UNITED STATES DEPARTMENT OF COMMERCE
Economics and Statistics Administration
U.S. Census Bureau
Washington, DC 20233-0001

December 31, 2002

DSSD A.C.E. REVISION II MEMORANDUM SERIES #PP- 49

MEMORANDUM FOR Donna Kostanich
Chair, A.C.E. Revision II Planning Group

From: Mary Mulry DK for MM
Chair, A.C.E. Revision II Assessment Subgroup

Prepared by: Richard A. Griffin
Chief, Estimation Staff

Subject: A.C.E. Revision II - Analysis of the Synthetic Assumption

The attached document was prepared to assist in assessing the Accuracy and Coverage Evaluation (A.C.E.) Revision II estimates. This has been a team effort by DSSD and SRD. The major contributors have been Don Malec and Jerry Maples of SRD and Bob Sands and Rick Griffin of DSSD.

This report focuses on the Synthetic Assumptions for the A.C.E. Revision II. The analysis deals with errors in A.C.E. Revision II synthetic estimates computed for geographic areas smaller than post-strata, specifically states, counties, and places.

A.C.E. Revision II Analysis of the Synthetic Assumption

Richard Griffin
Decennial Statistical Studies Division

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Executive Summary

The A.C.E. Revision II estimation methodology produces estimated coverage correction factors for each of the post-strata. These factors are applied or carried down within the post-strata to smaller levels of geography to produce sub-national estimates. This process is referred to as synthetic estimation. The key assumption underlying this methodology is that the net census coverage, estimated by the coverage correction factor is relatively uniform within the post-strata. Failure of this assumption lead to synthetic error.

It is important to understand that the design underlying the synthetic estimation methodology is directed at correcting for a systematic under or over count in the census. The synthetic estimates will not result in the correction of random counting errors that occur for any entity (blocks, tracts, counties, etc). Therefore, the synthetic estimate will not result in extreme changes in small geographic entities, nor will it correct for extreme errors. It is designed to remove the effects of systematic errors so that when small entities are aggregated, systematic and differential coverage errors are corrected.

We are concerned with synthetic error since it is not included directly in the bias estimates used in the loss function analysis. Furthermore, synthetic error cannot be estimated directly since this would require more sample observations for the A.C.E. Revision II than practical. The analysis of the effects of synthetic error are based on the construction of "artificial populations." These are populations that are created with surrogate variables that are known for the entire population, and are developed to reflect the distribution of net coverage error. An analysis of these populations for the effect of synthetic error is the basis on which this otherwise unknown effect is studied.

We assessed the level of bias in A.C.E. Revision II synthetic estimates at the state, county, and place levels. This involved defining the components of error in the synthetic estimate, creating artificial populations to estimate one of these components, and estimating the other component by obtaining post-stratum Dual System Estimate levels of bias from the A.C.E. Revision II Error Model.

1. Synthetic assumption

The synthetic assumption states that net census coverage does not vary within post-strata. For example, the synthetic assumption implies that net coverage in St. Louis, Missouri in a given post-stratum is the same as net coverage in the same post-stratum but in Milwaukee, Wisconsin.

2. Synthetic estimates

A synthetic estimate of population is the sum over post-strata for a particular geographic area of interest of the post-stratum census coverage correction factor times the post-stratum census count for that area.

3. Components of error in synthetic estimates

The bias of a synthetic estimate for a geographic area can be split into two components: (1) Bias due to applying the same coverage correction factor to areas with different net coverage and (2) Bias in the Dual System Estimate (DSE). Note that for A.C.E. Revision II the DSEs have been adjusted for correlation bias (The adjustment assumes no correlation bias for females and is an estimate under a model. A.C.E. Revision II estimates still have correlation bias but it is reduced due to the adjustment).

4. Estimation of components of bias

The synthetic bias due to differing net coverage is estimated using artificial populations. The bias due to DSE is estimated by obtaining the post-stratum-level bias in the DSE from the A.C.E. Revision II Error Model and distributing it to small areas in proportion to their census counts (or the value of their surrogate variable).

5. Artificial populations

We want to compare the synthetic estimates and the census counts for geographic areas to the true counts. However, we do not know the true population for a geographic area such as a state. Surrogate variables correlated with undercount and/or overcount which are available for small areas are used to create artificial populations. The known population counts for these surrogate variables are used to scale post-stratum-level weighted nonmatches and weighted erroneous enumerations to produce target or true population counts.

Artificial populations, thus, involve surrogate variables, not the real variable of interest. This is a limitation to consider when examining these results.

6. Relative bias in state synthetic estimates of total persons

The average relative bias in the state synthetic estimates is less than 1 percent for all six artificial populations.

7. Relative bias in county (100,000+ Pop.) synthetic estimates of total persons

The median relative bias in the county (100,000+ Pop.) synthetic estimates is less than 1 percent for all six artificial populations.

8. Loss function analysis

The loss Function Analysis does not include a measure of error due to the synthetic assumption. The effect of this bias on the loss function results is as follows:

A synthetic bias correction does not change the loss function results for any geographic grouping

and artificial population for :

- estimates of shares
- level (i.e., count) estimates for counties with population 100,000 or less
- level estimates for counties with population greater than 100,000
- level estimates for places with population at least 25,000 but less than 50,000.

For estimates of level for places with population at least 50,000 but less than 100,000, the synthetic bias correction for one of the four artificial populations analyzed changes the loss function decision from in favor of A.C.E. Revision II to in favor of the census.

For estimates of level for places with population greater than 100,000, the synthetic bias correction for one of the four artificial populations analyzed changes the loss function decision from in favor of the census to in favor of A.C.E. Revision II.

9. Limitations

- No artificial population provides the true population count for any geographic area.
- This analysis assumes no correlation bias in A.C.E. Revision II estimates. However, there is undoubtably residual correlation bias remaining after the correlation bias adjustment.
- There are probably other biases not reflected in the bias estimates used in the loss function analysis and thus not reflected in this analysis.
- The analysis did not account for synthetic variance

1. Background

The goal of the A.C.E. Revision II. Assessment of the Synthetic Assumption is to (1) estimate bias in synthetic estimates for states and counties of population 100,000 or greater and (2) correct loss function study output for synthetic estimation bias. Point (2) is necessary because the loss function analysis does not include an error component for failure of the synthetic assumption.

Similar assessments of the Synthetic Assumption were done for the original Census 2000 A.C.E. estimates produced in March 2001.

2. METHODOLOGY

This study answers the following questions:

- How much bias is there in A.C.E. Revision II synthetic estimates for states and counties of population 100,000 or more?

  For each state and county with a population of 100,000 or more, the synthetic population bias, post-stratum level DSE bias, total bias, and relative bias will be computed. Synthetic population bias will be compared with post-stratum level DSE bias.

- What is the effect of a synthetic bias correction on loss function results for A.C.E. Revision II?

  The loss function analysis will compute the census loss minus the A.C.E. Revision II loss for eleven groups of geographic areas. For each of the 11 groups the synthetic bias correction will be computed for each of six artificial populations. Thus, for each of 66 combinations of geographic group and artificial population, we will determine if a synthetic bias correction changes the loss function decision.

