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Information Paper

Labour Force Survey Standard Errors

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Labour Force Survey Standard Errors

2003

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
Aust.	Australia
LFS	Labour Force Survey
NSW	New South Wales
NT	Northern Territory
Qld	Queensland
RSE	relative standard error
SA	South Australia
SE	standard error
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia

INTRODUCTION

LABOUR FORCE SURVEY

The Australian Bureau of Statistics (ABS) has been conducting the Labour Force Survey (LFS) since 1960. Originally the survey was conducted quarterly, before becoming monthly in February 1978. The LFS provides timely information on the labour market activity of the usually resident civilian population of Australia aged 15 years and over.

RELIABILITY

Like data from all surveys, estimates from the LFS are subject to error. It is important to consider these errors when using LFS estimates, as they affect the accuracy of the estimates and, therefore, the importance that can be placed on interpretations drawn from the data.

Survey estimates are subject to two types of error:

- *sampling error*, which occurs because data were obtained from only a sample rather than the entire population
- *non-sampling error*, which arises from imperfections in reporting, recording or processing of the data that can occur in any survey or census.

The most commonly used measure of sampling error is the *standard error* (SE). This measure indicates the extent to which a survey estimate is likely to deviate from the true population value by chance.

Information about standard errors is provided for most ABS surveys. For the LFS, standard errors of selected estimates have been mathematically modelled as a function of the estimate itself. This approach simplifies the calculation of standard errors as it enables approximate standard errors to be calculated without needing unit records or sampling details.

Non-sampling error is difficult to quantify and there are no standard measures of non-sampling error produced for ABS surveys. However, every effort is made in the design and operation of the LFS to minimise non-sampling error.

SAMPLE DESIGN

The sample for the LFS is designed to ensure that standard errors on key estimates are minimised, within the cost and other constraints imposed. Every five years, following the availability of data from the Census of Population and Housing, the ABS reviews the LFS sample design. While the design has remained broadly the same since the introduction of the LFS, the review ensures that the survey continues to accurately reflect the geographic distribution of the Australian population, and remains efficient and cost-effective. A new sample design, based on 2001 census data, was phased-in from November 2002 to June 2003. For information about the sample design, see *Information Paper: Labour Force Survey Sample Design* (cat. no. 6269.0).

CONTENT OF THIS PAPER

This paper outlines the main features of the LFS, and shows how to calculate standard errors for a wide range of LFS estimates. These standard errors do not apply to seasonally adjusted and trend estimates — see the section 'Calculating standard errors' for more information.

CONTENT OF THIS PAPER *continued*

Standard error tables based on the standard error models are included at the end of the paper, as are examples showing how these can be used to calculate an approximate standard error for any LFS estimate. Alternatively, standard errors can be calculated directly from the model, using the formulae provided in the Appendix or the spreadsheet available on the ABS web site at <http://www.abs.gov.au> (Themes — Labour— LFS Standard Errors).

This information paper supplements information on the reliability of estimates published in *Labour Force, Australia* (cat. no. 6202.0). This paper replaces and updates information previously available in *Labour Force, Australia* (cat. no. 6203.0), which has now been discontinued.

Descriptions of the underlying concepts and structure of Australia's labour force statistics, and of the sources and methods used in compiling the estimates, are presented in *Labour Statistics: Concepts, Sources and Methods* (cat. no. 6102.0). This manual is available free of charge on the ABS web site at <http://www.abs.gov.au> (Themes — Labour).

UPDATES TO MODELS AND TABLES

A new issue of *Information Paper: Labour Force Survey Standard Errors* (cat. no. 6298.0) will be produced each time the standard error models are updated. This will occur at least every five years, following the introduction of the new sample into the LFS.

MODELS AND TABLES IN THIS ISSUE

The standard error models and tables in this first issue reflect the previous sample design based on the 1996 census. However, the models and tables still provide a good indication of the magnitude of standard errors under the current sample design (introduced between November 2002 and June 2003). A new issue of this publication, with standard error models and tables reflecting the current sample design based on the 2001 census, will be released in mid-2004.

SAMPLE DESIGN AND SURVEY METHODOLOGY

SAMPLE DESIGN

The LFS is designed primarily to provide reliable estimates of key labour force aggregates for the whole of Australia and, secondarily, for each state and territory.

The most accurate national estimates would be obtained if the total sample for Australia were distributed to the states and territories in proportion to their populations. However, for all states or territories to have estimates as accurate as one another (that is, relative standard errors about the same magnitude), equal size samples would be needed.

The actual distribution of the sample across states and territories is a compromise between one that would be optimum for national purposes and one that would give each state and territory the same accuracy. That is, the proportion of the population that is sampled (known as the sampling fraction) differs across states and territories, but not to the extent that they have identical sample sizes (and hence identical accuracy). Within each state or territory, each dwelling has the same probability of selection. The outcomes of the 2001 Labour Force Survey sample redesign are shown in the table below.

LABOUR FORCE SURVEY: 2001 SAMPLE REDESIGN

	DESIGN RELATIVE STANDARD ERROR %		
State or territory	*Employed persons*	*Unemployed persons*	*Sampling Fraction*
New South Wales	0.8	4.7	1 in 321
Victoria	0.8	4.7	1 in 270
Queensland	1.0	4.6	1 in 239
South Australia	1.2	5.6	1 in 149
Western Australia	1.0	5.7	1 in 165
Tasmania	1.7	7.4	1 in 90
Northern Territory	4.2	16.3	1 in 98
Australian Capital Territory	1.3	10.6	1 in 86
Australia	0.4	2.2	1 in 224

For more information on the design used, see *Information Paper: Labour Force Survey Sample Design* (cat. no. 6269.0).

SAMPLE ROTATION

One of the primary requirements of the LFS is to provide a measure of change in the characteristics of the labour force over time, especially month-to-month change.

Standard errors of monthly change could be minimised by collecting data from essentially the same sample of dwellings each month (while ensuring that new dwellings in the population are represented). However, it is undesirable to require respondents to be retained in the survey indefinitely, so a proportion of the sample is therefore deliberately replaced each month. This procedure is known as *sample rotation*.

Since the monthly LFS began in 1978, approximately one-eighth of the sample has generally been replaced each month. The LFS sample can be thought of as consisting of eight sub-samples (or rotation groups), with a new rotation group being introduced into the sample each month to replace an outgoing rotation group. This replacement one-eighth sample usually comes from the same area as the outgoing one.

SAMPLE ROTATION *continued*

The sample rotation method used in the LFS enables reliable estimates of monthly change in labour force characteristics to be compiled, as seven-eighths of the sample from one month is retained for the next month's survey. At the same time, the sample rotation method ensures that no dwelling is retained in the sample for more than eight months.

COLLECTION METHODOLOGY

LFS information is collected from the occupants of selected dwellings by specially trained interviewers. Interviews are generally conducted during the two weeks beginning on the Monday between the 6th and the 12th of each month. The information obtained relates to the week before the interview (i.e. the reference week).

Prior to August 1996, all interviews were conducted face-to-face. Over the period August 1996 to February 1997, the ABS introduced telephone interviewing to collect LFS data. With telephone interviewing, the first interview is conducted face-to-face and subsequent interviews are conducted by telephone (where this is acceptable to the respondent).

Interviewers may collect all information about each household member within the scope of the survey from the first responsible adult with whom the interviewer makes contact (rather than speaking to each individual personally). Where the person interviewed is unable to supply all of the details for another member of the household, the latter individual may be interviewed personally.

