

Instructions for Applying Statistical Testing to 2006-2008 ACS 3-Year 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 for multiyear estimates.

In general, ACS estimates are period estimates that describe the average characteristics of the population and housing over a period of data collection. For example, the 2008 ACS 1-year estimates are averages over the period from January 1, 2008 to December 31, 2008 because this is the period of time for which sample data were collected. Similarly, multiyear estimates are averages of the characteristics over several years. For example, the 2006-2008 ACS 3-year estimates are averages over the period from January 1, 2006 to December 31, 2008. Multiyear estimates cannot be used to say what was going on in any particular year in the period, only what the average value is over the full time period.

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 are coming. 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 data, and where to get standard errors are:

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 single-year or multiyear 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:

$$\text{Standard Error} = \text{Margin of Error} / Z$$

where $Z = 1.645$ for 2006 and later years as well as all multiyear estimates and $Z = 1.65$ for 2005 and earlier years.

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

$$\text{Margin of Error} = \max(\text{upper bound} - \text{estimate}, \text{estimate} - \text{lower bound})$$

All published ACS estimates use 1.645 (for 2006 and later years) or 1.65 (for 2005 and previous 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 Accuracy of the PUMS documentation users can calculate standard errors for their tabulations using a design factor method or a replicate weight method. For example, 2006-2008 Accuracy of the PUMS documentation can be used with the 2006-2008 ACS PUMS file to calculate standard errors. This document, available fall 2009 will be located here:

http://www.census.gov/acs/www/Products/PUMS/pumsaccuracy_archived.html

NOTE: ACS PUMS design factors *should not* be used to calculate standard errors of full ACS sample estimates, such as those found in data tables on AFF. In addition, Census 2000 design factors *should not* be used to calculate standard errors for *any* ACS estimate.

Obtaining Standard Errors for Derived Estimates

Once users have obtained standard errors for the basic estimates, there may be situations where they 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

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

- Proportions and Percents

Here a proportion is defined 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.

$$\text{Let } P = \frac{A}{B}.$$

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

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 or per capita income, 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 a user wants 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 $P = \frac{A + B + C}{D + E}$, then $SE(A+B+C)$ and $SE(D+E)$ can be estimated first, and then those results used to calculate $SE(P)$.

- Comparing Estimates for Overlapping Periods of Identical Length — The comparison of two individual estimates for different but overlapping 3-year periods is a special case of two individual estimates with the same period. For example, \hat{X} may represent an estimate of a characteristic for the period 2005-2007 and \hat{Y} the estimate of the same characteristic for 2006-2008. In this case, data for 2006 and 2007 are included in both estimates, and their contribution is largely subtracted out when differences are calculated.

In this case, it is possible to approximate the sampling correlation between the two estimates to improve upon the previous expression the standard error of a difference, namely:

$$SE(\hat{X} - \hat{Y}) = \sqrt{(1 - C) \sqrt{[SE(\hat{X})]^2 + [SE(\hat{Y})]^2}}$$

where C is the fraction of overlapping years. For example, the periods 2005-2007 and 2006-2008 overlap by two out of three years, so $C = 2 / 3 = 0.667$. In future, if the periods do not overlap, such as 2005-2007 and 2008-2010, then no factor is needed.

For examples of these formulas, please see the 2006-2008 Accuracy of the Data, available October 27, 2009 at <http://www.census.gov/acs/www/UseData/Accuracy/Accuracy1.htm>.

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.

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