2.1 Bias in Synthetic Estimates

The two components of error in synthetic estimates are: (1) **Synthetic population bias** due to applying the same coverage correction factor to areas with different net census coverage and (2) **Bias in the post-stratum level Dual System Estimate** (DSE). Synthetic bias will be measured for states and counties with greater than 100,000 population. For this study post-stratum refers to an "estimation cell" which is a cross of an E-sample and P-sample post-stratum. The decomposition of the error in a synthetic estimate into these two components is shown in the Appendix.

The basic methodology used to estimate the synthetic population bias component of synthetic error is artificial populations. We will use the same surrogate variables used for the previous

synthetic error assessments. These are shown in Table 1. Note that the correlations used to select these variables were computed using the original A.C.E. weighted P-sample non-matches and E-sample erroneous enumerations. We will not do a new analysis using A.C.E. Revision II results to potentially choose different surrogate variables. The methodology for forming the artificial population counts is shown in the Appendix.

For each of the six artificial populations for each state level (i.e. estimated count) and county level (only counties greater than 100,000 estimated count), both components of error in synthetic estimates are computed as well as the ratio of the synthetic population bias to the post-stratum level DSE bias.

2.2 Effect of Synthetic Error on the Weighted Squared Error Loss Function Analysis

The loss function analysis, employed by the Census Bureau, does not, traditionally, include an error component for the failure of the synthetic assumption. An expression for a bias correction to a weighted squared error loss function difference, Loss(Census) - Loss(A.C.E. Revision II), is shown in the Appendix. This bias correction term can be added to loss function results to correct for the bias of excluding synthetic error in the loss function target estimates. The interpretation of the bias correction term is most relevant in terms of the sign of the squared error loss function difference. If the loss function difference is positive, indicating A.C.E. Revision II is favorable, only a negative bias correction can change this making A.C.E. Revision II not favored. Similarly, if the difference is negative, indicating A.C.E. Revision II is not favored, this can be reversed only if the bias correction is positive. The amount of bias being added or subtracted must be larger than the absolute difference to reverse the outcome.

For A.C.E. Revision II there will be one loss function for each grouping detailed in Table 2. The sum of the weighted squared error loss function difference over geographic entities in the group, Loss(Census) - Loss(A.C.E. Revision II), will be provided as input to this evaluation.

Notation:
D = Loss(Census) - Loss(A.C.E. Revision II)
B = synthetic bias correction term
B/D = relative bias in D due to loss functions not including a synthetic error component
D + B = Bias corrected loss function difference.

For each of the six artificial population, for each grouping in Table 2, D, B, B/D, and D + B is produced. Thus, for a given grouping and artificial population we know if the synthetic bias correction would change a loss function decision.

Table 1: Surrogate Variables used to Create Artificial Populations

	Correlations (weighted analysis from original A.C.E.)	Undercount Surrogate	Overcount Surrogate	Correction for DSE bias proportional to:
Artificial Population 1	0.26	# non-substituted persons in households	#persons for whom reported date of birth and reported age were consistent (allocation not required)	Census Counts
Artificial Population 2	0.27	# non-substituted persons in households	# non-substituted persons in households	Census Counts
Artificial Population 3	0.26	# persons with 2 or more items allocated	#persons for whom reported date of birth and reported age were consistent (allocation not required)	Census Counts
Artificial Population 4	0.25	# persons whose household did not mail back the questionnaire	# persons whose household did not mail back the questionnaire	Census Counts
Artificial Population 5	0.27	# non-substituted persons in households	# non-substituted persons in households	Surrogate Variable
Artificial Population 6	0.25	# persons whose household did not mail back the questionnaire	# persons whose household did not mail back the questionnaire	Surrogate Variable

Household Persons only (Group Quarters Persons are Excluded)

Table 2 : Groupings for the loss functions*

Levels (i.e., count)
All Counties with population of 100,000 or less
All Counties with population greater than 100,000
All places with population at least 25,000 but less than 50,000
All places with population at least 50,000 but less than 100,000
All places with population greater than 100,000
Shares within state
All Counties
All places
Shares within U.S.
All places with population at least 25,000 but less than 50,000
All places with population at least 50,000 but less than 100,000
All places with population greater than 100,000
All states

*Loss functions are weighted. The weight is the reciprocal of the census count in the area.

3. Limitations

- Artificial populations were created using surrogate variables, available for small areas, correlated with gross undercount and/or gross overcount. The surrogate variables are not the variable of interest and the correlations of the selected surrogates were smaller than we would have preferred. No artificial population provides the true population count for any geographic area.

- The correlations used to select the artificial population surrogate variables were computed using the original A.C.E. data. We did not do a new analysis using A.C.E. Revision II results to potentially chose different surrogate variables.

4. Results

4.1 Levels of the components of bias in synthetic estimates for states

Tables 3, 4, 5, 6, 7, and 8 give the components of bias in the synthetic estimates for State levels for Artificial Populations 1, 2, 3, 4, 5 and 6 respectively. Column (1), SynB, is the synthetic population bias and column (2), DSEB, is the DSE level bias. Column (3) is the absolute value of the ratio of SynB to DSEB. Column (4) is the absolute relative total bias in the state synthetic estimate of level. The average and maximum value for columns (3) and (4) are displayed at the bottom of the Table.

The results for Artificial Populations 2 and 5 are almost identical as the results for Artificial

Populations 4 and 6. In each case these are different artificial populations but they are highly correlated. The difference is that for Artificial Populations 2 and 4 the DSE bias is allocated to states proportional to the census count and for Artificial Populations 5 and 6 the DSE bias is allocated proportional to the surrogate variable. The same surrogate variable is used for undercount and overcount for these artificial populations. In each case the surrogate variable is highly correlated with the census count. Thus, for analysis and discussion purposes, we will consider only Artificial Populations 1, 2, 3, and 4.

Artificial Populations 1 and 2 each have average absolute ratios of the synthetic population bias to the post-stratum DSE bias that are less than 0.1 (0.082 and 0.041 respectively) and a maximum ratio of less than 0.21 (0.210 and 0.124 respectively). For Artificial Population 3 the average of this absolute ratio is about 0.868 and the maximum is about 2.22. For Artificial Population 4 the average of this absolute ratio is about 1.23 and the maximum is about 9.89.

Artificial Populations 1, 2, 3, and 4 all have average absolute relative bias in the synthetic estimate less than 0.01 and maximum absolute relative bias less than 0.04.

4.2 Levels of the components of bias in synthetic estimates for counties (100,000 population +)

Table 9 provides the minimum, median, and maximum value over the 524 counties with population greater than 100,000 for each of the 6 artificial populations for

- the absolute ratio of synthetic population bias to post-stratum level DSE bias

- the absolute relative bias in synthetic estimates

For Artificial Populations 1 and 2 the median absolute ratio of the synthetic population bias to the post-stratum level DSE bias is less than 0.15 (0.14 and 0.06 respectively). For Artificial Populations 3 and 4 the median of this absolute ratio is greater than 1.2 (1.23 and 1.71 respectively).