SCOPE AND COVERAGE

The scope of a survey is the population for which estimates are required. In the LFS, scope is restricted to the usually resident civilian population of Australia aged 15 years and over (excluding the Jervis Bay Territory, the Territory of Christmas Island and the Territory of the Cocos (Keeling) Islands, which are out-of-scope for most ABS collections other than the Census of Population and Housing).

In the LFS, coverage rules are applied to ensure that each person is associated with only one dwelling, and hence has only one chance of selection. Persons who are away from their usual residence for six weeks or less at the time of interview are enumerated at their usual residence (where possible), with relevant information being provided by another usual resident present at the time of the survey. The chance of a person being enumerated at two separate dwellings in the one survey is considered to be negligible.

LFS estimates are calculated in such a way as to add up to independently estimated counts of the usually resident civilian population aged 15 years and over, a procedure which compensates for any under-enumeration in the survey.

For more information on LFS methodology, see *Labour Statistics: Concepts, Sources and Methods* (cat. no. 6102.0).

MEASURES OF SAMPLING ERROR

SAMPLING ERROR

Sampling error is the difference between the estimate obtained from a particular sample, and the value that would be obtained if the whole population were enumerated under the same procedures (referred to here as the 'population value'). As LFS estimates are based on information gathered from the occupants of a sample of dwellings, rather than all dwellings, they are subject to sampling error.

STANDARD ERROR

Although the sampling error for a particular sample is unknown (because the population value is unknown), the use of probability samples enables an estimate of the likely magnitude of the sampling error to be made from the sample. The standard error of an estimate is an estimate (either from the sample or otherwise) of its standard deviation (see glossary). Standard errors indicate how close the survey estimate is likely to be to the population value.

Small standard errors indicate that it is likely that sample estimates will be close to the population value, regardless of the sample selected. Conversely, large standard errors indicate there is a reasonable chance that the estimate from the particular sample chosen will not be close to the population value.

Standard errors are usually calculated from survey samples, and so are also subject to sampling error. Different random samples will produce different standard errors.

CONFIDENCE INTERVALS

Confidence intervals represent the range in which the population value is likely to lie. They are constructed using the estimate and associated standard error. Different confidence intervals can be created to represent different chances that the population value will lie within the range. For example, there is approximately a 95% chance (i.e. 19 chances in 20) that the population value lies within two standard errors of the estimate.

RELATIVE STANDARD ERROR

Another measure of sampling error is the *relative standard error* (RSE). The RSE is the standard error expressed as a fraction of the estimate, and is usually displayed as a percentage. Since the standard error of an estimate is generally related to the size of the estimate, it is not always simple to compare accuracies of two estimates of different sizes without also referring to the sizes of the estimates. The relative standard error avoids the need to refer to the size of the estimate, since the standard error is expressed as a proportion of the estimate. Relative standard errors are a useful measure in that they provide an immediate indication of the percentage errors likely to have occurred due to sampling.

Very small estimates tend to be subject to high relative standard errors which detract from their usefulness. In LFS publications, only estimates with relative standard errors of 25% or less are considered sufficiently reliable for most purposes. Estimates with larger relative standard errors are marked with an asterisk (*) to indicate they are subject to high sampling errors and should be used with caution.

Note: relative standard errors should only be calculated for level estimates. Estimates of movement may vary considerably, even being zero or negative, and do not represent a sensible basis for assessing the size of the movement standard error.

CALCULATING STANDARD ERRORS

STANDARD ERRORS FOR LFS ESTIMATES

Separate standard errors could be calculated for each individual LFS estimate for each time period. However, this would be costly, requiring information on the sample design, as well as access to the unit record data. To simplify calculation of standard errors (and to save costs), a model is fitted to the directly calculated standard errors for a range of labour force data items (for a particular period), and this model is then used to calculate approximate standard errors for estimates using only information on the size and type of the estimate for which the standard error is required.

The method used to calculate the standard errors for LFS estimates is the *group jack-knife method*. The standard errors calculated using this method are modelled against estimates of employed, unemployed and persons not in the labour force, cross classified by sex, age, marital status, state and part of state. Separate standard error models are fitted for each state and territory, and Australia.

Standard errors in this publication apply to original estimates; they are not applicable to seasonally adjusted or trend estimates. Work has commenced on developing methods to produce accurate standard errors for seasonally adjusted and trend estimates, and the results will be included in the next issue of this information paper. In the meantime, a reasonable approximation can be made for the standard errors of seasonally adjusted estimates (although not of trend estimates) using the standard errors for original estimates, as presented in this paper.

Publication of standard errors

Due to space limitations within paper publications, it is impractical to print a standard error for each LFS estimate published. Instead, standard errors can be calculated using the formulae provided in the appendix, or by interpolation from the tables in the back of this publication. These standard errors are applicable to all original LFS estimates, including those published in *Labour Force, Australia* (cat. no. 6202.0) and *Australian Labour Market Statistics* (cat. no. 6105.0), those included in electronic LFS products such as time series spreadsheets and data cubes, and LFS data included in other ABS publications and special data requests.

USING THE STANDARD ERROR MODEL FORMULAE

The standard error model formulae for both level and monthly movement standard errors have been included in the Appendix.

Approximate standard errors can be calculated using these formulae. They have also been used as the basis for a spreadsheet available from the ABS web site that can produce the approximate standard error and relative standard error for any LFS estimate entered (including rates). The spreadsheet is available on the ABS web site through <http://www.abs.gov.au> (Themes — Labour— LFS Standard Errors).

USING THE STANDARD ERROR TABLES

This publication contains two standard error tables, showing the modelled standard error applicable to all level and monthly movement estimates.

- Table 1 can be used to interpolate standard errors for level estimates (i.e. referring to a single point in time).
- Table 2 can be used to interpolate standard errors for monthly movements (the difference between estimates for two consecutive months).

ADDITIONAL TABLES PROVIDED

Tables 1 and 2 apply to estimates of counts of persons i.e. to the majority of estimates published from the LFS. Some adjustments are needed for a few other published variables, and so two additional tables are provided to assist in determining the reliability of these estimates:

- Table 3 provides factors to enable the calculation of standard errors or RSEs for estimates of hours worked, duration of unemployment, quarterly, six-monthly or annual movements, and averages.
- Table 4 provides an indicator of whether the RSE of a particular estimate is greater or less than 25%. Estimates with RSE greater than 25% are not considered to be sufficiently reliable for most purposes, and should be treated with caution.

The numbers in table 4 relate to estimates of persons. Any estimate based on fewer persons than the level indicated in table 4 has an estimated RSE greater than 25%. Different cut-offs are given for hours worked, duration of unemployment and other estimates.

EXAMPLES OF CALCULATIONS

EXAMPLES OF CALCULATIONS

This section illustrates how to use tables 1, 2, 3, and 4 to calculate standard errors, relative standard errors and confidence intervals for different types of estimates. The following examples will be shown:

- How to calculate standard errors for level estimates
- How to calculate the relative standard error (RSE)
- How to calculate a confidence interval
- How to calculate standard errors for movements
- How to calculate standard errors for hours worked
- How to calculate standard errors for duration of unemployment
- How to determine whether RSE is greater than 25%
- How to calculate standard errors for rates and percentages
- How to calculate standard errors for differences

All examples use estimates from the Labour Force Survey relating to October 2002 as published in *Labour Force, Australia* (cat. no. 6203.0), on 29 November 2002.

