these issues and will make the results of this research available....” (ESCAP, March, 2001).

This second round of analyses were undertaken and based on these in October of 2001 the ESCAP stated, “After assessing considerable new evidence, ESCAP now recommends that unadjusted Census 2000 data also be used for nonredistricting purposes.” (ESCAP, October, 2001)

This paper will present a chronological outline of that decision making process.

What evaluations were undertaken?

Nineteen evaluations were undertaken to support the March 2001 decision. These are all available on the census web site (www.census.gov) under the ESCAP heading. In the March ESCAP report these evaluations were presented under the following headings:

- Conduct of Key Operations
 - Census Quality Indicators
 - A.C.E. Quality Indicators
- Demographic Analysis
- Measures of Census and A.C.E. Quality
 - Total Error Model
 - Loss Function Analysis

- Other Factors
 - Synthetic Error
 - Balancing Error
 - Late adds and Imputations
 - Misclassification Error

What were the ESCAP I evaluation results?

Careful review of the evaluations led to the conclusion that census and A.C.E. operations were of high quality. Census operations and programs were completed on time; design upgrades in these programs produced measurable improvements; and staffing and pay innovations led to high quality workers and products.

A.C.E. operations were also similarly successful. The matching process was successfully automated. Computer processing was improved and its quality assured through rigorous testing. The computer assisted personal interview was completed on time. The software allowed better editing and quality assurance. The “evidence indicates that the A.C.E. was a clear operational success.” (Hogan, 2001).

However, demographic analysis (DA) estimates of the population were inconsistent with the adjusted data—especially for some particular population groups. The adjusted data estimated a net undercount of 1.2 percent while DA produced a “base” set of estimates showing a 0.7 percent over count and an “alternative” set having a 0.3 percent undercount.

Demographic analysis uses records of births, deaths, immigration and census tabulations of the foreign born to produce its estimates. The immigration component is the most troublesome. For the March decision, the Census Bureau acknowledged the inconsistency between the DA and A.C.E. estimates and promised to research it further.

The Total Error Model and examination of loss functions are ways to compare the unadjusted and adjusted data. These were studied thoroughly by ESCAP. However, the committee “did not have current results for certain measures of A.C.E. accuracy, and was forced to use 1990 data on potential A.C.E. errors. The

This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a Census Bureau review more limited in scope than that given to official Census Bureau publications. This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress.

ESCAP therefore directed and documented that a number of evaluations be conducted to inform the deliberations.” (ESCAP, March, 2001) Many of the evaluations feeding into the ESCAPII decision arose to meet this need.

Using the 1990 data, neither the Total Error Model and examination of loss functions indicated that the adjusted counts were inferior to the unadjusted. This positive result did not obviate the need to explore the previously mentioned disparity between DA and A.C.E. estimates. Therefore, these comparison vehicles could not be used, by themselves, to justify concluding that adjustment would improve accuracy of Census 2000.

Synthetic error is a factor in understanding coverage estimation results. The synthetic assumption is that “the net census coverage, estimated by the coverage correction factor is relatively uniform within the post-strata. Failures of this assumption lead to synthetic error.” (Griffin, et al., 2001) Griffin and Malec measured synthetic error for the March ESCAP decision. The committee was particularly concerned because synthetic error was not a component of the Total Error Model and the loss functions. Most of the results of the evaluation indicated that correcting for synthetic bias would not change the loss function results. But some results were mixed—showing that synthetic bias could have a noteworthy effect on the loss function results. This result indicated further evaluation was in order.

Geographic balancing error occurs when the P-sample (The “population” sample households completing the A.C.E. interview.) matching error does not agree with the E-sample (The sample of those enumerated in the census.) matching error. The A.C.E. results did, in fact, exhibit a “much greater increase in the match rate (3.8 percent) than the correct enumeration rate (2.9 percent)” (ESCAP, March, 2001) in the blocks surrounding the A.C.E. sample blocks. So, balancing error was suspected and further evaluation was ordered.

Absence of or incomplete names on the census form prohibits matching those names to the A.C.E. These cases are covered in the dual system estimate (DSE) of coverage by treating them as whole person imputations. Likewise late adds (people whose census record was processed too late to be included in the A.C.E. matching) are treated as imputations in the DSE. The number of these cases had increased considerably over the 1990 census numbers, so the ESCAP was particularly interested in their effect on the estimates. The evaluation indicated and the committee agreed that

there did appear to be some geographic clustering of these cases within post-strata. They concluded that this in turn might increase synthetic error, but they did not believe that this level of heterogeneity in poststrata would increase the synthetic error appreciably.