Artificial Populations 1, 2, 3, and 4 all have median absolute relative bias in the synthetic estimate less than 0.011. The maximum absolute relative bias is less than 0.04 for Artificial Populations 1, 2, and 3. For Artificial Population 4, the maximum absolute relative bias is much larger at 0.48.

4.3 Effect of synthetic error on weighted squared error loss function analysis

The loss function analysis does not include an error component for the failure of the synthetic assumption. An expression for a bias correction to a squared error loss function difference, Loss(Census) - Loss(A.C.E. Revision II), is shown in the Appendix. This bias correction term can be added to loss function results to correct for the bias of excluding synthetic error in the loss function target estimates. The interpretation of the bias correction term is most relevant in terms of the sign of the squared error loss function difference. If the loss function difference is positive,

indicating A.C.E. Revision II is favored, only a negative bias correction can change this making A.C.E. Revision II not favored. Similarly, if the difference is negative, indicating A.C.E. Revision II is not favored, this can be reversed only if the bias correction is positive. The amount of bias being added or subtracted must be larger than the absolute difference to reverse the outcome.

Tables 10 through 20 show the bias correction term for each of the 11 geographic groups shown in Table 2. In each table results are shown for each of the six artificial populations. Column (1) is the census squared error loss minus the A.C.E. Revision II squared error loss. This has a bias due to excluding synthetic error. Column (2) is the synthetic bias correction term. Column (3) is the relative bias (column (2) / column (1)). Column (4) is the bias corrected loss function difference (column (1) + column (2)).

For level estimates for counties with a population of 100,000 or less (Table 10) all of the artificial populations have a positive bias correction less than 11 percent. Thus the loss function analysis is conservative in that the bias correction would make A.C.E. Revision II even more favored.

For level estimates for counties with a population greater than 100,000 (Table 11), Artificial Population 1 has a -4.7 percent bias correction which is much smaller than the loss function difference and would thus not change the loss function decision in favor of A.C.E. Revision II. All the other artificial populations have a conservative positive bias correction also not changing the loss function decision in favor of A.C.E. Revision II.

For level estimates for places with a population at least 25,000 but less than 50,000 (Table 12), Artificial Population 4 has about a -15 percent bias correction which is smaller than the loss function difference and would thus not change the loss function decision in favor of A.C.E. Revision II. All the other artificial populations have a conservative positive bias correction also not changing the loss function decision in favor of A.C.E. Revision II.

For level estimates for places with a population at least 50,000 but less than 100,000 (Table 13), the bias correction is positive for one of the four artificial populations analyzed and the loss function analysis is conservative. For Artificial Populations 1 and 3, the bias correction is negative (-12.05 percent and -10.81 percent respectively) but much smaller than the loss function difference and would not change the decision in favor of A.C.E. Revision II. However, for Artificial Population 4 the bias correction is about -150 percent and would thus change the loss function decision from in favor of A.C.E. Revision II to in favor of the census.

For level estimates for places with a population greater than 100,000 (Table 14), the loss function difference is negative indicating a decision in favor of the census. This is the only geographic grouping from Table 2 with this loss function result. Artificial Population 1 has a 27.35 percent relative bias correction which would strengthen the decision in favor of the census. For Artificial Population 2 the relative bias is about -6 percent and would not change the loss function decision. For artificial population 3, the relative synthetic bias correction is nearly -80 percent which, although large, would still not change the loss function decision in favor of the census. However,

for Artificial Population 4 the bias correction is about -500 percent and would thus dramatically change the loss function decision from in favor of the census to in favor of A.C.E. Revision II.

For all groupings for share estimates from Table 2 (Tables 15, 17, 18, 19, and 20), the synthetic bias correction is negligible (0.00 percent rounded to two decimal places) so that the synthetic bias correction would not change any of the loss function decisions, which were all in favor of A.C.E. Revision II. Note that loss function results for place shares within state (Table 16) were not available in time for this results document. The artificial population bias correction estimates are provided.

5. Conclusions

! The bias of a synthetic estimate can be split into two components: (1) the synthetic population bias due to carrying the post-stratum level net coverage adjustment down to sub-national levels and (2) bias in the post-stratum level DSE including correlation bias. For states the average bias in synthetic estimates ranges from about 0.5 percent to 0.8 percent. For counties the median bias in synthetic estimates ranges from about 0.4 percent to 1.0 percent.

! Two of four artificial populations analyzed show the synthetic population bias to be much less than the post-stratum level DSE bias for both states and counties with population of 100,000 or more. For the other two artificial populations the median of the absolute ratio of synthetic population bias to the post-stratum level DSE bias is close to 1 or greater than 1.

! For all geographic groups for estimates of shares, the synthetic bias correction is negligible and would not change any loss function decisions.

! For estimated levels (i.e., counts) for counties with population 100,000 or less, counties with population greater than 100,000 and places with population at least 25,000 but less than 50,000 and for all four artificial populations used for analysis either

(1) A negative synthetic bias correction in the census loss minus the A.C.E. Revision II loss is necessary to correct a loss function result that is in favor of the A.C.E. Revision II). This means that the loss function analysis overestimates the true gains from A.C.E. Revision II. However, in all these cases the bias corrections are negative by only small amounts relative to the loss function analysis results, so that correcting for this bias would not change the loss function results to favor the census, or

(2) The bias correction is positive and the results of the loss function analysis remain favorable to A.C.E. Revision II.

! For level estimates for places with population at least 50,000 but less than 100,000 the loss function analysis is in favor of A.C.E. Revision II. and for three of the four artificial

populations used for analysis either point (1) or point (2) from the bullet above are applicable so that the synthetic bias correction does not change loss function decisions. However for Artificial Population 4 the relative synthetic bias correction is about -150 percent and changes the loss function decision from in favor of A.C.E. Revision II to in favor of the census.

! For level estimates for places with population greater than100,000 the loss function analysis is in favor of the census and for three of the four artificial populations used for analysis either point (1) or point (2) from the bullet above are applicable so that the synthetic bias correction does not change loss function decisions. However for Artificial Population 4 the relative synthetic bias correction is about -500 percent and changes the loss function decision from in favor of the census to in favor of A.C.E. Revision II.

6. References

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Table 3: State Level Synthetic Bias Using Artificial Population 1