The standard errors shown in these examples have been interpolated linearly from tables 1 and 2, using the method demonstrated in examples 1 and 4 (a and b). It is also possible to calculate standard errors using the formulae from the models shown in the Appendix, and these are noted in examples 1 and 4 (a and b), although they are not used in the other examples.

HOW TO CALCULATE STANDARD ERRORS FOR LEVEL ESTIMATES

To interpolate the standard error of a level estimate from table 1, first find the 'size of estimate' value closest to the level estimate. When the level estimate falls between two 'size of estimate' values listed in table 1 (referred to as 'upper value' and 'lower value'), an interpolation factor needs to be calculated before the standard error itself can be calculated.

Interpolation Factor

$$\text{Factor} = \frac{\text{estimate} - \text{lower value}}{\text{upper value} - \text{lower value}}$$

Standard Error

Once the interpolation factor has been calculated, the following formula can then be applied using the standard errors (SEs) corresponding to the upper and lower values in table 1.

$$\text{SE}(\text{estimate}) = \text{SE}(\text{lower}) + \left(\text{factor} \times \left[\text{SE}(\text{upper}) - \text{SE}(\text{lower})\right]\right)$$

Example 1

PERSONS EMPLOYED, OCTOBER 2002

The Labour Force Survey estimate for the number of persons employed in Australia in October 2002 was 9,390,600.

To derive a standard error from table 1, first locate the range in which the estimate falls. In this example, 9,390,600 falls between 5,000,000 (lower value) and 10,000,000

Example 1 continued

(upper value). Thus, the standard error will lie between 23,000 and 40,350, and can be calculated as follows:

Interpolation factor

$$\begin{aligned}\text{Factor} &= \frac{\text{estimate} - \text{lower value}}{\text{upper value} - \text{lower value}} \\ &= \frac{9{,}390{,}600 - 5{,}000{,}000}{10{,}000{,}000 - 5{,}000{,}000} \\ &= \frac{4{,}390{,}600}{5{,}000{,}000} \\ &= 0.88\end{aligned}$$

Standard error

$$\begin{aligned}\text{SE}(\text{estimate}) &= \text{SE}(\text{lower}) + \left(\text{factor} \times \left[\text{SE}(\text{upper}) - \text{SE}(\text{lower})\right]\right) \\ &= 23{,}000 + \left(0.88 \times [40{,}350 - 23{,}000]\right) \\ &= 23{,}000 + \left(0.88 \times [17{,}350]\right) \\ &= 23{,}000 + 15{,}268 \\ &= 38{,}268\end{aligned}$$

If using the model formula from the Appendix, or as incorporated into the spreadsheet on the ABS web site, the standard error will be 37,967. See the Appendix for more information.

HOW TO CALCULATE THE RELATIVE STANDARD ERROR (RSE)

Once the standard error for a level estimate has been derived, it can be used to calculate the Relative Standard Error (RSE) using the formula below.

Relative Standard Error Formula

$$\text{RSE}(\text{estimate}) = \frac{\text{SE}(\text{estimate}) \times 100}{\text{estimate}}$$

The standard error spreadsheet available on the ABS web site incorporates this formula, and will provide the RSE for any estimate specified.

Example 2

PERSONS EMPLOYED, OCTOBER 2002

The estimate for persons employed in October 2002 was 9,390,600 and, as shown in example 1, the calculated standard error (using table 1) is 38,268. The relative standard error can be worked out as follows:

$$\begin{aligned}\text{RSE}(\text{estimate}) &= \frac{\text{SE}(\text{estimate}) \times 100}{\text{estimate}} \\ &= \frac{38{,}268 \times 100}{9{,}390{,}600} \\ &= 0.41\%\end{aligned}$$

HOW TO CALCULATE A CONFIDENCE INTERVAL

Standard errors can be used to derive confidence intervals, which show the range around the estimate within which the population value is likely to fall, for a given probability.

Confidence Interval Formula

(Y is a factor which depends on the level of probability associated with the confidence interval)

Confidence interval lower bound = estimate − Y × SE(estimate)
Confidence interval upper bound = estimate + Y × SE(estimate)

Most commonly, confidence intervals are constructed for 67%, 95% and 99% levels of probability.

- 67% chance (2 chances in 3) that the population value lies within one standard error of the estimate (Y=1)
- 95% chance (19 chances in 20) that the population value lies within two standard errors of the estimate (Y=2)
- 99% chance (99 chances in 100) that the population value lies within three standard errors of the estimate (Y=3).

Example 3

PERSONS EMPLOYED, OCTOBER 2002

The estimate of persons employed in October 2002 was 9,390,600, with an estimated standard error (using table 1) of 38,268. The confidence interval can be estimated as follows.

For 67% chance:

estimate − SE(estimate) to estimate + SE(estimate)
= 9,390,600 − 38,268 to 9,390,600 + 38,268
= 9,352,332 to 9,428,868

For 95% chance:

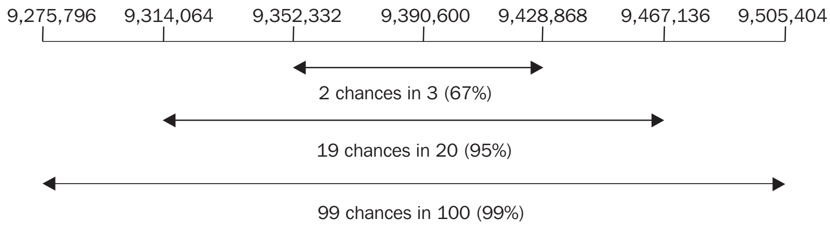
estimate − 2 × SE(estimate) to estimate + 2 × SE(estimate)
= 9,390,600 − 2 × 38,268 to 9,390,600 + 2 × 38,268
= 9,360,600 − 76,536 to 9,390,600 + 76,536
= 9,314,064 to 9,467,136

For 99% chance:

estimate − 3 × SE(estimate) to estimate + 3 × SE(estimate)
= 9,390,600 − 3 × 38,268 to 9,390,600 + 3 × 38,268
= 9,360,600 − 114,804 to 9,390,600 + 114,804
= 9,275,796 to 9,505,404

The following diagram shows the three confidence intervals. The diagram illustrates how the width of the interval increases as the probability of containing the population value increases.

Example 3 continued



HOW TO CALCULATE STANDARD ERRORS FOR MOVEMENTS

The techniques used to calculate standard errors for estimates of monthly movements are similar to those used to calculate standard errors for estimates of level. A formula is provided in the Appendix to enable calculation of standard errors of monthly movement directly from the standard error model. Standard errors for consecutive months can also be interpolated from table 2 .

To obtain standard errors for estimates of quarterly, six-monthly or annual movements, a factor from table 3 is applied to the standard error of the larger estimate. The following two examples illustrate the differences between calculations of monthly and other movements.

Example 4a

PERSONS EMPLOYED PART-TIME, SEPTEMBER TO OCTOBER 2002

This example calculates a standard error for the estimated change in the number of persons employed part-time between September 2002 (2,667,100) and October 2002 (2,698,900). This represents an upward movement of 31,800.

The calculation of a standard error of a monthly movement uses the larger of the two level estimates that are being differenced to calculate the movement. In this example, the larger estimate is October 2002 with 2,698,900.

