American Community Survey: Improving Reliability for Small Area Estimates

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Abstract

Recent research has indicated that, while the reliability of ACS estimates of county level characteristics generally agree with theoretical predictions, census tract level reliability is lower than desirable. This paper discusses the results of methodological research to improve the reliability of small-area ACS estimates by reducing tract-level ACS standard errors using alternative weighting methods. These include applying an intermediate set of weighting adjustments at the tract level before the final county level housing unit and population controls are applied.

Keywords: American Community Survey, variance estimation

1. Introduction[1]

The American Community Survey (ACS) is a continuous monthly survey which will replace the decennial census "long form" sample for the 2010 and future censuses. Full implementation of the ACS began in 2005. Operational feasibility testing had been ongoing since 1996. As its primary purpose is to replace the long form, its estimates should be of comparable utility to those who use long form estimates. One measure of similarity is comparing the magnitude of the estimated sampling error from each survey on estimates of similar characteristics.

From the earliest planning for the ACS, it has been acknowledged that its sampling error would in general be larger than the long form's due to its smaller sample size and use of subsampling for personal interviews of nonrespondents; one-third higher was generally quoted. Data from the ACS Test, conducted in 36 counties during 1999-2001, was intended to be compared with 2000 Census data for a variety of purposes, including the comparison of standard errors. Relationships between standard errors at the county level were about as expected, but the relationship at the census tract level appeared to be a higher ratio than 1.33.

This paper presents research into why the ACS tract-level standard errors were higher than predicted, and more importantly explores alternative options to reduce tract-level standard errors when they are produced from the full implementation data for the first time in 2010.

2. Brief Overview of ACS Sampling and Estimation

The ACS samples about three million addresses annually evenly divided throughout the year, systematically sampled from the Census Bureau's Master Address File (MAF). As in the long form, the initial sampling rate varies by census block (the smallest defined piece of census geography) based on the size of the census tract and/or the governmental units that the block is a part of. Blocks that are part of small governmental units are sampled at a higher rate than the base rate (about 2.5 percent), and blocks in large tracts are sampled at a lower rate[2]. Units that have not responded to the mail form are sent for telephone interviewing, if a telephone number is available. Units that still have not responded are subsampled for computer assisted personal interviewing (CAPI) at rates of 1-in-3, 2-in-5, or 1-in-2, depending on its tract's estimated response rate, with higher CAPI sampling rates applied in areas of lower initial response. Units without mailable addresses are sent directly to CAPI at a 2-in-3 subsampling rate. The subsampling of nonrespondents for personal interviewing is one of the striking differences between the ACS and the long form sample, which did 100% followup.

[1] This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress. The views expressed on statistical and methodological issues are those of the author and not necessarily those of the U.S. Census Bureau.

[2] The block-level sampling rates depend on estimates of the size (number of occupied housing units) of the governmental units the block is contained within, including place, minor civil division (in 12 states), American Indian and Alaskan Native areas, Hawaiian Homelands, and school districts. The size of the smallest governmental unit a block is contained within determines the base sampling rate. Annual block-level rates range as high as 10 percent for blocks within governmental units with fewer than 200 estimated occupied housing units.

The base weight for each housing unit is the inverse of the sampling rate. Weights for units sampled for CAPI are also multiplied by the inverse of the CAPI rate. After several small ratio adjustments, including non-interview adjustments, the first set of controls are applied. County level housing unit estimates from the official intercensal estimates program are used as controls for the total estimate of housing units. To this point, there is no separate person weight - all persons in a household have the housing unit's weight. Next, the weights for persons are adjusted to county-level totals - also from the official intercensal estimates - by age, sex, race, and Hispanic origin (with collapsing of groups, where necessary). Occupied housing units are reweighted to match the household's "principle person" (the female spouse of the male householder if such a person exists, or the householder otherwise), and the housing unit weights are readjusted to the county control totals. Controls are used for both coverage and variance reduction purposes.

