Instructions for Applying Statistical Testing to ACS 2007 Data

This document provides some basic instructions for obtaining the ACS standard errors needed to do statistical tests, as well as performing the statistical testing.

Obtaining Standard Errors

Where the standard errors come from, and whether they are readily available or users have to calculate them, depends on where the ACS data is coming from. If the estimate of interest is published on American FactFinder (AFF), then AFF should also be the source of the standard errors. Possible sources for the estimates and standard errors are listed below:

1. ACS data from published tables on American FactFinder

    All ACS estimates from tables on AFF include either the 90 percent margin of error or 90 percent confidence bounds. The margin of error is the maximum difference between the estimate and the upper and lower confidence bounds. Most tables on AFF containing 2005 or later ACS data display the margin of error.

    Use the margin of error to calculate the standard error (dropping the "+/-" from the displayed value first) as:

    Standard Error = Margin of Error / Z

    where Z =1.65 for 2005 and earlier years and 1.645 for 2006 and later years.

    If confidence bounds are provided instead (as with most ACS data 2004 and earlier), calculate the margin of error first before calculating the standard error:

    Margin of Error = max (upper bound - estimate, estimate - lower bound)

    All published ACS estimates use 1.65 (for 2005 and previous years) or 1.645 (for 2006 and later years) to calculate 90 percent margins of error and confidence bounds. Other surveys may use other values.

2. ACS public-use microdata sample (PUMS) tabulations

    Using the methods described in the 2007 Accuracy of the PUMS documentation, available at http://www.census.gov/acs/www/Products/PUMS/codelist2007.html users can calculate standard errors for tabulations from the 2007ACS PUMS files. Users can find accuracy documents for previous year's PUMS with appropriate instructions at http://www.census.gov/acs/www/Products/PUMS/codelist2007.html.

NOTE: ACS PUMS design factors *should not* be used to calculate standard errors of full ACS sample estimates, such as those on AFF.

Obtaining Standard Errors for Derived Estimates

Once users have obtained standard errors for the basic estimates, there may be situations where users create derived estimates, such as percentages or differences that also require standard errors.

All methods in this section are approximations and users should be cautious in using them. They may be overestimates or underestimates of the estimate's standard error, and may not match direct calculations of standard errors or calculations obtained through other methods.

- Sum or Difference of Estimates

$$SE(A + B + \ldots) = SE(A - B - \ldots) = \sqrt{SE(A)^2 + SE(B)^2 + \ldots}$$

- Proportions and Percents

  Here we define a proportion as a ratio where the numerator is a subset of the denominator, for example the proportion of persons 25 and over with a high school diploma or higher.

Let $P = \dfrac{A}{B}$.

$$SE(P) = \frac{1}{B}\sqrt{SE(A)^2 - P^2 \times SE(B)^2}$$

If the value under the square root sign is negative, then instead use

$$SE(P) = \frac{1}{B}\sqrt{SE(A)^2 + P^2 \times SE(B)^2}$$

If P = 1 then use

$$SE(P) = \frac{SE(A)}{B}$$

If $Q = 100\% \times P$ (a percent instead of a proportion), then $SE(Q) = 100\% \times SE(P)$.

- Means and Other Ratios

  If the estimate is a ratio but the numerator is not a subset of the denominator, such as persons per household, per capita income, or percent change, then

$$SE\left(\frac{A}{B}\right) = \frac{1}{B}\sqrt{SE(A)^2 + \left(\frac{A}{B}\right)^2 \times SE(B)^2}$$

- Products

    For a product of two estimates - for example if users want to estimate a proportion's numerator by multiplying the proportion by its denominator - the standard error can be approximated as

    $$SE(A \times B) = \sqrt{A^2 \times [SE(B)]^2 + B^2 \times [SE(A)]^2}$$

Users may combine these procedures for complicated estimates. For example, if the desired estimate is $P = \dfrac{A + B + C}{D + E}$, then SE(A+B+C) and SE(D+E) can be estimated first, and then those results used to calculate SE(P).

For examples of these formulas, please see the 2007 Accuracy of the Data document at http://www.census.gov/acs/www/Downloads/ACS/accuracy2007.pdf

Instructions for Statistical Testing

Once standard errors have been obtained, doing the statistical test to determine significance is not difficult. The determination of statistical significance takes into account the difference between the two estimates as well as the standard errors of both estimates.
For two estimates, A and B, with standard errors SE(A) and SE(B), let

$$Z = \frac{A - B}{\sqrt{(SE(A))^2 + (SE(B))^2}}$$

If $Z < -1.645$ or $Z > 1.645$, then the difference between A and B is significant at the 90 percent confidence level. Otherwise, the difference is not significant. This means that there is less than a 10 percent chance that the difference between these two estimates would be as large or larger by random chance alone.

Users may choose to apply a confidence level different from 90 percent to their tests of statistical significance. For example, if $Z < -1.96$ or $Z > 1.96$, then the difference between A and B is significant at the 95 percent confidence level.

This method can be used for any types of estimates: counts, percentages, proportions, means, medians, etc. It can be used for comparing across years, or across surveys. If one of the estimates is a fixed value or comes from a source without sampling error (such as the Census 2000 SF1), use zero for the standard error for that estimate in the above equation for Z.

NOTE: Making comparisons between ACS single-year and multiyear estimates is very difficult, but can be done with caution. Instructions for applying statistical testing to ACS Multiyear data will be forthcoming.

This is the method used in determining statistical significance for the ACS Ranking Tables published on AFF. Note that the user's determination of statistical significance may not match the Ranking Table's result for the same pair of estimates, because the significance tests for the Ranking Tables are made using unrounded standard errors. Standard errors obtained from the rounded margins of error or confidence bounds are unlikely to match the unrounded standard error, and so statistical tests may differ.

Using the rule of thumb of overlapping confidence intervals does not constitute a valid significance test and users are discouraged from using that method.