To derive a standard error from table 2, first locate the range in which the larger of the two estimates falls. Here, the larger of the estimates (2,698,900) falls between values 2,000,000 (lower) and 5,000,000 (upper). Thus, table 2 shows that the standard error for the monthly movement will lie between 10,580 and 14,660, and can be calculated as follows.

First, calculate the interpolation factor:

$$\begin{aligned}\text{Factor} &= \frac{\text{estimate} - \text{lower value}}{\text{upper value} - \text{lower value}} \\ &= \frac{2{,}698{,}900 - 2{,}000{,}000}{5{,}000{,}000 - 2{,}000{,}000} \\ &= \frac{698{,}900}{3{,}000{,}000} \\ &= 0.23\end{aligned}$$

Second, calculate the standard error for a monthly movement.

Example 4a continued

$$\begin{aligned}\text{SE(monthly movement)} &= \text{SE(lower)} + (\text{factor} \times [\text{SE(upper)} - \text{SE(lower)}]) \\ &= 10{,}580 + (0.23 \times [14{,}660 - 10{,}580]) \\ &= 10{,}580 + (0.23 \times [4{,}080]) \\ &= 10{,}580 + 938 \\ &= 11{,}518\end{aligned}$$

If using the model formula from the Appendix, or as incorporated into the spreadsheet on the ABS web site, the standard error for the monthly movement between September and October 2002 is 11,773. See the Appendix for more information.

Example 4b

PERSONS EMPLOYED PART-TIME, OCTOBER 2001 TO OCTOBER 2002

This example calculates a standard error for the estimated change in the number of persons employed part-time between October 2001 (2,565,400) and October 2002 (2,698,900). This represents an upward movement of 133,500.

To determine the standard error for the annual movement, multiply the standard error of the larger estimate by the annual movement factor from table 3 (1.36). Factors are provided in table 3 to enable the calculation of standard errors for movements over a quarterly, six-monthly or annual period.

For this example, the standard error of the larger estimate is calculated using table 1. Here, the larger of the estimates (2,698,900) falls between values 2,000,000 (lower) and 5,000,000 (upper). Thus, table 1 shows that the standard error will lie between 15,000 and 23,000, and can be calculated as follows.

First, calculate the interpolation factor:

$$\begin{aligned}\text{Factor} &= \frac{\text{estimate} - \text{lower value}}{\text{upper value} - \text{lower value}} \\ &= \frac{2{,}698{,}900 - 2{,}000{,}000}{5{,}000{,}000 - 2{,}000{,}000} \\ &= \frac{698{,}900}{3{,}000{,}000} \\ &= 0.23\end{aligned}$$

Second, calculate the standard error for the estimate.

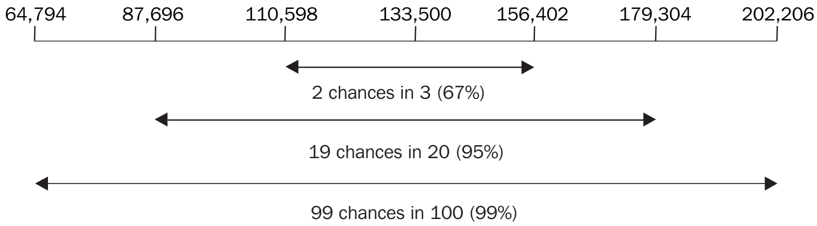
$$\begin{aligned}\text{SE(estimate)} &= \text{SE(lower)} + (\text{factor} \times [\text{SE(upper)} - \text{SE(lower)}]) \\ &= 15{,}000 + (0.23 \times [23{,}000 - 15{,}000]) \\ &= 15{,}000 + (0.23 \times [8{,}000]) \\ &= 15{,}000 + 1{,}840 \\ &= 16{,}840\end{aligned}$$

The calculation of the standard error of the movement over a twelve-month period between October 2001 and October 2002 is as follows:

Example 4b continued

$$\begin{aligned} SE(\text{annual movement}) &= SE(\text{estimate}) \times \text{factor} \\ &= 16{,}840 \times 1.36 \\ &= 22{,}902 \end{aligned}$$

The standard error can be used to calculate a confidence interval for the change in persons employed part-time between October 2001 and October 2002.



HOW TO CALCULATE STANDARD ERRORS FOR HOURS WORKED

To calculate relative standard errors for aggregate or average hours worked, it is necessary to first calculate the relative standard error for the total number of persons on which the estimate is based, then multiply this by the relevant factor from table 3. Note that the factors from table 3 should be applied to *relative* standard errors, and not to standard errors. If required, the resultant relative standard error can then be converted to a standard error.

Example 5

AVERAGE HOURS WORKED, OCTOBER 2002

The average number of hours worked in October 2002 was estimated to be 31.9. This estimate is based on the number of hours worked by all employed persons. The relative standard error on the estimate of the number of employed persons in October 2002 was calculated in example 2, and is 0.41%.

The calculation of the relative standard error for the estimate of average number of hours worked in October 2002 is:

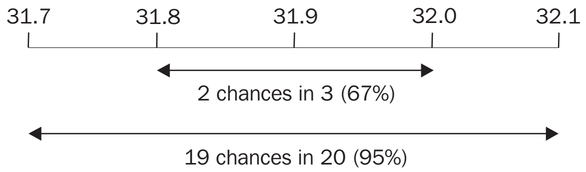
$$\begin{aligned} RSE(\text{average hours}) &= RSE(\text{employed}) \times \text{factor from table 3} \\ &= 0.41 \times 0.91 \\ &= 0.37\% \end{aligned}$$

The approximate standard error of this estimate of average hours worked is calculated by reversing the formula used to calculate the relative standard error:

$$\begin{aligned} SE &= RSE(\text{average hours}) \times \text{estimated average hours} \div 100 \\ &= 0.37 \times 31.9 \div 100 \\ &= 0.1 \text{ hours} \end{aligned}$$

Using this information gives an approximate 67% confidence interval for average hours worked of 31.8 to 32.0, and an approximate 95% confidence interval of 31.7 to 32.1. See diagram below.

Example 5 continued



HOW TO CALCULATE STANDARD ERRORS FOR DURATION OF UNEMPLOYMENT

Relative standard errors for estimates of average duration of unemployment and median duration of unemployment can be calculated by applying the relevant factor from table 3 to the relative standard error of the estimate of number of unemployed persons.

The median duration of unemployment is the duration which divides unemployed persons into two equal groups, one comprising persons whose duration of unemployment is above the median, and the other comprising persons whose duration is below it. In LFS publications, the median duration of unemployment is always expressed as a whole number of weeks.

Example 6

MEDIAN DURATION OF UNEMPLOYMENT, OCTOBER 2002

The number of unemployed persons in October 2002 was estimated to be 569,900, and their median duration of unemployment in October 2002 was estimated to be 16 weeks. The relative standard error on the estimated duration of unemployment can be calculated based on the relative standard error on the estimate of the number of unemployed persons in October 2002 (1.59%, calculated using the methods shown in examples 1 and 2).