Areas with populations of 65,000 or more will have single-year estimates published. Areas between 20,000 and 65,000 will have estimates published based on an accumulation of three years' worth of sample, and areas smaller than 20,000 population will have estimates based on five years' worth of data. These five year estimates will include all census tracts and block groups. Block groups are collections of blocks, and tracts are collections of block groups that contain an average of around 4,300 persons. The first three-year estimates (2005-2007) would be published in 2008, and the first five-year estimates (2005-2009) would be published in 2010.

ACS variances are calculated using the successive differences replication methodology, currently in use by the Current Population Survey, and also used with the Census 2000 long form.(Fay and Train, 1995) All published ACS estimates will include some reliability measure (e.g. a confidence bound or margin of error) from which the standard error can be calculated.

3. Brief Overview of Census 2000 Long Form Sampling and Estimation

The Census 2000 long form sample was a systematic sample of housing units across the United States with an overall sampling rate of approximately 1-in-6. Mail nonresponse was followed up with a 100% personal interview. Blocks were sampled at varying rates, based on the size of the tract and governmental units containing it, as with the ACS. Blocks in small governmental units were sampled at 1-in-2 or 1-in-4, blocks in large tracts were sampled at 1-in-8, and other blocks were sampled at 1-in-6. The overall national sample was about 1-in-6.

Weighting was done within specially defined final weighting areas, which were formed from collections of blocks that contained at least 400 sample persons. About half of these final weighting areas nationwide exactly matched to a census tract. Raking (or iterative proportional fitting) was used to adjust the initial long form weights (inverses of the observed sampling rates) to match population and housing unit counts from the 2000 census. Person weights were obtained using four sets of margins (with collapsing where necessary): 21 categories for type of household, initial sampling rate groups, householder/nonhouseholder, and 312 combinations of age, sex, race and Hispanic origin. Weights for occupied housing units were obtained using a different raking matrix than vacant housing units. Occupied units used three sets of margins: 19 types of household, initial sampling rate groups, and 24 cross classifications of tenure and race and Hispanic origin of the householder. Vacant housing units were adjusted to just one margin, type of vacant unit (for sale, for rent, and other).

Direct variance estimates for approximately 4000 specified estimates were calculated for final weighting areas and larger geographic areas using the successive differences replication methodology. These estimates were grouped into common topics, and a regression method was used to produce design factors for these subject areas, which were published with the census long form data. Users could approximate the standard error of any selected estimate by using the design factor for the appropriate geographic area and subject, and the simple random sample formulas supplied in the SF-3 technical documentation.(U.S. Census Bureau 2002a)

4. 1999-2001 ACS/Census Comparison Test

Thirty six counties were selected to be included in a three year ACS test, running from 1999 through 2001. The data for the three years would be accumulated and compared with the Census 2000 long form data as a way to directly compare ACS data with the long form data it is intended to replace. [Research detailing the comparisons of the ACS Comparison Test estimates with their long form counterparts can be found in Diffendal et al (2004).]

With only three years worth of data, sampling rates were increased to bring the counties closer to the amount of sample that would be normally collected in five years. When the comparison test was implemented, the planned annual full implementation sample was three percent of all housing units, and so a 15 percent sample over five years. Twenty-nine of the counties were sampled each year at five percent. Due to budget constraints, seven counties with large populations were sampled at lower rates - five at three percent per year (San Francisco, CA; Broward, FL; Lake, IL; Bronx, NY; and Franklin, OH) and two at one percent per year (Fort Bend and Harris, TX).

For the comparison study, estimates were produced at the county and census tract levels. The combined sample size of three percent for Fort Bend and Harris counties was insufficient to support tract-level estimates with acceptable reliability, and tract-level estimates were not produced (specially designed "neighborhood" estimates were produced instead). Because of the small sample size, Fort Bend and Harris counties were excluded from this research.

