There are a number of unavoidable errors that can occur in business surveys, which fall into two types: sampling error and non-sampling error.

Sampling error is incurred when the statistical characteristics of a population are estimated from a subset, or sample, of that population. Since the sample does not include all members of the population, statistics on the sample, such as means and quantiles, generally differ from parameters on the entire population.

Non-sampling error is a catch-all term for the deviations of estimates from their true values that are not a function of the sample chosen, including various systematic errors and random errors that are not due to sampling.

ONS aims to minimise these errors by applying robust methodology techniques.

One form of non-sampling error is non-response bias. This can occur when sampled businesses fail to respond to survey questions or the response is unusable. Non-response bias occurs in statistical surveys if the answers of respondents differ from the potential answers of those who did not respond. This tends to occur when the question of interest is related to the reason for non-response.

When one or more values are missing for a sampled business by simply discarding any sampled business that has a missing value may introduce bias or affect the representativeness of the results. A process called imputation preserves all cases by replacing missing data with a probable value based on other available information. Once all missing values have been imputed, the complete data set can then be analysed.

*Ratio imputation* is the most common imputation method used in ONS business surveys when the contributor has a valid value in the previous period. It applies a period on period movement ratio to the contributor’s previous period value to create a value for the missing data item. There are two standard approaches to ratio imputation - *mean of ratios*, and *ratio of means*. The imputation method used for the turnover question in Retail Sales (May 2014 results), Index of Production (June 2014 results) and Index of Services (June 2014 results) will be updated from the *mean of ratios* method to the *ratio of means* method.
**Ratio imputation - how does it work?**

Impute for current period by calculating growth factor (R) and multiplying by previous period response $y_{i,t-1}$.

$$y_{i,t}^* = R \times y_{i,t-1}$$

The method for calculating R differs between *mean of ratios* and *ratio of means*. Both are based on businesses which returned data in both current and previous period.

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### Mean of ratios:

$$R_t = \frac{1}{n_{impclass}} \sum_{i} \frac{y_{i,t}}{y_{i,t-1}}$$

Can apply two refinements:
- Trimming - due to sensitivity to extreme ratios
- Weighting – to account for growth in previous period

$$R = wR_t + (1 - w)R_{t-1}$$

### Ratio of means:

$$R = \frac{1}{n_{impclass}} \sum_{i} y_{i,t}$$

$$R = \frac{1}{n_{impclass}} \sum_{i} y_{i,t-1}$$

Therefore:

$$R = \frac{\sum_{i} y_{i,t}}{\sum_{i} y_{i,t-1}}$$

No trimming parameters or weighting required.

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**Why is the imputation method changing?**

The *mean of ratios* method has historically been used within ONS business surveys, but the *ratio of means* method is becoming used more widely across ONS business surveys. Analysis over the years has identified that the *ratio of means* method is expected to produce less non-response bias than the *mean of ratios* method. This is likely to be due to the application of more stable growth factors in the *ratio of means* method. The growth factors applied in the *mean of ratios* method are sensitive to outlying ratios (i.e. large and small) and require regular reviews to ensure a sufficient level of trimming is being conducted to achieve a robust growth factor. The growth factor (R) is robust for the *ratio of means* method and requires no trimming or weighting.

The *ratio of means* method is now recognised in the *Recommended Practices for Editing and Imputation in Cross-Sectional Business Surveys* EDIMBUS manual (see C.4.2) as international best practice for imputation when the contributor has a valid value in the previous period.