State	*(1) SynB*	*(2) DSEB*	*(3) ABS(SynB/DSEB)*	*(4) ABS((SynB+DSEB))/N*
Alabama	4001.1581	19066.748	0.2098501	0.0052319
Alaska	-504.8856	3911.2727	0.1290847	0.005447
Arizona	-900.1393	30129.345	0.0298758	0.0057482
Arkansas	1006.6893	11695.058	0.0860782	0.0047783
California	-30320.41	213756.53	0.1418455	0.005438
Colorado	-2258.765	21149.269	0.1068011	0.0044116
Connecticut	-1011.925	14554.71	0.0695256	0.0040225
Delaware	306.98191	3154.7908	0.0973066	0.0044515
D.C.	375.5114	4028.6755	0.0932096	0.0076385
Flordia	-6495.442	76571.764	0.0848282	0.0044323
Georgia	-1276.545	39639.878	0.0322036	0.0046956
Hawaii	130.98717	11765.671	0.011133	0.0098947
Idaho	-251.9019	5148.1537	0.0489305	0.0038139
Illinois	-128.9524	55021.154	0.0023437	0.0045029
Indiana	2946.481	22634.914	0.1301742	0.0042954
Iowa	-701.77	9850.3747	0.071243	0.0031815
Kansas	646.20171	10855.309	0.0595286	0.0043517
Kentucky	2497.2972	15299.518	0.1632272	0.0044439
Louisiana	3006.6801	21300.416	0.1411559	0.0054735
Maine	67.209857	5660.7868	0.0118729	0.0045673
Maryland	3021.7925	22819.029	0.1324242	0.0048907
Massachusetts	2900.6996	25791.822	0.1124659	0.0045855
Michigan	-2376.522	35335.202	0.0672565	0.003359
Minnesota	783.09791	15260.598	0.051315	0.0033276
Mississippi	2424.4566	13363.906	0.1814183	0.0056043
Missouri	-270.3529	21209.418	0.0127468	0.0038071
Montana	-688.3688	4508.2121	0.1526922	0.0042312
Nebraska	-384.5535	6510.9441	0.0590626	0.0036219
Nevada	1817.6317	13139.997	0.1383282	0.0075041
New Hampshire	625.89553	4746.5581	0.131863	0.0044167
New Jersey	-1412.635	39284.359	0.0359592	0.0045448
New Mexico	1626.424	14203.129	0.1145117	0.0087769
New York	-2083.315	105856.42	0.0196806	0.0055125
North Carolina	-278.7612	37909.769	0.0073533	0.0047041
North Dakota	238.85379	2173.049	0.1099164	0.0038238
Ohio	-5229.016	42267.146	0.1237135	0.0033149
Oklahoma	288.75255	17618.46	0.0163892	0.0052268
Oregon	-187.8145	15610.021	0.0120317	0.004544
Pennsylvania	2149.5551	48811.68	0.0440377	0.0042051
Rhode Island	-24.73831	5186.0959	0.0047701	0.0050044
South Carolina	-336.0514	17770.547	0.0189106	0.0043805
South Dakota	125.51873	2632.0958	0.0476878	0.0037139
Tennessee	3681.5066	22287.719	0.1651809	0.0046044
Texas	26280.579	130780.29	0.2009521	0.0075856
Utah	-1743.341	8898.9515	0.1959041	0.0032177
Vermont	-50.14785	2886.1564	0.0173753	0.0047328
Virginia	377.64213	28851.972	0.013089	0.004135
Washington	-1945.577	26824.71	0.0725293	0.004248
West Virginia	-662.0913	6374.6717	0.1038628	0.0031923
Wisconsin	-152.7594	19224.481	0.0079461	0.0036222
Wyoming	349.17436	2326.5167	0.1500846	0.0054699
Average			0.0822518	0.004786
Maximum			0.2098501	0.0098947

Table 4: State Level Synthetic Bias Using Artificial Population 2

State	(1) SynB	(2) DSEB	(3)ABS(SynB/DSEB)	(4) ABS((SynB+DSEB)/N)
Alabama	-1565.956	19066.748	0.0821302	0.0039642
Alaska	413.07587	3911.2727	0.1056116	0.0069251
Arizona	-1611.699	30129.345	0.0534927	0.0056075
Arkansas	566.81425	11695.058	0.0484661	0.0046121
California	1629.4099	213756.53	0.0076227	0.0063912
Colorado	-644.0897	21149.269	0.0304545	0.0047905
Connecticut	537.52053	14554.71	0.036931	0.0044848
Delaware	-391.4691	3154.7908	0.1240872	0.0035501
D.C.	-241.769	4028.6755	0.060012	0.0065609
Flordia	-647.9579	76571.764	0.0084621	0.0048039
Georgia	-1783.378	39639.878	0.0449895	0.0046333
Hawaii	81.81521	11765.671	0.0069537	0.0098534
Idaho	221.49755	5148.1537	0.0430247	0.0041842
Illinois	773.40041	55021.154	0.0140564	0.0045773
Indiana	-1863.738	22634.914	0.0823391	0.0034849
Iowa	271.99347	9850.3747	0.0276125	0.0035213
Kansas	436.32898	10855.309	0.040195	0.004272
Kentucky	1289.2019	15299.518	0.0842642	0.004141
Louisiana	-100.6912	21300.416	0.0047272	0.0047704
Maine	523.62177	5660.7868	0.0924998	0.004933
Maryland	-1674.34	22819.029	0.0733747	0.0039983
Massachusetts	2121.2748	25791.822	0.082246	0.0044603
Michigan	1046.8107	35335.202	0.0296252	0.0037092
Minnesota	-4.90903	15260.598	0.0003217	0.0031637
Mississippi	800.50214	13363.906	0.0599003	0.005025
Missouri	695.32821	21209.418	0.0327839	0.0039834
Montana	243.70345	4508.2121	0.0540577	0.0052691
Nebraska	119.25535	6510.9441	0.0183161	0.003921
Nevada	-518.8975	13139.997	0.0394899	0.0063245
New Hampshire	-86.49243	4746.5581	0.0182221	0.0038288
New Jersey	897.34808	39284.359	0.0228424	0.0048233
New Mexico	-334.9711	14203.129	0.0235843	0.0076811
New York	-7494.535	105856.42	0.0707991	0.0052235
North Carolina	1636.967	37909.769	0.0431806	0.0049448
North Dakota	67.637949	2173.049	0.0311258	0.0035514
Ohio	2349.7838	42267.146	0.0555936	0.0039959
Oklahoma	990.53061	17618.46	0.0562212	0.0054328
Oregon	971.2402	15610.021	0.062219	0.0048872
Pennsylvania	264.52468	48811.68	0.0054193	0.0040489
Rhode Island	-161.468	5186.0959	0.0311348	0.0048712
South Carolina	62.913396	17770.547	0.0035403	0.0044812
South Dakota	15.521373	2632.0958	0.005897	0.0035652
Tennessee	1137.3053	22287.719	0.0510283	0.0041514
Texas	-3360.65	130780.29	0.0256969	0.0061453
Utah	622.03431	8898.9515	0.0698997	0.004286
Vermont	27.926597	2886.1564	0.0096761	0.0048637
Virginia	158.20372	28851.972	0.0054833	0.0041039
Washington	1198.8893	26824.71	0.0446935	0.0047875
West Virginia	629.97018	6374.6717	0.0988239	0.0039172
Wisconsin	-344.6757	19224.481	0.017929	0.0035856
Wyoming	29.334114	2326.5167	0.0126086	0.0048129
Average			0.0409611006	0.004699584
Maximum			0.1240872	0.0098534