Unlike the full implementation of the ACS, CAPI subsampling for nonrespondents in the ACS test was done at a fixed rate of 1-in-3. The variable subsampling rates were a recent design improvement.

Another important difference between the ACS test and both the full implementation plans and the long form is the exclusion of the group quarters population (e.g. persons in college dormitories, nursing homes, military barracks, etc.). A special tabulation of the long form data for these 36 counties excluding the group quarters population was used in the comparison study. Collection of group quarters data for the ACS will begin in 2006.

Prior to the public release of ACS/Census 2000 comparison data, it was provided to four groups of researchers who used local expert knowledge to focus the comparison on one or more of the 36 test counties. The group studying Oneida and Vilas counties, WI, noted that ratios of tract-level standard errors between the ACS and the long form were higher than expected.(Van Auken et al, 2004) This discovery spurred the research described below, to determine the cause of the larger-than-expected ratios, and to develop alternative weighting methods to reduce standard errors for tracts.

5. Theoretical Relationships of Standard Errors

Possibly the first discussion of the relative reliability between census long form and ACS estimates is found in Alexander (1993). It states that for “small areas” (below 250,000 persons), the ACS five-year averages would expect to have a coefficient of variation (CV) 25% higher than for the corresponding long form estimates. However, this calculation was done assuming a much larger sample size than any recent plans for full implementation.

The 1999-2001 ACS test was designed to emulate a full implementation sample of 15% over a five year period. The ratio of 1.33 was derived at this point under this sample size assumption (as a five-year cumulation), using a model that included parameters such as the ACS mail, CATI (computer assisted telephone interview), and CAPI response rates, and the nonmailable rate. Test counties which had sampling rates of 3% or 1% per year would be expected to have ratios higher than 1.33.

With several simplifying assumptions, the variance of an ACS estimate of a proportion can be shown to be approximated by:

$$Var(\hat{p}) = \frac{pq}{n}\left[\frac{1}{r_1}\alpha(1-r_1 f) + \frac{9}{4}\frac{1}{r_2}\beta(1-r_2\frac{2}{3}f) + 9\frac{1}{r_3}\gamma(1-r_3\frac{1}{3}f)\right] \quad (1)$$

where:

- p = the proportion, q = 1-p
- n = sample size
- f = sampling fraction = n/N
- α = proportion of sample responding by mail or CATI [group 1]
- β = proportion of sample responding through CAPI for unmailable addresses [group 2]
- γ = proportion of sample responding through CAPI for nonresponse [group 3]
- r_1, r_2, r_3 = inverse of simple noninterview adjustment (# in sample / # in sample and responded) for groups 1-3

For the long form, the variance approximation expression is simpler:

$$Var(\hat{p}) = \frac{pq}{Rn}(1 - Rf) \quad (2)$$

where:

- p = the proportion, q = 1-p
- n = sample size
- f = sampling fraction = n/N
- R = response rate

The following table shows the expected ratio of CVs for several combinations of operational parameters.

Source of Operational Parameters	Five-Year Sampling Fraction (%)	
	15	< 12.5
Experimental Phase (pre-1999)	1.33	1.45
Comparison Test/ Supplemental Survey (1999-2004)	1.41	1.51

The ratio of about 1.33 came the original assumption of a five-year sampling fraction of 15 percent, and early (pre-1999) estimates of operational parameters. With better information on the values of the operational parameters from the ACS test and Supplemental Survey results, the approximate ratio would be about 1.41. This is the value that should be used in comparison with the ACS test and long form standard error ratios.

Currently, the ACS sample contains about three million addresses per year under full implementation, which equates to a five-year aggregate sampling rate of less than 12.5 percent. Using current projections for the operational parameters, the model gives an expected CV ratio of 1.51. Simply by updating estimates of sample size and other operational parameters, the ACS CV would be expected to be 50 percent larger than the corresponding long form CV, rather than the previously-stated estimate of 33 percent larger.