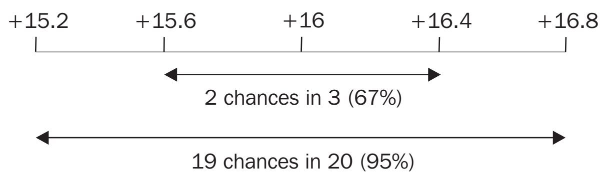
The calculation for the relative standard error for the estimate of median duration of unemployment in October 2002 is:

$$\begin{aligned}\text{RSE}(\text{median duration}) &= \text{RSE}(\text{unemployed}) \times \text{factor from table 3}\\ &= 1.59 \times 1.73\\ &= 2.75\%\end{aligned}$$

The approximate standard error of this estimate of median duration of unemployment is calculated by reversing the formula used to calculate the relative standard error:

$$\begin{aligned}\text{SE} &= \text{RSE}(\text{median duration}) \times \text{estimated median duration} \div 100\\ &= 2.75 \times 16 \div 100\\ &= 0.4 \text{ weeks}\end{aligned}$$

Using this information gives the following approximate confidence intervals for median duration of unemployment in October 2002:



HOW TO DETERMINE WHETHER RSE IS GREATER THAN 25%

Rather than calculate the RSE for an estimate, table 4 can be used to indicate whether the RSE of a particular estimate is greater or less than 25%. Estimates with RSE greater than 25% are not considered to be sufficiently reliable for most purposes, and should be treated with caution.

Example 7

AVERAGE DURATION OF UNEMPLOYMENT FOR PERSONS AGED 15 TO 19 YEARS ATTENDING SCHOOL AND LOOKING FOR FULL-TIME WORK, OCTOBER 2002

In October 2002, an estimated 4,900 persons aged 15–19 years attending school were unemployed and looking for full-time work. From table 4, the cut-off for an estimate of persons to have an RSE greater than 25% is 4,400. As the estimate of interest is greater than 4,400, it has an RSE of less than 25% (although only slightly less).

The estimate for average duration of unemployment for persons aged 15–19 years attending school and looking for full-time work is 23.4 weeks. Referring to table 4 shows that the 25% RSE cut-off for estimates of average duration of unemployment is 10,400 persons. The estimated number of persons contributing to the estimate of 23.4 weeks is 4,900, which is less than the cut-off of 10,400. Thus, the RSE on the estimate of average duration of unemployment for persons aged 15–19 years looking for full-time work is *greater* than 25%, and the estimate should be used with caution.

HOW TO CALCULATE STANDARD ERRORS FOR RATES AND PERCENTAGES

Rates and percentages formed from the ratio of two estimates (for example, unemployment rates) are also subject to sampling errors. When the estimate in the numerator (x) is a sub-set of the estimate in the denominator (y), the RSE of the ratio depends only on RSE (x) and RSE (y).

$$\mathrm{RSE}(x/y)=\sqrt{\left[\mathrm{RSE}(x)\right]^2-\left[\mathrm{RSE}(y)\right]^2}$$

The standard error spreadsheet available on the ABS web site incorporates this formula. Thus, for any rate specified, the spreadsheet will provide the standard error and relative standard error.

Example 8a

UNEMPLOYMENT RATE, OCTOBER 2002

The unemployment rate is calculated as the number of unemployed persons divided by the number of persons in the labour force (i.e. employed plus unemployed). The estimated unemployment rate for October 2002 was 5.7%. The relative standard error for the number of unemployed persons can be calculated using the methods shown in examples 1 and 2 (1.59%), and the relative standard error for the number of persons in the labour force can be calculated in the same way (0.41%).

As unemployed persons are a subset of the labour force, the relative standard error for the unemployment rate in October 2002 is:

Example 8a continued

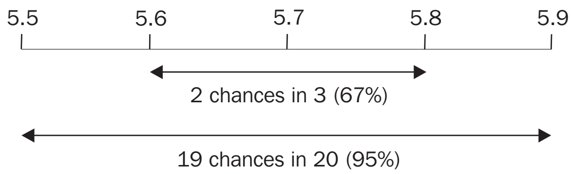
$$\begin{aligned}\text{RSE}(\text{unemployment rate}) &= \sqrt{[\text{RSE}(\text{unemployed})]^2 - [\text{RSE}(\text{labour force})]^2}\\ &= \sqrt{(1.59)^2 - (0.41)^2}\\ &= \sqrt{2.52 - 0.17}\\ &= \sqrt{2.35}\\ &= 1.53\%\end{aligned}$$

Based on this, the approximate standard error for the unemployment rate can be derived:

$$\begin{aligned}\text{SE} &= \text{RSE} \times \text{estimate} \div 100\\ &= 1.53 \times 5.7 \div 100\\ &= 0.1 \text{ percentage points}\end{aligned}$$

That is, the standard error on the estimated unemployment rate (5.7%) is 0.1 percentage points.

The confidence intervals for the unemployment rate for October 2002, calculated using this information, are:



Example 8b

PARTICIPATION RATE, OCTOBER 2002

LFS estimates are derived by weighting sample values so they add up to independent estimates of the civilian population aged 15 years and over (the independent population estimates are referred to as benchmarks). This weighting is done within subgroups determined by the cross-classification of age, sex, capital city/rest of state and state/territory of usual residence. When the denominator in a rate is a population value for a benchmark cell (and hence is independent of the sampling process), then it is not subject to sampling error. Hence the relative standard error of the rate is the same as the relative standard error of the numerator.

An example of this is the labour force participation rate for the Australian civilian population. In October 2002, the labour force participation rate was estimated to be 63.4%. The standard error for the number of persons in the labour force (9,960,500) can be calculated using the method shown in example 1 (40,350), and the relative standard error can be calculated using the method shown in example 2 (0.41%).

As the denominator is the total civilian population aged 15 years and over (and hence is a benchmark cell), its relative standard error is zero. Hence the relative standard error on the participation rate is:

$$\begin{aligned}\text{RSE}(\text{participation rate}) &= \sqrt{[\text{RSE}(\text{labour force})]^2 - [\text{RSE}(\text{population})]^2}\\ &= \sqrt{(0.41)^2 - (0)^2}\\ &= 0.41\%\end{aligned}$$

Example 8b continued

Thus, the approximate standard error for the participation rate can be derived:

$$\begin{aligned}\text{SE} &= 0.41 \times 63.4 \div 100 \\ &= 0.3 \text{ percentage points}\end{aligned}$$

Standard Errors for Monthly Movements of Rates

It is also possible to calculate the standard error on monthly movements of rates, where the denominator is a population value for a benchmark cell (as explained above). The formula below can be used to calculate approximate standard errors for the monthly movements of rates such as the employment to population ratio, and the participation rate.

$$\text{SE(monthly movement of } \frac{x}{y}) = \text{SE(monthly movement of } x) \times \frac{\text{MAX}(\frac{x_t}{y_t}, \frac{x_{t\text{-}1}}{y_{t\text{-}1}})}{\text{MAX}(x_t, x_{t\text{-}1})}$$

where

t = current month

t–1 = previous month, and

MAX (a, b) is the maximum of a and b

Although this formula has been used to calculate standard errors for monthly movements of the unemployment rate, it is not as appropriate. Recent analysis has found that the formula tends to understate the standard error on the monthly movement of unemployment rates. An improved formula will be provided in the next release of this information paper in 2004.

HOW TO CALCULATE STANDARD ERRORS FOR DIFFERENCES

It may be of interest to know whether the difference between two estimates is statistically significant. The standard error of the difference between two estimates depends on their standard errors and the correlation between them. When the correlation between two estimates is known (or can be approximated), the standard error of their difference is given by the following formula:

$$\text{SE}(x-y) = \sqrt{\left[\text{SE}(x)\right]^2 + \left[\text{SE}(y)\right]^2 - 2 \times \text{correlation} \times \text{SE}(x)\text{SE}(y)}$$

If the correlation is close to zero, an approximate standard error may be calculated by the following formula:

$$\text{SE}(x-y) = \sqrt{\left[\text{SE}(x)\right]^2 + \left[\text{SE}(y)\right]^2}$$

While the formula will only be exact for differences between uncorrelated estimates, it is expected to provide a good approximation for differences between estimates from non-overlapping populations (e.g. males and females as in the following example).