Table 5: State Level Synthetic Bias Using Artificial Population 3

State	(1) SynB	(2) DSEB	(3) ABS(SynB/DSEB)	(4) ABS((SynB+DSEB)/N)
Alabama	-4582.413	19066.748	0.2403353	0.0032787
Alaska	7405.3477	3911.2727	1.8933345	0.0183278
Arizona	-13052.53	30129.345	0.4332165	0.0033503
Arkansas	-7744.027	11695.058	0.6621624	0.0014815
California	-293841.5	213756.53	1.3746548	0.0023557
Colorado	3733.8424	21149.269	0.1765471	0.0058192
Connecticut	-1310.25	14554.71	0.0900224	0.0039335
Delaware	2780.1897	3154.7908	0.8812596	0.0076561
D.C.	-8211.133	4028.6755	2.0381717	0.0071475
Flordia	47313.708	76571.764	0.6179002	0.0078625
Georgia	-83974.38	39639.878	2.1184319	0.0053721
Hawaii	14806.659	11765.671	1.2584627	0.0223738
Idaho	2892.0446	5148.1537	0.5617635	0.0062782
Illinois	28861.739	55021.154	0.5245571	0.0068975
Indiana	16837.311	22634.914	0.7438646	0.0066433
Iowa	14233.895	9850.3747	1.4450105	0.0084192
Kansas	4980.3698	10855.309	0.4587958	0.0060015
Kentucky	29086.726	15299.518	1.9011532	0.0111575
Louisiana	35312.94	21300.416	1.6578521	0.0128417
Maine	5139.2081	5660.7868	0.9078611	0.0086465
Maryland	16041.372	22819.029	0.7029822	0.007373
Massachusetts	-21684.91	25791.822	0.8407668	0.0006538
Michigan	-27993.11	35335.202	0.7922158	0.0007463
Minnesota	13518.556	15260.598	0.8858471	0.0059849
Mississippi	-1377.026	13363.906	0.1030407	0.0042492
Missouri	6537.7578	21209.418	0.3082479	0.0050512
Montana	-730.7752	4508.2121	0.1620987	0.0041841
Nebraska	8872.3061	6510.9441	1.3626758	0.0091447
Nevada	-3892.976	13139.997	0.2962692	0.0046259
New Hampshire	978.14004	4746.5581	0.2060735	0.0047077
New Jersey	20323.803	39284.359	0.517351	0.0071719
New Mexico	-890.784	14203.129	0.0627174	0.007371
New York	-47656.45	105856.42	0.4501989	0.0030841
North Carolina	38849.919	37909.769	1.0247997	0.0096426
North Dakota	4828.5217	2173.049	2.2220031	0.0111815
Ohio	21586.583	42267.146	0.5107178	0.0057286
Oklahoma	25078.066	17618.46	1.4233972	0.0125533
Oregon	-889.4394	15610.021	0.0569787	0.0043364
Pennsylvania	-24572.9	48811.68	0.5034226	0.0019957
Rhode Island	-955.7003	5186.0959	0.1842813	0.004098
South Carolina	18032.192	17770.547	1.0147235	0.0090374
South Dakota	3169.2281	2632.0958	1.2040702	0.0078452
Tennessee	23437.693	22287.719	1.0515967	0.0081357
Texas	89494.08	130780.29	0.6843086	0.0106713
Utah	9272.7001	8898.9515	1.0419992	0.0082121
Vermont	2750.1076	2886.1564	0.9528616	0.00945
Virginia	52295.585	28851.972	1.812548	0.0115647
Washington	-54738.71	26824.71	2.0406075	0.0047236
West Virginia	3128.6475	6374.6717	0.4907935	0.0053219
Wisconsin	23789.337	19224.481	1.2374502	0.0082067
Wyoming	2730.3801	2326.5167	1.1735914	0.0103884
Average			0.86825316748	0.006899146
Maximum			2.2220031	0.0223738

Table 6: State Level Synthetic Bias Using Artificial Population 4

State	(1) SynB	(2) DSEB	(3) ABS(SynB/DSEB)	(4) ABS(SynB+DSEB)/N)
Alabama	-85822	19066.748	4.50111521114	0.0148379
Alaska	8312.1755	3911.2727	2.1251843	0.0198255
Arizona	11368.695	30129.345	0.3773296	0.0081807
Arkansas	5891.3732	11695.058	0.503749	0.0066281
California	62903.077	213756.53	0.2942744	0.0082244
Colorado	24600.212	21149.269	1.1631708	0.0107515
Connecticut	9416.3153	14554.71	0.64696	0.007142
Delaware	-11663.54	3154.7908	3.6970881	0.0107755
D.C.	6533.2017	4028.6755	1.6216748	0.018516
Flordia	24197.706	76571.764	0.3160134	0.006386
Georgia	-82257.39	39639.878	2.0751173	0.0051651
Hawaii	14033.051	11765.671	1.1927114	0.0217083
Idaho	-273.783	5148.1537	0.0531808	0.0037968
Illinois	33702.289	55021.154	0.6125333	0.0072985
Indiana	22121.811	22634.914	0.9773313	0.0075395
Iowa	4299.9411	9850.3747	0.4365256	0.0049295
Kansas	-54329.06	10855.309	5.0048381	0.0161137
Kentucky	4753.4858	15299.518	0.3106951	0.0050102
Louisiana	25795.779	21300.416	1.2110458	0.0106599
Maine	-2393.676	5660.7868	0.4228521	0.0026
Maryland	5277.9335	22819.029	0.2312953	0.00532
Massachusetts	37833.771	25791.822	1.4668902	0.0102253
Michigan	-24584.08	35335.202	0.6957391	0.0010932
Minnesota	-6608.569	15260.598	0.4330478	0.0017918
Mississippi	11141.886	13363.906	0.8337297	0.0087257
Missouri	8938.9709	21209.418	0.4214623	0.0054908
Montana	2219.7329	4508.2121	0.4923754	0.0074766
Nebraska	8373.7949	6510.9441	1.2861107	0.0088457
Nevada	17979.66	13139.997	1.3683153	0.0157401
New Hampshire	5096.511	4746.5581	1.0737277	0.0081219
New Jersey	5328.4095	39284.359	0.1356369	0.005358
New Mexico	-5075.163	14203.129	0.3573271	0.0050424
New York	73835.579	105856.42	0.6975069	0.009584
North Carolina	-94225.55	37909.769	2.4855215	0.0069581
North Dakota	1319.8981	2173.049	0.6073945	0.0055472
Ohio	-8238.652	42267.146	0.1949186	0.0030447
Oklahoma	16635.817	17618.46	0.9442265	0.0100462
Oregon	-154386.1	15610.021	9.8901923	0.0391123
Pennsylvania	38163.146	48811.68	0.7818446	0.0071981
Rhode Island	-4985.082	5186.0959	0.9612398	0.000194
South Carolina	-9056.608	17770.547	0.5096415	0.0021846
South Dakota	2767.2805	2632.0958	1.0513601	0.0072977
Tennessee	7849.0425	22287.719	0.3521689	0.0053473
Texas	92577.338	130780.29	0.7078845	0.0108223
Utah	-35470.97	8898.9515	3.9859718	0.0117704
Vermont	1627.1383	2886.1564	0.5637734	0.007553
Virginia	3085.4155	28851.972	0.1069395	0.0045198
Washington	-42456.81	26824.71	1.5827499	0.0026508
West Virginia	2171.6978	6374.6717	0.340676	0.0047835
Wisconsin	20945.031	19224.481	1.0894979	0.0076599
Wyoming	729.50927	2326.5167	0.3135629	0.0062523
Average			1.22761870157	0.008240416
Maximum			9.8901923	0.0391123