Neither of these approximate variance formulas incorporate the reduction in variance due to use of controls. Also note that this is a theoretical calculation based on national parameters, and for a given geographic area, the ratio of CVs could be greater than or smaller than 1.51, since the ratio is a function of the specific operational parameters of that area.

6. Examining ACS/Census Comparison Standard Errors

The estimates and standard errors of the three-year combined ACS level estimates were computed as averages of the three individual year's estimates.

$$Est_{3Yr} = \frac{Est_{1999} + Est_{2000} + Est_{2001}}{3}$$

$$SE_{3Yr} = \frac{\sqrt{SE_{1999}^2 + SE_{2000}^2 + SE_{2001}^2}}{3}$$

"Profile tables" had been originally published for both the single-year ACS test data and the Census 2000 long form, summarizing the data from the myriad summary tables produced, and grouping estimates for similar subjects together. The profiles were split into four "tables", corresponding to the broad categories of demographic (sex, age, race, relationship), social (education, ancestry, place of birth), economic (employment, income, poverty), and housing characteristics (physical characteristics, value, home costs). For this research, 306 matched characteristics from the profile tables were chosen for comparison.

For the ACS estimates, the direct replicate single-year standard errors were used to construct the standard errors of the three-year estimates. For the long form, generalized standard errors using the simple random sampling standard error formula and published design factors were used. For each line in the profile, the ratio of the standard error of the ACS to the standard error of the long form was computed. For county-level estimates, all ratios in the county were averaged together. For tract-level estimates, all ratios in all tracts in the county were averaged together. Both the ACS and long form standard error estimation procedures break down for estimates of zero. Because these approximations differ from the methods used for other estimates, ratios of standard errors for zero estimates were excluded from the analysis.

[The table on page 8 contains all the data used in the comparisons discussed in this section and the next. I will note which columns are being compared in each section.]

6.1 Comparison 1 - County/Tract SE Ratios Using Production ACS Data

Columns 1 and 2 of the overall comparison table on page 8 give the county- and tract-level average standard error ratios for the 34 ACS comparison test counties (excluding Fort Bend and Harris), while column 3 has the percent increase from the county ratio to the tract ratio.

Most of the county-level average ratios for the 5 percent counties were near or below the "expected" value of 1.41. Fulton County is a clear outlier; its "bad behavior" will be partially explained below. Only three of the other 5 percent counties had ratios over 1.50 - Otero, Zapata, and Vilas (which will also be partially explained below). Ratios for the 3 percent counties were, as expected, higher than most of the 5 percent counties.

However, tract-level ratios were much higher across the board. Most of the tract ratios for 5 percent counties are between 1.8 and 2.0, indicating an average increase of 80 to 100 percent from the long form standard error to the ACS standard error. On average, the tract ratio was 46 percent higher than the county ratio.

Six counties are separated out as "5% MCD counties" in the table. In an oversight during sampling for the ACS comparison test, minor civil divisions (MCDs - townships, typically) were not used in determining the size of the smallest governmental unit containing each block. MCDs only exist in certain states; Massachusetts, New York, Pennsylvania and Wisconsin all have MCDs and have counties in the ACS comparison test group. If an MCD would have been the smallest governmental unit containing a block, more units should have been in sample than were selected. This was corrected in time for sample selection of the 2003 ACS test, and MCDs are included in the governmental unit measure of size determination under the 2005 full implementation of the ACS.

Additionally, another improvement was made to the ACS sampling methodology for the 2005 full sample that brought it in line with the long form methodology. The ACS had used counts of housing units on the MAF in evaluating sizes of governmental units to determine sampling rates. The Census 2000 long form used an estimate of occupied housing units, multiplying the MAF count by the occupancy rate from the 1990 census. For many areas, the difference between the two is minimal. However, in counties with a large number of vacant units (usually due to seasonal housing), the difference in sampling rates can be very large. Oneida County had a vacancy rate of over 40 percent, while Vilas County's rate was nearly 60 percent.