Finally, ESCAP considered misclassification error—when people are put into different post-strata in the census and the A.C.E. The evaluation found that two small groups were significantly affected by this type error: American Indians living off of reservations and Native Hawaiians and Pacific Islanders. The amount of misclassification error was small and was in small population groups. As such it had no effect on the dual system estimates.

What topics were addressed for the ESCAP II decision?

The results above from the evaluations leading to the ESCAP I decision noted some areas that needed more research:

- Demographic analysis
- Synthetic Error
- Balancing Error
- Missing Data Studies
- Total Error Model components
 - Measurement of Census Omissions
 - Measurement of Erroneous Enumeration, Including Duplication

As stated earlier, the ESCAP I committee had to rely on 1990 estimates of error in the Total Error Model results it considered. Several studies were included in the ESCAP II phase to determine (current) error levels from Census 2000 and its A.C.E. These included the Measurement Error Reinterview/Evaluation Followup and the Matching Error Study. These two evaluations and some additional creative work on the topic of duplication were available for the deliberations regarding (respectively) the two topics above: the Measurement of Erroneous Enumeration, Including Duplication and the Measurement of Census Omissions.

What were the final Demographic Analysis results?

As mentioned earlier, the international migration factor in the demographic analysis (DA) needed some further research based on later census tabulations. Additionally, some work needed to be done on vital events counts—like births and deaths.

The Census Bureau decided to call in a nation-wide

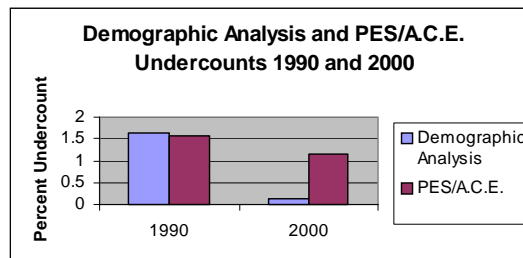
panel of independent experts to assess the estimates. The experts were drawn from academia, state agencies, professional organizations and international organizations in March of 2001. They concurred almost unanimously that the Bureau should concentrate its research on the international migration aspect of the DA estimates.

Between March and October of 2001, the Census Bureau conducted an extensive review of the components of population change used to construct the DA estimates. The research activities were concentrated in two areas: (1) analysis of the administrative records used in the DA estimates (births, deaths, legal international migration, Medicare data), and (2) recalibration of the international migration components (in particular, those components that are least well measured--unauthorized migration, emigration, and temporary migration). The major data set that enabled this review was an early tabulation from Census 2000 on the foreign-born population--this data set was not available in March 2001.

The largest numerical revision to the components of change was for unauthorized immigrants. The revised estimate of the residual foreign born population--a category comprised primarily of the unauthorized population--was 10.24 million, or 1.38 million higher than the implied estimate used in the March Alternative DA population estimate of 282.3 million. However, the estimate of legal immigration decreased by 879,619 and the estimate of births was lowered by 715,181. The net effect of the revisions was to lower the DA estimate of the population by 575,853. (Robinson, 2001)

The September 2001 demographic analysis estimate of the Census 2000 net undercount of the population was 0.3 million or 0.12 percent. This did not agree with the March A.C.E. estimate of a 3.3 million person undercount or 1.15 percent.

The difference between the two estimates was large. In the 1990 Post-Enumeration Survey the two sets of estimates were very close. The following graph exhibits the agreement of the DA and PES in 1990 and the disparity between the DA and A.C.E. estimates in 2000:



What were the results of studies dealing with Balancing Error and Missing Data?

As noted earlier, ESCAP I did suspect that balancing error might be a problem in the A.C.E. In a post-enumeration survey, the expected number of correct enumerations in the blocks surrounding the sample blocks should equal the number of matches in surrounding blocks. (Beaghen, 2001) The A.C.E. found about 3 million more matches in surrounding blocks than correct enumerations.