Table 7: State Level Synthetic Bias Using Artificial Population 5

State	(1) SynB	(2) DSEB	(3) ABS(SynB/DSEB)	(4) ABS((SynB+DSEB)/N)
Alabama	-1566	19066.748	0.0821302086	0.0039641
Alaska	413.07587	3911.2727	0.1056116	0.0069257
Arizona	-1611.699	30129.345	0.0534927	0.0056072
Arkansas	566.81425	11695.058	0.0484661	0.0046122
California	1629.4099	213756.53	0.0076227	0.0063913
Colorado	-644.0897	21149.269	0.0304545	0.0047904
Connecticut	537.52053	14554.71	0.036931	0.0044849
Delaware	-391.4691	3154.7908	0.1240872	0.0035499
D.C.	-241.769	4028.6755	0.060012	0.0065605
Flordia	-647.9579	76571.764	0.0084621	0.0048039
Georgia	-1783.378	39639.878	0.0449895	0.0046332
Hawaii	81.81521	11765.671	0.0069537	0.0098533
Idaho	221.49755	5148.1537	0.0430247	0.0041843
Illinois	773.40041	55021.154	0.0140564	0.0045773
Indiana	-1863.738	22634.914	0.0823391	0.0034848
Iowa	271.99347	9850.3747	0.0276125	0.0035214
Kansas	436.32898	10855.309	0.040195	0.0042721
Kentucky	1289.2019	15299.518	0.0842642	0.0041412
Louisiana	-100.6912	21300.416	0.0047272	0.0047705
Maine	523.62177	5660.7868	0.0924998	0.0049332
Maryland	-1674.34	22819.029	0.0733747	0.0039982
Massachusetts	2121.2748	25791.822	0.082246	0.0044604
Michigan	1046.8107	35335.202	0.0296252	0.0037092
Minnesota	-4.90903	15260.598	0.0003217	0.0031637
Mississippi	800.50214	13363.906	0.0599003	0.0050252
Missouri	695.32821	21209.418	0.0327839	0.0039835
Montana	243.70345	4508.2121	0.0540577	0.0052692
Nebraska	119.25535	6510.9441	0.0183161	0.003921
Nevada	-518.8975	13139.997	0.0394899	0.0063241
New Hampshire	-86.49243	4746.5581	0.0182221	0.0038288
New Jersey	897.34808	39284.359	0.0228424	0.0048234
New Mexico	-334.9711	14203.129	0.0235843	0.0076806
New York	-7494.535	105856.42	0.0707991	0.0052232
North Carolina	1636.967	37909.769	0.0431806	0.0049449
North Dakota	67.637949	2173.049	0.0311258	0.0035514
Ohio	2349.7838	42267.146	0.0555936	0.003996
Oklahoma	990.53061	17618.46	0.0562212	0.005433
Oregon	971.2402	15610.021	0.062219	0.0048873
Pennsylvania	264.52468	48811.68	0.0054193	0.0040489
Rhode Island	-161.468	5186.0959	0.0311348	0.0048709
South Carolina	62.913396	17770.547	0.0035403	0.0044812
South Dakota	15.521373	2632.0958	0.005897	0.0035652
Tennessee	1137.3053	22287.719	0.0510283	0.0041515
Texas	-3360.65	130780.29	0.0256969	0.0061452
Utah	622.03431	8898.9515	0.0698997	0.0042861
Vermont	27.926597	2886.1564	0.0096761	0.0048637
Virginia	158.20372	28851.972	0.0054833	0.0041039
Washington	1198.8893	26824.71	0.0446935	0.0047875
West Virginia	629.97018	6374.6717	0.0988239	0.0039173
Wisconsin	-344.6757	19224.481	0.017929	0.0035856
Wyoming	29.334114	2326.5167	0.0126086	0.0048128
Average			0.0409611003	0.004699574
Maximun			0.1240872	0.0098533

Table 8: State Level Synthetic Bias Using Artificial Population 6

State	(1) SynB	(2) DSEB	(3) ABS(SynB/DSEB)	(4) ABS((SynB+DSEB)/N)
Alabama	-85822	19066.748	4.50111521114	0.0148652
Alaska	8312.1755	3911.2727	2.1251843	0.0197735
Arizona	11368.695	30129.345	0.3773296	0.0081832
Arkansas	5891.3732	11695.058	0.503749	0.0066275
California	62903.077	213756.53	0.2942744	0.0082247
Colorado	24600.212	21149.269	1.1631708	0.0107422
Connecticut	9416.3153	14554.71	0.64696	0.0071356
Delaware	-11663.54	3154.7908	3.6970881	0.0107947
D.C.	6533.2017	4028.6755	1.6216748	0.0184898
Flordia	24197.706	76571.764	0.3160134	0.0063888
Georgia	-82257.39	39639.878	2.0751173	0.0051717
Hawaii	14033.051	11765.671	1.1927114	0.0216492
Idaho	-273.783	5148.1537	0.0531808	0.0037963
Illinois	33702.289	55021.154	0.6125333	0.0072987
Indiana	22121.811	22634.914	0.9773313	0.007542
Iowa	4299.9411	9850.3747	0.4365256	0.0049266
Kansas	-54329.06	10855.309	5.0048381	0.0161662
Kentucky	4753.4858	15299.518	0.3106951	0.005009
Louisiana	25795.779	21300.416	1.2110458	0.0106578
Maine	-2393.676	5660.7868	0.4228521	0.0025994
Maryland	5277.9335	22819.029	0.2312953	0.0053204
Massachusetts	37833.771	25791.822	1.4668902	0.0102092
Michigan	-24584.08	35335.202	0.6957391	0.0010944
Minnesota	-6608.569	15260.598	0.4330478	0.0017901
Mississippi	11141.886	13363.906	0.8337297	0.0087225
Missouri	8938.9709	21209.418	0.4214623	0.00549
Montana	2219.7329	4508.2121	0.4923754	0.0074777
Nebraska	8373.7949	6510.9441	1.2861107	0.008837
Nevada	17979.66	13139.997	1.3683153	0.0157342
New Hampshire	5096.511	4746.5581	1.0737277	0.0081195
New Jersey	5328.4095	39284.359	0.1356369	0.0053561
New Mexico	-5075.163	14203.129	0.3573271	0.0050479
New York	73835.579	105856.42	0.6975069	0.0095684
North Carolina	-94225.55	37909.769	2.4855215	0.0069663
North Dakota	1319.8981	2173.049	0.6073945	0.0055423
Ohio	-8238.652	42267.146	0.1949186	0.0030443
Oklahoma	16635.817	17618.46	0.9442265	0.0100359
Oregon	-154386.1	15610.021	9.8901923	0.0393179
Pennsylvania	38163.146	48811.68	0.7818446	0.0071967
Rhode Island	-4985.082	5186.0959	0.9612398	0.0001939
South Carolina	-9056.608	17770.547	0.5096415	0.0021859
South Dakota	2767.2805	2632.0958	1.0513601	0.0072925
Tennessee	7849.0425	22287.719	0.3521689	0.0053497
Texas	92577.338	130780.29	0.7078845	0.0108141
Utah	-35470.97	8898.9515	3.9859718	0.0117885
Vermont	1627.1383	2886.1564	0.5637734	0.0075501
Virginia	3085.4155	28851.972	0.1069395	0.0045199
Washington	-42456.81	26824.71	1.5827499	0.0026538
West Virginia	2171.6978	6374.6717	0.340676	0.0047763
Wisconsin	20945.031	19224.481	1.0894979	0.0076574
Wyoming	729.50927	2326.5167	0.3135629	0.0062584
Average			1.22761870157	0.008243603
Maximum			9.8901923	0.0393179