Vilas, Oneida, and Fulton counties will be particularly helped by the MCD correction and the use of occupied units. Five year full implementation samples in Fulton will likely be double that of the 1999-2001 comparison test. Oneida and Vilas should have sample sizes 50 to 70 percent larger than they had from 1999-2001. We should keep those future improvements in mind when we continue to see a poor relative performance from the ACS standard errors in subsequent tables for these three counties.

One question that quickly arose was whether the use of generalized variance functions for the long form estimates instead of direct standard errors was contributing to the observed discrepancy. Long form design factors are calculated by state. To the extent that a county or tract's variance characteristics differ from the state's, the generalized variance approach to variance estimation may not adequately reflect local variation.

The long form estimates for which direct standard errors had been calculated were almost exclusively different values than those in the comparison profile. The available long form estimates with standard errors were usually more finely detailed than the estimates in the comparison profile, such as estimates by sex and age, but not sex alone or age alone. This was useful in the computation of the design factors, but wasn't useful to our research. The ACS three-year average estimates and standard errors were calculated for some of the estimates that the long form direct variance estimates were available for, and county and tract ratios were calculated for this small subset of estimates. The patterns were little different from those seen above in the table, with a generally large increase from county to tract average ratios. For the most part, the generalized variances did a reasonable job approximating the direct variances.

However, it doesn't really matter what the direct long form standard error are because the main concern here is the perception of the reliability of ACS estimates by data users. These data users will never see long form direct variances; all they have are the generalized variances using the design factors, and it's the relationship they can see which we must address. The generalized variances are the proper estimates to compare with the ACS values in our research.

The obvious question raised by data in the first columns was, why are the tract ratios so much worse than the county ratios? The major difference in tract level estimation between the ACS and the long form is the long form's use of tract level controls, and that seemed a likely cause.

6.2. Comparison 2 - County/Tract SE Ratios Using Production ACS Data, Profile Table 1 Only

Profile Table 1 contains the estimates for demographic characteristics that can be found on the census short form - age, sex, race, and Hispanic origin, among others. These are the characteristics used for ACS county-level controls, and they also make up one of the four dimensions of long form controls.

At the county level, the average standard error ratio (column 4) is near or even below one - the ACS is doing as well or better than the long form, on average. But at the tract level, for these demographic characteristics, the ACS standard errors are on average at least twice as large as the long form (column 5).

ACS estimates were controlled at the county level for these demographic characteristics, as were the long form estimates, and the standard errors are comparable. The ACS estimates were not controlled at the tract level while the long form estimates were, and the ratios are more than twice as large. This was clear evidence that the lack of tract level controls for the ACS was source of the discrepancy between the county and tract level average ratios.

7. Reweighting the ACS Estimates to Reduce Tract-Level Standard Errors

With the lack of ACS tract level controls identified as the likely reason why the tract level average standard error ratios are much higher than expected relative to the county level, we implemented several different weightings of the ACS data to see how much of variance reduction might be achieved.

7.1 Comparison 3 - Tract SE Ratios Using Production ACS Data and Best-Case Scenario Reweighting

The first reweighting attempts to represent a "best-case scenario" (BCS) - having annual, detailed tract level population and housing unit controls. The current intercensal estimates program cannot produce tract level controls, but looking at a BCS reweighting would provide insight into how much the tract level average ratios could be reduced by using tract level controls.

> BCS reweighting: All three years' worth of sample were pooled and weighted together. For housing unit controls, we used Census 2000 tract housing unit counts, and for person controls, we used Census 2000 counts for the same age/sex/race/Hispanic breakdown used annually for the ACS county-level controls, and not the more detailed long form controls.

The BCS and further reweightings all use tract level values as intermediate controls. The final step is always controlling to the county level intercensal estimates. Because of this, the county level ratios change very little between different weightings, and they were not included in the table on page 8. Some loss of reliability in subcounty level estimates is expected, as the county level controls are applied after the tract level controls.