Immediately after the ESCAP I decision, the Census Bureau mounted field followup efforts to explore the balancing issue. Field representatives checked the location of a sample of census housing units that had been coded as erroneous enumerations to determine if they were inside or outside of the sample block and surrounding ring of blocks. In addition they checked units in the A.C.E. sample to see how often they were mistakenly included in the sample blocks but really existed in a block surrounding the sample block--called A.C.E. sample geocoding error. This effort determined that the major cause of the apparent balancing error derived from this type of geocoding error. Since in A.C.E. matching we searched the surrounding blocks for people, this type of error was insignificant; it had little or no effect on the undercount estimates. (ESCAP, October, 2001)

After the A.C.E. operations were complete, some households still had missing data; all or part of their data items were not captured in the interview(s). The missing items could have been enumeration status, residency (on census day) status or match status. ESCAP II looked at and compared different ways to deal with these missing data. Seven different missing data treatment methods were explored. New undercount estimates were computed for each method.

“The alternatives considered indicated that the choice of

missing data model can have a significant effect on the resulting estimates of coverage error.” (ESCAP, October, 2001)

When the effects of these different models were represented in terms of uncertainty in the A.C.E. estimates, that uncertainty was approximately at the same level as the uncertainty surrounding the estimates themselves (384,000). (Keathley, et al., 2001)

What was the outcome of the research into the Measurement of Census Omissions?

Coverage measurement surveys are dependent on good matching of the A.C.E. sample and the census sample. The Census Bureau conducted two evaluations to measure whether our matching was done correctly: the Matching Error Study and the Evaluation Followup (EFU).

The Matching Error Study determined that matching error caused the A.C.E. to overstate the national population by 385,000 people (due to error in the match rate itself).

However, the matching results were more consistent in 2000 than in the 1990 Post-Enumeration Survey.

- In 1990 the gross PES sample matching error rate (nonmatch to match and match to nonmatch) was 1.55 percent; the net rate was 0.93 percent.
- In Census 2000, the gross rate was 0.46 percent and the net equal to 0.41percent. (Bean, 2001)

The EFU concentrated on the residence status of sampled people--whether they were actually resident in the sample areas on census day, and their mover status--whether they had moved in or out between census day and their A.C.E. interview day.

The Evaluation Followup uncovered error that, for the most part, offset the error found in the Matching Error Study. The EFU showed that misclassification of movers (e.g., people who had just moved in were mistakenly classified as census day residents) resulted in an overstatement of the net undercount by about 450,000 people. (Raglin, et al., 2001)

So, these two studies leave a small net difference of 65,000 people in the undercount estimates. Research continues into these two areas of interest.

What were the results of the Measurement of Erroneous Enumeration, Including Duplication research?

By far the most significant problem found with the A.C.E. survey was that it did not measure a significant portion of erroneous enumerations in the census. Evaluations available for the ESCAP II decision indicated that the A.C.E. had failed to identify 3 to 4 million people. (ESCAP, October, 2001) This error played a large role in the ESCAP decision in October to use the unadjusted data for Census 2000 non-redistricting purposes.

The Evaluation Followup study and the Person Duplication evaluations played a significant role in this finding. Initially, the EFU indicated a large number of erroneous enumerations had been missed by the A.C.E. These findings were immediately and carefully reviewed. Additionally, evaluations of person duplication in the census were pursued. They found even more duplicate enumerations that had not been perceived by the A.C.E. or the Evaluation Followup.

The Evaluation Followup gave the Census Bureau the first indication that there was a problem with erroneously enumerated people. It found an additional 1,900,000 people who were erroneously enumerated more than the 4,200,000 found by the A.C.E. In addition, the EFU found about 4,500,000 cases that could not be resolved. (Krejsa, 2001)

Because of the “potentially significant implications” of these estimates, the Census Bureau undertook a very careful review of the EFU data and design. A “review sample” was chosen and the matching for it done over again. This time the matching was done by our most experienced clerks at the National Processing Center in Jeffersonville, Indiana. They detected some changes from the production matching. The revised estimate from their review was 1,450,000 more erroneously enumerated people. Additionally, the review took a conservative approach to coding difficult cases and concluded that there were over 15 million people who could not be resolved or for which conflicting data had been collected.

Simultaneously, person duplication evaluations were taking place. For the first time these studies applied computer matching to the entire nation.

Matches were done that looked for all duplicates in the nation and looked nationally for duplicates of the A.C.E. sample cases. Since the A.C.E. had done a complete

(i.e., including clerical work) search for duplicates within the sampled areas and their surrounding blocks, the national computer-only duplicate search results could be compared to the A.C.E. results to provide a measure of its efficiency.