Table 9: County (100,000 population +) Level Synthetic Bias
524 Counties

Artificial Population	ABS(SynB/DSEB)			ABS((SynB + DSEB)/N)		
	Minimum	Median	Maximum	Minimum	Median	Maximum
1	0.0005938	0.141258	1.6651694	0.0004317	0.0040581	0.0137441
2	0.00002983	0.0557772	1.2147835	0.000436	0.00415704	0.0119128
3	0.0196354	1.2336545	8.2979858	0.00000096	0.0067859	0.0333999
4	0.0014608	1.7067164	154.77892	0.00000481	0.0106894	0.4778258
5	0.00002983	0.0557772	1.2147835	0.000436	0.00415716	0.0119116
6	0.0014608	1.7067164	154.77892	0.00000482	0.0106947	0.5045436

Table 10: Weighted Loss Function Synthetic Bias Correction for County Levels (population of 100,000 or less)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	11783.41	367.65244	3.12%	12151.062
2	11783.41	90.114116	0.76%	11873.524
3	11783.41	192.56111	1.63%	11975.971
4	11783.41	1292.9947	10.97%	13076.405
5	11783.41	90.114116	0.76%	11873.524
6	11783.41	1292.9947	10.97%	13076.405

Table 11: Weighted Loss Function Synthetic Bias Correction for County Levels (population greater than 100,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	12552.27	-590.2602	-4.70%	11962.01
2	12552.27	382.49645	3.05%	12934.766
3	12552.27	2951.5618	23.51%	15503.832
4	12552.27	7148.6898	56.95%	19700.96
5	12552.27	382.49645	3.05%	12934.766
6	12552.27	7148.6898	56.95%	19700.96

Table 12: Weighted Loss Function Synthetic Bias Correction for Place Levels (population at least 25,000 but less than 50,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	1819.67	59.995739	3.30%	1879.6657
2	1819.67	143.01819	7.86%	1962.6882
3	1819.67	550.03199	30.23%	2369.702
4	1819.67	-273.5789	-15.03%	1546.0911
5	1819.67	143.01819	7.86%	1962.6882
6	1819.67	-273.5789	-15.03%	1546.0911

Table 13: Weighted Loss Function Synthetic Bias Correction for Place Levels (population of at least 50,000 but less than 100,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	1467.37	-176.817	-12.05%	1290.553
2	1467.37	92.601241	6.31%	1559.9712
3	1467.37	-158.5755	-10.81%	1308.7945
4	1467.37	-2214.297	-150.90%	-746.9267
5	1467.37	92.601241	6.31%	1559.9712
6	1467.37	-2214.297	-150.90%	-746.9267

Table 14: Weighted Loss Function Synthetic Bias Correction for Place Levels (population greater than 100,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	-1019.56	-278.8054	27.35%	-1298.365
2	-1019.56	57.204553	-5.61%	-962.3554
3	-1019.56	799.62231	-78.43%	-219.9377
4	-1019.56	5197.8852	-509.82%	4178.3252
5	-1019.56	57.204553	-5.61%	-962.3554
6	-1019.56	5197.8852	-509.82%	4178.3252

Table 15: Weighted Loss Function Synthetic Bias Correction for County shares within state

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	0.001126233	1.38e-10	0.00%	0.0011262
2	0.001126233	2.41e-11	0.00%	0.0011262
3	0.001126233	2.47e-12	0.00%	0.0011262
4	0.001126233	3.00e-10	0.00%	0.0011262
5	0.001126233	2.41e-11	0.00%	0.0011262
6	0.001126233	3.03e-10	0.00%	0.0011262

Table 16: Weighted Loss Function Synthetic Bias Correction for Place shares within State

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus ACE Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	not available	9.68e-09	not available	9.68e-09
2	not available	5.95e-10	not available	5.95e-10
3	not available	2.22e-08	not available	2.22e-08
4	not available	-5.87e-09	not available	-5.87e-09
5	not available	5.96e-10	not available	5.96e-10
6	not available	-5.72e-09	not available	-5.72e-09

Table 17: Weighted Loss Function Synthetic Bias Correction for Place shares within U.S. (places with population at least 25,000 but less than 50,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	0.00004384	3.57e-15	0.00%	4.38e-05
2	0.00004384	4.28e-15	0.00%	4.38e-05
3	0.00004384	-1.14e-14	0.00%	4.38e-05
4	0.00004384	1.42e-14	0.00%	4.38e-05
5	0.00004384	4.28e-15	0.00%	4.38e-05
6	0.00004384	1.42e-14	0.00%	4.38e-05

Table 18: Weighted Loss Function Synthetic Bias Correction for Place shares within U.S. (places with population at least 50,000 but less than 100,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	0.000040575	-2.95e-15	0.00%	4.06e-05
2	0.000040575	2.99e-15	0.00%	4.06e-05
3	0.000040575	-1.42e-14	0.00%	4.06e-05
4	0.000040575	-2.72e-14	0.00%	4.06e-05
5	0.000040575	2.99e-15	0.00%	4.06e-05
6	0.000040575	-2.72e-14	0.00%	4.06e-05

Table 19: Weighted Loss Function Synthetic Bias Correction for Place shares within U.S. (places with population greater than 100,000)

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	0.000026311	-6.71e-15	0.00%	2.63e-05
2	0.000026311	1.10e-14	0.00%	2.63e-05
3	0.000026311	1.16e-13	0.00%	2.63e-05
4	0.000026311	1.09e-13	0.00%	2.63e-05
5	0.000026311	1.10e-14	0.00%	2.63e-05
6	0.000026311	1.09e-13	0.00%	2.63e-05

Table 20: Weighted Loss Function Synthetic Bias Correction for state shares within U.S.

Weighted Squared Error Loss (Weight = 1/ census count)				
Artificial Population	Census Loss minus A.C.E. Revision II Loss (1)	Synthetic Bias Correction (2)	Relative Bias (3)	Corrected Loss (4)
1	0.000018214	2.53e-16	0.00%	1.82e-05
2	0.000018214	2.04e-15	0.00%	1.82e-05
3	0.000018214	6.44e-14	0.00%	1.82e-05
4	0.000018214	8.40e-15	0.00%	1.82e-05
5	0.000018214	2.04e-15	0.00%	1.82e-05
6	0.000018214	8.40e-15	0.00%	1.82e-05

APPENDIX

1. Forming artificial populations

Let X denote a surrogate for weighted non-matches and Y denote a surrogate for weighted erroneous enumerations.

j indicates a non-zero post-stratum formed by the crossing of the E and P sample post-stratifications. Each j will be associated with a E-sample component based on the E-sample post-stratification and a P-sample component based on the P-sample post-stratification.