Comparing the tract level ratios for production and BCS (columns 2 & 7), the tract level controls improved the average ratios of most counties by between 10 and 25 percent (column 8). The BCS average ratios from many of the 5 percent counties are closer to the 1.41 ratio suggested by current parameters in section 5.

7.2 Comparison 4 - Tract SE Ratios Using Production ACS Data with BCS and MTC Reweightings

Even though detailed tract level population controls like those used for the BCS reweighting are not currently feasible, a proxy for tract level housing unit controls is available in tract level address counts from the MAF, the sampling frame for the ACS. There is a strong correlation between MAF counts and the eventual housing unit estimate, so these were likely the best currently available values to use as tract level controls.

> MAF Tract Counts (MTC): The MTC reweighting used tract-level MAF counts as an intermediate set of controls. No tract-level population controls were used. The three years' worth of data were pooled together before weighting, as in the BCS.

With MTC, we see a small, almost across-the-board improvement (column 9). The tract average ratios have generally decreased, but are closer to the production values than to the BCS values. The "How much of BCS" column (#10) indicates how much of the improvement from the BCS weighting that the MTC weighting achieved. For example, for Pima County, the MTC was an improvement of 0.09 over production, or about one-third of the possible gain from the Best-Case Scenario (0.29).

7.3 Comparison 5 - Tract SE Ratios Using Production ACS Data with BCS and MTC Reweightings, Housing Unit Characteristics Only

Profile table 4 contains all the housing-related estimates. Not surprisingly, using the tract-level MAF controls has the most effect here of any of the profile tables. We can also see that, for most counties, the improvement in the tract average ratio is almost as large for MTC as it is for BCS (columns 11-14). The BCS weighting used as accurate a tract control as could be used, and it barely beat the "reasonably close" MAF count controls of MTC. This result suggested that any reasonable set of tract level population controls might provide a significant improvement in reliability in the tract level average ratios.

7.4 Comparison 6 - Tract SE Ratios Using Production ACS Data with ARM and BCS Reweightings

Research into incorporating tract-level information from administrative records was beginning when this initial analysis was taking place (see section 8). A third weighting was undertaken, this time using a low-detail population control, to simulate a possible future set of administrative records-based tract-level controls.

> Administrative Records and MAF Counts (ARM): We used the Census 2000 tract counts of white/non-white as our intermediate tract-level population controls, and retained the tract-level MAF count controls from MTC.

The final columns in the table on page 8 (columns 15 & 16) show that even with as little tract detail as white-nonwhite, those controls would further reduce the tract ratios. Seeing that these simple population controls doubled the gains of using the MAF tract counts alone is very encouraging. Incorporating tract-level population information will improve the reliability of the ACS tract-level estimates, and research into these administrative records-based methods is ongoing.

8. Future Research

The data from the reweightings have shown fairly conclusively that obtaining some form of tract-level controls is the key to reducing the ACS tract-level standard errors, and the more detailed they are, the lower the variances we expect. The tract-level MAF counts seem to be an acceptable proxy for tract-level housing unit controls. No other tract-level estimates are currently available to be used as controls.

The Census Bureau is researching alternatives to produce subcounty (tract-level) controls. One proposal is to use a regression-based model-assisted estimator in conjunction with administrative records data to predict tract populations and characteristics, which could be incorporated into the ACS estimation process as a weighting adjustment.(Fay 2005) Another proposal would use tract-level estimates based on an administrative records database.

The first ACS tract-level estimates will be not be produced until 2010, leaving time for the research into tract-level variance reduction methods to continue.

References

Alexander, Charles H (1993). “A Continuous Measurement Alternative for the U.S. Census”, Continuous Measure Research Series Memorandum CM-10 (Internal Census Bureau Memorandum dated 10/28/1993).