The rough error in the A.C.E. estimates due to the measurement of erroneous enumeration, including duplication, could be approximated by combining the EFU results with the duplication studies results. The estimate of error not measured in the A.C.E. was about 3 million persons. Additionally, combining the EFU and duplication studies allowed an estimate of 800,000 more errors in the large pool of unresolved and conflicting cases. "Thus, the approximate range of potential overstatement of the net undercount was reduced to between 3 and 4 million persons." (ESCAP, October, 2001)

(The results of the EFU review and of the person duplication studies are presented in other papers in this session.)

What was the ESCAP II October, 2001 recommendation?

As a result of these studies, "The ESCAP now recommends that unadjusted Census 2000 data also be used for non-redistricting purposes. The effect of this new evidence is that the Accuracy and Coverage Evaluation (A.C.E.) overstated the net undercount by at least 3 million persons." (ESCAP, October, 2001)

What work is being done to revise the A.C.E. estimates?

The Census Bureau is pursuing updating the A.C.E. estimates (These are called the Revised A.C.E. estimates.) by using what has been learned in the evaluations. It is possible that revised estimates could be used to improve the bureau's intercensal estimates program or for survey controls.

In addition, this work is central to planning for 2010. Since, using nationwide computer matching, the Census Bureau is finding more duplicates than our coverage measurement surveys have previously uncovered, then this research needs to be completed to inform future census taking efforts.

The Census Bureau did use the review sample of 17,000 people to produce a "Revised Early Approximation" of Census 2000 coverage. (Thompson, et al., 2001) The estimation procedure combined the EFU and duplication

studies. The bureau is planning on using this general estimation methodology for the Revised A.C.E. estimates. Additionally, the Revised A.C.E. estimates will deal with some other challenge that have arisen as a result of our evaluation efforts.

- The estimates will incorporate a rework of A.C.E. match codes for all the cases in the EFU sample. So the sample size will be about 70,000 people. This will help stabilize the estimates.
- Preliminary analysis of the results of this rework indicate that the unresolved cases will be dramatically reduced. Carefully thought out missing data models will be applied to the remaining unresolved or conflicting cases.
- The national count of duplicates in the census will be identified using a more refined matching algorithm. Census 2000 was the first attempt at nationwide duplicate searching. Many problems have been identified and solved.
- Correlation bias has never been accounted for in previous coverage measurement surveys. Census 2000, though, appears to have had a very small net undercount. So, correlation bias becomes more important. The Census Bureau may incorporate a correlation bias correction in the Revised ACE estimates.
- Since duplication is playing a larger role in the census error structure, factors relating to over count might well be different from those relating to undercount. For the Revised A.C.E. estimates the bureau is considering separate post-stratification factors for the A.C.E. census sample and A.C.E. sample.

We should note finally that the Revised A.C.E. estimates may or may not provide any improvement to the Census Bureau's population estimates. The variance of these estimate is unknown at this time as is the quality of the results from the methodology outlined above. To assess the estimates we well be examining these variances and other measures of the quality of the results. In any case, with these estimates the bureau will have completed its research into person coverage of Census 2000.

References

Beaghen, M., "Accuracy and Coverage Evaluation: TES Balancing," DSSD Census 2000 Procedures and Operations Memorandum Series, T-12, March, 2001.

Bean, S., "ESCAP II: Accuracy and Coverage Evaluation Matching Error, Report 7," October, 2001.

ESCAP, "Report of the Executive Steering Committee for A.C.E. Policy," March, 2001.

ESCAP, "Executive Steering Committee for Accuracy and Coverage Evaluation Policy on Adjustment for Non-Redistricting Uses," October, 2001.

Griffin, R., Malec, D., "Accuracy and Coverage Evaluation: Assessment of Synthetic Assumption," DSSD Census 2000 Procedures and Operations Memorandum Series B-14, March, 2001.

Hogan, H., "Data and Analysis to Inform the ESCAP Report," DSSD Census 2000 Procedures and Operations Memorandum Series B-1, March, 2001.

Keathley, D., Kearney, A., Bell, W., "ESCAP II: Analysis of Missing Data Alternatives for the Accuracy and Coverage Evaluation, Report 12" October, 2001.

Krejsa, E., Raglin, D., "ESCAP II: Evaluation Results for Changes in A.C.E. Enumeration Status, Report 3," October, 2001.

Robinson, G., "ESCAP II: Demographic Analysis Results, Report 1," October, 2001.

Raglin, D., Krejsa, E., "ESCAP II: Evaluation Results for Changes in Mover and Residence Status in the A.C.E.," October, 2001.

Thompson, J., Waite, P.J., Fay, R., "Basis of 'Revised Early Approximation' of Undercounts Released Oct. 17, 2001," October, 2001.