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Example 9

UNEMPLOYMENT RATES FOR MALES AND FEMALES, OCTOBER 2002

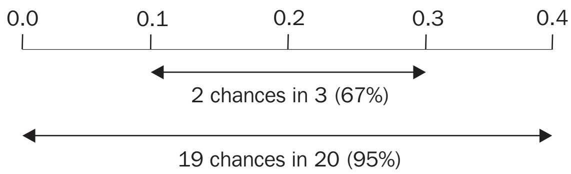
This example involves the difference between unemployment rates for males and females for October 2002, which were 5.8% and 5.6% respectively.

To calculate an approximate standard error of the difference, it is first necessary to obtain the standard error of each of the rates, using the method given in example 8a. This gives the following estimates of standard error:

- males — standard error on unemployment rate = 0.1 percentage points
- females — standard error on unemployment rate = 0.1 percentage points

$$
\begin{aligned}
SE(\text{male} - \text{female}) &= \sqrt{\left[SE(\text{male})\right]^2 + \left[SE(\text{female})\right]^2} \\
&= \sqrt{\left[(0.1)\right]^2 + \left[(0.1)\right]^2} \\
&= \sqrt{0.01 + 0.01} \\
&= \sqrt{0.02} \\
&= 0.1 \text{ percentage points}
\end{aligned}
$$

This standard error can be used to create a confidence interval for the difference between the unemployment rates for males and females in October 2002:



STANDARD ERRORS FOR STATES AND TERRITORIES

SAMPLE DESIGN

As noted in the earlier section on sample design, the level of accuracy of estimates from the Labour Force Survey differs between states and territories. To have the same level of accuracy, identical sample sizes would be required for each state and territory. However, the most accurate national estimates would require the sample to be distributed to states and territories in proportion to their populations. In the design of the sample for the Labour Force Survey, a compromise is made between the accuracy of state and territory estimates and the accuracy of the national estimate. As a result, the sample size and level of accuracy differs between states and territories, with the smaller states and territories having a smaller sample size (and hence higher RSEs).

STANDARD ERROR MODELS

The standard error models are created for each state and territory using only estimates relating to the particular state or territory. The modelled standard errors for each state and territory are incorporated into the tables included at the back of this publication, and in the spreadsheet available on the ABS web site at <http://www.abs.gov.au> (Themes—Labour—LFS Standard Errors).

EXAMPLES

The standard errors and relative standard errors for state and territory estimates can be calculated using the same procedures shown in the examples for national estimates in the previous section.

The magnitude of standard errors varies between states and territories. This is shown in the example below, using estimates of the unemployment rate for August and September 2002. The following table shows the relevant unemployment rates and standard errors.

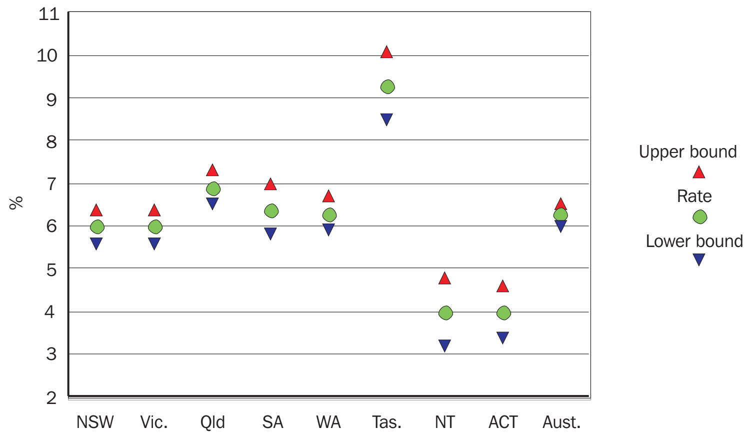
UNEMPLOYMENT RATE

State or territory	*August 2002* %	*September 2002* %	*Change* % pts	*Standard error September 2002* % pts	*Standard error change* % pts
New South Wales	5.4	6.0	0.6	0.2	0.1
Victoria	5.9	6.0	0.1	0.2	0.1
Queensland	6.9	6.9	0.0	0.2	0.2
South Australia	6.7	6.4	–0.3	0.3	0.2
Western Australia	6.2	6.3	0.1	0.2	0.2
Tasmania	8.8	9.3	0.5	0.4	0.3
Northern Territory	4.5	4.0	–0.5	0.4	0.4
Australian Capital Territory	4.6	4.0	–0.6	0.3	0.2
Australia	6.0	6.2	0.2	0.1	0.1

A 95% confidence interval for the unemployment rate can be calculated using the estimated unemployment rate then adding twice (for the upper bound), and subtracting twice (for the lower bound), the standard error for the estimate. The 95% confidence intervals for the September 2002 unemployment rates in each state and territory, and nationally, are shown in the following graph. Note that the width of the confidence intervals is greater in the smaller states and territories, reflecting the lower level of accuracy associated with their smaller sample sizes.

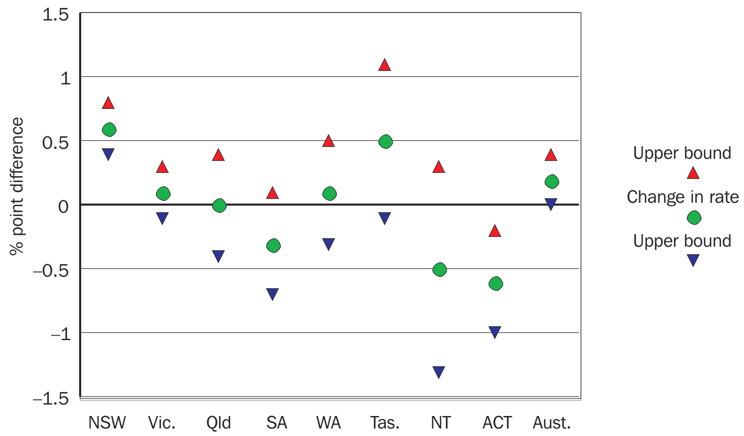
EXAMPLES *continued*

Unemployment rate: 95% confidence interval September 2002



Similarly, 95% confidence intervals can be derived for the change in the unemployment rate between August and September 2002. Again, as shown in the graph below, the width of the confidence intervals is greater in the smaller states and territories.

Change in unemployment rate: 95% confidence interval August to September 2002



Note: As mentioned at the end of example 8b, the formula used to calculate the standard errors underpinning these confidence intervals is likely to understate them to some extent.