Diffendal, Gregg J., Rita Jo Petroni, and Andre L. Williams (2004). "Meeting 21st Century Demographic Data Needs—Implementing the American Community Survey Report 8: Comparison of the American Community Survey Three-Year Averages and the Census Sample for a Sample of Counties and Tracts". http://www.census.gov/acs/www/AdvMeth/acs_census/creports/Report08.pdf

Fay, Robert E. (2005). "Model-assisted Estimation for the American Community Survey". ASA Proceedings of the Section on Survey Research Methods, American Statistical Association (Alexandria, VA).

Fay, Robert E. and George F. Train (1995). "Aspects of survey and model-based postcensal estimation of income and poverty characteristics for states and counties". ASA Proceedings of the Section on Government Statistics, 154-159, American Statistical Association (Alexandria, VA).

U.S. Census Bureau (2002a), “Summary File 3 Technical Documentation”, http://www.census.gov/prod/cen2000/doc/sf3.pdf.

U.S. Census Bureau (2002b), “Accuracy of the Data (2001)”, http://www.census.gov/acs/www/Downloads/ACS/Accuracy01.pdf.

Van Auken, Paul, Roger Hammer, Paul Voss, and Daniel Veroff (2004). "American Community Survey and Census Comparison - Final Analytical Report - Oneida and Vilas Counties, Wisconsin - Flathead and Lake Counties, Montana". http://www.census.gov/acs/www/AdvMeth/acs_census/lreports/vossetal.pdf

Table: Comparison of ACS County and Tract Standard Error Average Ratios for Production and Experimental Weightings