DSE_j = the Dual System Estimate for Post-stratum j

E_j = the weighted E sample total associated with post-stratum j

CE_j = the weighted E sample number of correct enumerations associated with post-stratum j

EE_j = the weighted E sample number of erroneous enumerations associated with post-stratum j

$Cen_{.j}$ = the census count in post-stratum j

Note that for any variable V, $V_{.j}$ is the sum of V_{ij} over areas i.

Define the estimated weighted non-matches associated with post-stratum j as follows:

$$NONMATCH_j = DSE_j - Cen_{.j}(\frac{CE_j}{E_j})$$

Define the estimated weighted erroneous enumerations associated with post-stratum j as follows:

$$ERR_j = Cen_{.j}(\frac{EE_j}{E_j})$$

Denote the estimated DSE bias (estimated from the A.C.E. Revision II Error Model) as $\hat{D}_j$

N_{ij} is the artificial population count and Cen_{ij} is the census count for area i, post-stratum j.

$$N_{ij} = Cen_{ij} + X_{ij}\frac{NONMATCH_j}{X_{.j}} - Y_{ij}\frac{ERR_j}{Y_j} - Cen_{ij}\frac{\hat{D}_j}{Cen_{.j}} \qquad (1)$$

$$N_{.j} = Cen_{.j} + NONMATCH_j - ERR_j - \hat{D}_j = Cen_{.j} + DSE_j - Cen_{.j} - \hat{D}_j = DSE_j - \hat{D}_j$$

Equation (1) was used for Artificial Populations 1, 2, 3, and 4. For Artificial Populations 2 and 4, X and Y represented the same variable. In order to consider alternatives that use a surrogate variable instead of the Census counts to allocate the DSE bias, $\hat{D}_j$, Artificial Populations 5 and 6 were created using the single surrogate variable for Artificial Populations 2, and 4 respectively. Denoting the single surrogate variable by X, equation (2) is the artificial population count used for Artificial Populations 5 and 6.

$$N_{ij} = Cen_{ij} + X_{ij}\frac{(DSE_j - Cen_{.j} - \hat{D}_j)}{X_{.j}} \qquad (2)$$

2. Decomposition of the Error in a Synthetic Estimate into Two Additive Components.

Notation

$N_{i.}$ = the true population for area i

cen_{ij} = census count for area i, post-stratum j

$cen_{.j}$ = census count in post-stratum j

$CF_{.j} = \frac{N_{i.}}{cen_{.j}}$ = true coverage correction factor for post-stratum j

$\hat{CF}_{.j} = \frac{DSE_j}{cen_{.j}}$ = estimated coverage factor for post-stratum j

$\hat{N}_{i.} = \sum_j \hat{CF}_{.j}\, cen_{ij}$ = the A.C.E. Revision II synthetic estimate for area i

$\tilde{N}_{i.} = \sum_j CF_{.j} cen_{ij}$ = the known population synthetic estimate for area i

Then $\hat{N}_{i.} - N_{i.} = (\tilde{N}_{i.} - N_{i.}) + (\hat{N}_{i.} - \tilde{N}_{i.})$

Define:

$B_i = E(\hat{N}_{i.} - N_{i.})$, the bias in the synthetic estimate

$SynB_i = \tilde{N}_{i.} - N_{i.}$, the error due to carrying down the true post-stratum coverage correction factors to area i. Since the true coverage correction factors are used, bias in the DSE at the post-stratum level is excluded from this error.

$DSEB_i = E(\hat{N}_{i.} - \tilde{N}_{i.})$, the error due to using the estimated coverage correction factors instead of the true coverage correction factors for each post-stratum. This error is due to bias in the DSE including correlation bias.

3. Specifying Bias due to Synthetic Estimation

The first component of the synthetic bias is estimated using artificial populations, the second component is estimated using post-stratum biases, estimated as part of the A.C.E. Revision II Error Model and Loss Function work. The estimate of bias for area i takes the following form:

$$\hat{B}_i = \hat{SynB}_i + \hat{DSEB}_i = (\tilde{N}_{i.} - N_{i.}) + \sum_j \frac{Cen_{ij}}{Cen_{.j}} \hat{D}_j.$$

Here, the first part is estimated from an artificial population; it is the known artificial population synthetic count minus the actual population count from the artificial population.

The second part contains the post-stratum bias, $\hat{D}_j$, (estimated elsewhere) which is an estimate of: ($E(DSE_j)$-the true population of post-stratum j). The true population of post-stratum j is estimated using results from the A.C.E. Revision II Error Model Analysis. In this second term, we weight the post-stratum bias by the proportion of post-stratum census counts in area i .

4. Correction for Synthetic Bias in Loss Function Analysis

Notation:

D_g = the census squared error loss minus the A.C.E. Revision II squared error loss using synthetic target estimates.

D_t = the census squared error loss minus the A.C.E. Revision II squared error loss using "true" target estimates.

The loss function analysis output is in terms of expected losses using the synthetic target estimates, i.e., $\Delta_g = E(D_g)$. However, we would like to know $\Delta_t = E(D_t)$. Therefore, we develop an expression for a bias correction term, B, to be added to Δ_g to correct loss function results for synthetic bias so that

$$\Delta_t = \Delta_g + B.$$

Define:

w_i = the squared error loss function weight for area i.

Note: For this derivation, assume the same weight is used for the A.C.E. Revision II Loss and the Census Loss.

Cen_i = the census count for area i

N_i = the "true" target estimate for area i

$\tilde{N}_i$ = the synthetic target estimate for area i = $\sum_j \frac{C_{ij}}{C_{.j}}(DSE_j - \hat{D}_j)$

$\hat{N}_i$ = the A.C.E. synthetic estimate for area i (includes DSE post-stratum biases)

$= \sum_j \frac{C_{ij}}{C_{.j}} DSE_j$

b_i = bias in the post-stratum level DSE allocated to area i

By definition,

$$a_i = E(\hat{N}_i) = \tilde{N}_i + b_i$$

Using this notation:

$D_g = \sum_i [w_i(Cen_i - \tilde{N}_i)^2 - w_i(\hat{N}_i - \tilde{N}_i)^2]$, and

$$D_t = \sum_i [w_i(Cen_i - N_i)^2 - w_i(\hat{N}_i - N_i)^2]$$

$$= D_g + 2\sum_i w_i(\tilde{N}_i - N_i)(Cen_i - \hat{N}_i)$$

The resulting expected difference is:

$$\Delta_t = \Delta_g + 2\sum_i w_i(\tilde{N}_i - N_i)(Cen_i - a_i)$$

$$= \Delta_g + 2\sum_i w_i(\tilde{N}_i - N_i)(Cen_i - \tilde{N}_i - b_i),$$

So B = bias correction term = $2\sum_i w_i(\tilde{N}_i - N_i)(Cen_i - \tilde{N}_i - b_i)$.

Estimates for this bias term are made by using artificial population values for the terms N_i and $\tilde{N}_i$ and by estimating b_i with $\sum_j \frac{Cen_{ij}}{Cen_{.j}} \hat{D}_j$. An analogous approach is used for shares.