TABLE 1

STANDARD ERRORS OF LEVEL ESTIMATES(a)—For September 1997 onwards(b)

Size of estimate	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.	
	no.	no.	no.	no.	no.	no.	no.	no.	no.	%
100	. .	. .	. .	. .	. .	100	100	130	. .	. .
200	. .	. .	. .	210	210	140	130	160	140	70.0
300	220	230	310	250	260	160	150	180	180	60.0
500	320	320	390	310	330	200	190	210	270	54.0
700	400	390	460	360	380	230	220	240	340	48.6
1,000	520	490	540	410	450	270	250	270	440	44.0
1,500	670	620	650	490	540	320	290	310	570	38.0
2,000	800	740	740	550	610	360	330	340	700	35.0
2,500	900	850	800	600	650	400	350	350	800	32.0
3,000	1 000	900	900	650	700	400	400	400	900	30.0
3,500	1 100	1 000	950	700	750	450	400	400	950	27.1
4,000	1 200	1 050	1 000	750	800	450	450	450	1 050	26.3
5,000	1 350	1 200	1 100	800	900	500	450	500	1 200	24.0
7,000	1 600	1 400	1 300	900	1 050	600	550	550	1 450	20.7
10,000	1 900	1 650	1 500	1 050	1 200	700	600	600	1 700	17.0
15,000	2 300	1 950	1 800	1 250	1 400	800	700	750	2 100	14.0
20,000	2 600	2 200	2 050	1 400	1 550	900	800	800	2 450	12.3
30,000	3 100	2 600	2 400	1 650	1 850	1 050	900	950	2 950	9.8
40,000	3 450	2 900	2 750	1 850	2 050	1 150	1 000	1 100	3 300	8.3
50,000	3 700	3 100	3 000	2 050	2 200	1 250	1 100	1 200	3 650	7.3
100,000	4 600	3 900	4 000	2 700	2 850	1 600	1 400	1 650	4 750	4.8
150,000	5 250	4 550	4 700	3 200	3 300	1 900	1 600	1 950	5 500	3.7
200,000	5 750	5 100	5 300	3 550	3 650	2 100	1 800	2 250	6 150	3.1
300,000	6 700	6 050	6 250	4 200	4 150	2 450	. .	2 700	7 150	2.4
500,000	8 350	7 550	7 650	5 100	4 950	2 900	. .	. .	8 700	1.7
1,000,000	11 650	10 600	10 000	6 700	6 150	. .	. .	. .	11 350	1.1
2,000,000	17 150	15 400	13 050	8 750	7 600	. .	. .	. .	15 000	0.8
5,000,000	30 750	26 500	18 400	. .	. .	. .	. .	. .	23 000	0.5
10,000,000	. .	. .	. .	. .	. .	. .	. .	. .	40 350	0.4

. . not applicable

(a) Estimates of number of persons for a given month.

(b) For standard errors in earlier periods, see issues of *Labour Force, Australia* (cat. no. 6203.0) for the relevant period.

Use of this table is demonstrated in example 1.

TABLE 2

STANDARD ERRORS OF MONTHLY MOVEMENT ESTIMATES(a)—October 1997 to November 1997 onwards(b)

Size of larger estimate	*NSW*	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT*	*Aust.*
100	. .	. .	. .	. .	. .	100	90	100	310
200	. .	. .	330	210	270	130	110	130	400
300	490	400	380	240	300	150	130	140	460
500	580	480	450	280	360	180	160	170	550
700	650	530	500	320	400	200	180	190	630
1,000	730	600	570	360	450	220	210	210	710
1,500	840	690	660	420	520	260	240	240	820
2,000	920	760	730	460	570	280	270	270	910
2,500	1 000	820	780	500	610	310	300	290	980
3,000	1 060	880	840	530	650	330	320	310	1 050
4,000	1 170	970	920	590	720	360	360	340	1 160
5,000	1 260	1 040	1 000	630	770	390	390	360	1 260
7,000	1 410	1 170	1 120	710	860	440	440	400	1 420
10,000	1 590	1 320	1 270	810	970	500	500	450	1 610
15,000	1 820	1 520	1 460	930	1 110	570	590	520	1 860
20,000	2 010	1 670	1 610	1 030	1 220	630	660	570	2 060
30,000	2 300	1 920	1 860	1 190	1 390	730	770	650	2 380
50,000	2 740	2 290	2 220	1 420	1 650	870	930	760	2 850
70,000	3 060	2 560	2 490	1 600	1 840	980	1 060	850	3 210
100,000	3 460	2 890	2 820	1 810	2 070	1 100	1 210	960	3 650
150,000	3 960	3 320	3 240	2 080	2 360	1 270	1 410	1 090	4 210
200,000	4 370	3 670	3 580	2 300	2 600	1 400	1 580	1 200	4 670
300,000	5 000	4 210	4 120	2 660	2 970	1 610	. .	1 370	5 390
500,000	5 950	5 010	4 920	3 180	3 520	1 930	. .	. .	6 470
1,000,000	7 510	6 340	6 260	4 050	4 420	. .	. .	. .	8 270
2,000,000	9 490	8 030	7 960	5 160	5 550	. .	. .	. .	10 580
5,000,000	12 920	10 970	10 930	. .	. .	. .	. .	. .	14 660
10,000,000	. .	. .	. .	. .	. .	. .	. .	. .	18 750

. . not applicable

(a) Monthly movement in the estimated number of persons.

(b) For standard errors in earlier periods, see issues of *Labour Force, Australia* (cat. no. 6203.0) for the revelant period. For standard errors during phase-in of the new sample between November 2002 and June 2003, see note below. For movement standard errors for periods other than one month, see table 3.

Use of this table is demonstrated in example 4a.

Introduction of new sample

During the introduction of the new LFS sample from November 2002 to June 2003, standard errors for movement estimates were higher than those presented in this table. In this period, the standard errors were highest in the first two months, when a larger proportion of the new sample was introduced.

As a result:

- a separate movement standard error table was produced for the first two months, and this was published in the November and December 2002 issues of *Labour Force, Australia* (cat. no. 6203.0)
- although movement standard errors for the remainder of the sample implementation period would have been slightly higher than those shown in table 2, no separate standard error table was produced for those months.

For more information, see Appendix: Standard Error Models.

TABLE 3

FACTORS FOR OTHER ESTIMATES

Estimate type	*Factor*	*Apply to*
Hours worked		
Aggregate(a)	1.36	RSE for estimated number of persons
Average(a)	0.91	RSE for estimated number of persons
Duration of unemployment		
Average(a)	1.48	RSE for estimated number of persons
Median	1.73	RSE for estimated number of persons
Movement(b)		
Quarterly	1.04	SE for larger estimate
Six-monthly	1.28	SE for larger estimate
Annual	1.36	SE for larger estimate
Average(b)		
Quarterly	0.88	SE for largest contributing monthly estimate
Annual	0.72	SE for largest contributing monthly estimate

(a) These factors apply for Australia-level estimates only. The spreadsheet available through the ABS web site incorporates factors for each state and territory.
(b) These factors apply for estimates of persons only.

Applying factors for hours worked or duration of unemployment

To calculate the Relative Standard Error (RSE) for one of the estimate types in the above table, determine the RSE for the estimate of the number of persons on which the estimate is based (that is, the number of employed persons relating to an hours worked estimate, or the number of unemployed persons relating to a duration of unemployment estimate), and then apply the factor in table 3 to that RSE. This will give an approximate RSE for the estimate of interest. If required, this can be used to determine an approximate standard error. See examples 5 and 6 for more information.

Applying factors for movements

Factors for movements enable the calculation of standard errors for movements other than monthly. To calculate standard errors for estimates of quarterly, six-monthly or annual movements, multiply the standard error of the larger estimate by the appropriate factor shown in table 3. See example 4b for more information.