Which weighting?	Production			Production			Best-Case Scenario		MAF Tract Controls		Prod-uction	Best-Case Scenario	MAF Tract Controls		ARM	
Which Items?	Overall			Demographic Items Only			Overall		Overall		Housing Unit Items Only				Overall	
Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
5% counties	County Ratio	Tract Ratio	% Incr Cty->Tr	County Ratio	Tract Ratio	% Incr Cty->Tr	Tract Ratio	% Decrease Prod->BCS	Tract Ratio	How much of BCS?	Tract Ratio	Tract Ratio	Tract Ratio	How much of BCS?	Tract Ratio	How much of BCS?
Pima, AZ	1.23	1.76	43%	0.89	2.00	125%	1.47	16%	1.67	31%	1.63	1.53	1.55	80%	1.60	55%
Jefferson, AR	1.34	1.93	44%	0.95	2.26	138%	1.50	22%	1.83	23%	1.54	1.44	1.48	60%	1.66	63%
Tulare, CA	1.48	1.95	32%	1.06	2.21	108%	1.54	21%	1.79	39%	1.73	1.59	1.63	71%	1.71	59%
Upson, GA	1.16	1.83	58%	0.87	2.07	138%	1.56	15%	1.74	33%	1.58	1.52	1.52	100%	1.64	70%
Miami, IN	1.26	1.64	30%	0.87	2.01	131%	1.32	20%	1.57	22%	1.35	1.27	1.30	63%	1.43	66%
Black Hawk, IA	1.34	1.73	29%	0.94	2.11	124%	1.39	20%	1.63	29%	1.46	1.37	1.39	78%	1.52	62%
De Soto, LA	1.29	1.89	47%	0.91	2.08	129%	1.59	16%	1.82	23%	1.64	1.56	1.59	62%	1.71	60%
Calvert, MD	1.22	1.84	51%	0.96	2.17	126%	1.52	17%	1.73	34%	1.63	1.53	1.54	90%	1.62	69%
Madison, MS	1.18	1.90	61%	0.83	2.22	167%	1.60	16%	1.85	17%	1.58	1.50	1.54	50%	1.71	63%
Iron, MO	1.22	1.81	48%	0.91	2.37	160%	1.56	14%	1.78	12%	1.47	1.49	1.49	100%	1.65	64%
Reynolds, MO	1.21	1.89	56%	0.92	2.29	149%	1.40	26%	1.86	6%	1.60	1.58	1.59	50%	1.61	57%
Washington, MO	1.28	1.92	50%	0.95	2.50	163%	1.24	35%	1.76	24%	1.48	1.40	1.46	25%	1.46	68%
Flathead, MT	1.45	2.08	43%	1.04	2.79	168%	1.64	21%	1.96	27%	1.71	1.62	1.67	44%	1.80	64%
Lake, MT	1.35	1.76	30%	1.12	2.08	86%	1.53	13%	1.73	13%	1.52	1.47	1.49	60%	1.63	57%
Douglas, NE	1.17	1.75	50%	0.85	2.04	140%	1.48	15%	1.67	30%	1.55	1.47	1.48	88%	1.60	56%
Otero, NM	1.54	1.85	20%	1.17	2.02	73%	1.49	19%	1.88	-8%	1.76	1.63	1.73	23%	1.68	47%
Multnomah, OR	1.19	1.73	45%	0.85	1.99	134%	1.43	17%	1.64	30%	1.55	1.46	1.49	67%	1.57	53%
Sevier, TN	1.30	1.99	53%	0.86	2.54	195%	1.50	25%	1.88	22%	1.69	1.59	1.63	60%	1.65	69%
Starr, TX	1.48	2.21	49%	1.15	2.79	143%	1.88	15%	2.11	30%	1.85	1.74	1.79	55%	1.99	67%
Zapata, TX	1.63	1.91	17%	1.42	1.96	38%	1.90	1%	1.90	100%	1.82	1.81	1.81	100%	1.90	100%
Petersburg, VA	1.11	1.74	57%	0.82	1.99	143%	1.55	11%	1.70	21%	1.48	1.43	1.46	40%	1.63	58%
Yakima, WA	1.24	1.80	45%	0.92	2.08	126%	1.39	23%	1.68	29%	1.57	1.47	1.50	70%	1.59	51%
Ohio, WV	1.28	1.88	47%	0.96	2.42	152%	1.64	13%	1.84	17%	1.53	1.48	1.52	20%	1.73	63%
5% MCD counties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hampden, MA	1.21	1.78	47%	0.84	2.13	154%	1.42	20%	1.67	31%	1.58	1.48	1.51	70%	1.57	58%
Rockland, NY	1.19	1.77	49%	0.85	2.14	152%	1.39	21%	1.63	37%	1.59	1.45	1.48	79%	1.54	61%
Fulton, PA	2.95	4.22	43%	2.80	5.83	108%	2.82	33%	3.86	26%	3.40	3.25	3.32	53%	3.33	64%
Schuykill, PA	1.33	2.29	72%	0.96	3.17	230%	1.72	25%	2.15	25%	1.78	1.66	1.71	58%	1.91	67%
Oneida, WI	1.33	2.19	65%	0.92	2.84	209%	1.81	17%	2.23	-11%	1.85	1.76	1.82	33%	1.95	63%
Vilas, WI	1.74	2.25	29%	1.27	2.87	126%	1.84	18%	2.23	5%	2.07	1.97	2.01	60%	1.96	71%
3% counties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
San Francisco, CA	1.51	2.21	46%	1.11	2.51	126%	1.92	13%	2.13	28%	2.04	1.94	1.97	70%	2.05	55%
Broward, FL	1.49	2.14	44%	1.11	2.48	123%	1.80	16%	2.02	35%	1.99	1.86	1.88	85%	1.94	59%
Lake, IL	1.45	2.27	57%	1.04	2.74	163%	1.92	15%	2.13	40%	2.00	1.86	1.89	79%	2.06	60%
Bronx, NY	1.64	2.46	50%	1.28	2.72	113%	2.23	9%	2.41	22%	2.20	2.14	2.15	83%	2.36	43%
Franklin, OH	1.55	2.45	58%	1.10	2.91	165%	2.12	13%	2.34	33%	2.10	1.99	2.01	82%	2.26	58%