Chapter 7
Standard errors

All survey estimates are subject to sampling error, which is a measure of the uncertainty in a survey estimate due to the necessity of selecting a sample of the population. This chapter presents estimates for the standard errors of key variables used in the 2013-14 English Housing Survey (EHS) annual reports and provides some detail on how these errors were calculated.

Overview

7.1 Standard errors for the 2013-14 EHS were calculated on weighted data using Stata. Several factors of the design impact on the sample errors: weighting, clustering and stratification.

Sources of error in surveys

7.2 Survey results are subject to various sources of error. The total error in a survey estimate is the difference between the estimate derived from the data collected and the true value for the population. There are two main types of error: systematic and random error.

Systematic error

7.3 Systematic error, or bias, covers those sources of error which will not average to zero over repeats of the survey. Bias may occur, for example, if a certain section of the population is excluded from the sampling frame, because non-respondents to the survey have different characteristics to respondents, or if interviewers systematically influence responses in one way or another. When carrying out a survey, substantial efforts are put into the avoidance of or adjustment for systematic errors but it is possible that some may still occur.

Random error

7.4 The most important component of random error is sampling error, which is the error that arises because the estimate is based on a random sample rather than a full census of the population. The results obtained for any single sample may, by chance, vary from the true values for the population but the variation would be expected to average to zero over a number of repeats of the survey. The amount of variation depends on the size of the sample, the sample design and the weighting methodology.

7.5 Random error may also result from other sources such as variations in respondents' interpretation of the questions, or variations in the way different interviewers ask questions. Efforts are made to minimise these effects through pilot work and interviewer training.

Standard errors for complex sample designs

7.6 Several factors of the design impact on the sample errors: weighting, clustering and stratification. In considering the reliability of estimates, standard errors calculated on the basis of a simple random sample design will not reflect the true variation because of the complex sample design.

7.7 Weighting for different sampling probabilities and different response rates results in larger sampling errors than for an equal-probability sample without weights. However, using population totals to control for differential non-response tends to lead to a small reduction in the errors. The method used to calculate the sampling errors correctly allows for the inflation in the sampling errors caused by the first type of weighting but, in treating the second type of weighting in the same way as the first, incorrectly inflates the estimates further. Therefore the standard errors and design factors (defts) presented in the tables below are likely to be slight over-estimates. Weighted data were used so that the values of the percentages and means were the same as those in the EHS annual reports.

7.8 The EHS uses a two-stage stratified sample design. The two-stage sample of addresses can lead to an increase in standard error if the households or individuals within primary sampling units (PSUs) are relatively homogenous but the PSU means differ from one another. Each year of the EHS covers half of the PSUs in England, so the loss in precision from clustering should be fairly small. Because alternative halves are used each year, the sample combining two years of data is, in fact, unclustered.

7.9 Stratification tends to reduce standard error and is of most advantage where the stratification factor is related to the characteristics of interest on the survey.

Design factors

7.10 The design factor, or deft, is the ratio of the standard error of an estimate from a complex sample to the standard error that would have resulted had the survey design been a simple random sample of the same size. The size of the design factor depends on the degree to which a characteristic is a) clustered within PSUs, b) varies across the strata and c) is correlated with the weights. If the design factor is below 1.0, this shows that a complex sample design improved on the estimate expected from a simple random sample, probably due to the benefits of stratification. Design factors greater than 1.0 instead show that the estimate is a less reliable estimate than might be gained from a simple random sample, due to the effects of clustering and weighting.

7.11 The design factors for selected survey estimates are shown in the tables below. These can be used to estimate likely sampling errors for other variables on the basis of their similarity to one of the variables presented. The standard error (se) of a proportion (p) based on a simple random sample (srs) multiplied by the deft gives the standard error of a complex design.

$$se(p) = deft \times se(p)_{srs}$$

where[1]:

$$se(p)_{srs} = \sqrt{\frac{p \times (100 - p)}{n}}$$

7.12 The formula to calculate the standard error of the difference between two percentages for a complex sample design is:

$$se(p_1 - p_2) = \sqrt{\frac{deft_1^2 \times (p_1 \times (100 - p_1))}{n_1} + \frac{deft_2^2 \times (p_2 \times (100 - p_2))}{n_2}}$$

7.13 Where p_1 and p_2 are observed percentages for the two subsamples and n_1 and n_2 are the subsample sizes.

Confidence intervals

7.14 Although the estimate produced from a sample survey will rarely be identical to the population value, statistical theory allows us to measure the accuracy of any survey result. The standard error can be estimated from the values obtained for the sample and allows the calculation of confidence intervals, which indicate the range of random variation in the survey estimates.

7.15 It is common, when quoting confidence intervals, to refer to the 95% confidence interval around a survey estimate. This is calculated as 1.96 times the standard error on either side of the estimated percentage or mean since, under a normal distribution, 95% of values lie within 1.96 standard errors of

[1] The precise formula uses *n-1* as the denominator but this equates to *n* in large samples.

the mean value. If it were possible to repeat the survey under the same conditions many times, 95% of these confidence intervals would contain the population value.

7.16 The 95% confidence interval for the difference between two percentages is given by:

$$p_1 - p_2 \pm 1.96 \times se(p_1 - p_2)$$

7.17 If this confidence interval includes zero then the hypothesis that the two proportions are the same and the observed difference is due to chance alone is not rejected. If the interval does not include zero then it is unlikely (less than five per cent probability) that the observed difference could have occurred by chance and this constitutes a ’significant difference’ at the 95% confidence level.