TABLE 4

LEVELS AT WHICH LABOUR FORCE ESTIMATES HAVE A RELATIVE STANDARD ERROR OF 25%—September 1997 onwards(a)

	NSW	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT*	*Aust.*
Estimates of:(b)									
Aggregate hours worked	10 600	8 200	7 200	4 000	4 800	1 800	1 500	1 800	8 700
Average hours worked	4 600	3 800	3 700	2 000	2 400	800	700	1 000	3 500
Average duration of unemployment	10 400	9 600	7 300	4 100	5 000	1 800	1 100	1 900	10 400
Median duration of unemployment	16 800	12 700	10 800	6 000	7 200	2 800	2 500	2 600	14 300
All other estimates	5 900	4 500	4 100	2 400	2 800	1 100	1 000	1 100	4 400

(a) For standard errors in earlier periods, see issues of *Labour Force, Australia* (cat. no. 6203.0) for the relevant period.

(b) The entries in this table refer to the number of persons contributing to the estimate.

Use of this table is demonstrated in example 7.

APPENDIX STANDARD ERROR MODELS

STANDARD ERROR MODELS

As explained in the section 'Calculating Standard Errors', standard error models are fitted for LFS level and monthly movement estimates, to simplify the calculation of standard errors. The model formulae are presented here to enable users to calculate standard errors directly from the models, if desired. These formulae are also the basis of the spreadsheets available through the ABS web site <http://www.abs.gov.au> (Themes—Labour— LFS Standard Errors), which will provide users with the appropriate standard error for any estimate specified.

STANDARD ERROR MODEL FOR LEVEL ESTIMATES

The level estimate standard error model for the LFS is a spline model composed of several different models linked together. For any LFS estimate of number of persons, the modelled RSE is given by the following formula (where logarithms are to base 10):

$$\begin{aligned}\log(\text{RSE}) = {} & a + b \times [\log(\text{estimate})] + c \times [\log(\text{estimate})]^2 \\ & + d \times [\log(\text{estimate}) - k_1] \times \max\{[\log(\text{estimate}) - k_1],0\} \\ & + e \times [\log(\text{estimate}) - k_2] \times \max\{[\log(\text{estimate}) - k_2],0\}\end{aligned}$$

The number of terms in the standard error model used will depend on the size of the estimate, and the area of interest (i.e. Australia, or a particular state or territory).

PARAMETERS TO CALCULATE LEVEL STANDARD ERRORS(a)— September 1997 onwards

State or territory	*a*	*b*	*c*	*d*	*e*	*k1*	*k2*
New South Wales	1.8567	0.2375	–0.0952	0.2124	0	5.0	0
Victoria	2.1649	0.0789	–0.0789	0.1585	0	4.8	0
Queensland	3.2456	–0.4683	–0.0121	0	0	0	0
South Australia	3.3223	–0.5546	–0.0047	0	0	0	0
Western Australia	3.1138	–0.4214	–0.0221	0	0	0	0
Tasmania	3.1209	–0.5356	–0.0093	0	0	0	0
Northern Territory	3.1027	–0.5336	–0.0115	0	0	0	0
Australian Capital Territory	3.6221	–0.8076	0.0251	0	0	0	0
Australia	1.9150	0.1424	–0.0780	0.0945	0.5518	5.0	6.5

(a) For estimates of number of persons.

The parameters used in the standard error model formula depend on the area of interest (i.e. Australia or a particular state or territory). There are three parameters (a, b, and c) that are used in all cases; the remaining parameters (and the last two terms of the formula) are only used in some situations.

EXAMPLE A1

The Labour Force Survey estimate for the number of people employed in Australia in October 2002 was 9,390,600. The standard error can be calculated from the model formula as follows.

Standard error

$$\begin{aligned}\log(\text{RSE}) &= 1.915 + 0.1424 \times \log(9{,}390{,}600) - 0.078 \times [\log(9{,}390{,}600)]^2 \\ &\quad + 0.0945 \times [\log(9{,}390{,}600) - 5.0]^2 \\ &\quad + 0.5518 \times [\log(9{,}390{,}600) - 6.5]^2 \\ &= -0.3933 \\ \text{RSE} &= 0.4043 \\ \text{SE} &= 37{,}967\end{aligned}$$

This is slightly smaller than the standard error estimate of 38,268 interpolated from table 1 (example 1).

STANDARD ERROR MODEL FOR MONTHLY MOVEMENT ESTIMATES

The formula for the standard error model for estimates of monthly movement is simpler than that for level estimates, with only two terms (where logarithms are to base 10).

$$\log(SE) = a + b \times \log(MAXEST)$$

MAXEST represents the larger of the level estimates in the movement pair.

The following table provides the parameters a and b for this model. Note that these parameters do not apply during the phase-in of the new LFS sample from November 2002 to June 2003 — the section below provides more information on movement standard errors during this period.

PARAMETERS TO CALCULATE MONTHLY MOVEMENT STANDARD ERRORS—October 1997 to November 1997 onwards(a)

State or territory	*a*	*b*
New South Wales	1.8525	0.3372
Victoria	1.7591	0.3405
Queensland	1.7174	0.3465
South Australia	1.5078	0.3499
Western Australia	1.6677	0.3296
Tasmania	1.3112	0.3463
Northern Territory	1.1783	0.3810
Australian Capital Territory	1.3533	0.3254
Australia	1.7846	0.3555

(a) For movement standard errors during phase-in of the new sample between November 2002 and June 2003, see note below.

EXAMPLE A2

The Labour Force Survey estimate for the number of people employed part-time in Australia increased from 2,667,100 in September 2002 to 2,698,900 in October 2002. The standard error of the difference between the two months' estimates (31,800) can be calculated from the model formula as follows.

Standard error

$$\log(SE) = 1.7846 + 0.3555 \times \log(2{,}698{,}900)$$
$$= 4.0707$$
$$SE = 11{,}773$$

This is slightly larger than the standard error estimate of 11,518 interpolated from table 2 (example 4a).

INTRODUCTION OF NEW SAMPLE

During the introduction of the new LFS sample from November 2002 to June 2003, standard errors for movement estimates were higher than those derived from the model. The new sample was introduced in two ways: phasing in one-eighth of the private dwelling sample in larger urban areas and less remote areas each month; and introducing the private dwelling sample in remote, less-populated areas and the non-private dwelling sample over two months. Thus, the standard errors were highest in the first two months, as a larger proportion of the sample was introduced.

As a result:

- A separate movement standard error model was produced for the first two months. This model is presented below, while the resulting table was published in the November and December 2002 issues of *Labour Force, Australia* (cat. no. 6203.0).
- Although movement standard errors for the remainder of the sample implementation period would have been slightly higher than those produced from the usual model, no separate standard error model was produced for those months.

INTRODUCTION OF NEW SAMPLE *continued*

The table below contains the model parameters to be used for monthly movements for October to November 2002 and November to December 2002.

PARAMETERS TO CALCULATE MONTHLY MOVEMENT STANDARD ERRORS—October to November 2002 and November to December 2002 only

State or territory	*a*	*b*
New South Wales	1.8770	0.3372
Victoria	1.7785	0.3405
Queensland	1.7490	0.3465
South Australia	1.5323	0.3499
Western Australia	1.6988	0.3296
Tasmania	1.3300	0.3463
Northern Territory	1.2302	0.3810
Australian Capital Territory	1.3533	0.3254
Australia	1.8096	0.3555

For more information on the LFS sample redesign, see *Information Paper: Labour Force Survey Sample Design* (cat. no. 6269.0).

GLOSSARY

Aggregate hours worked
The total number of hours a group of employed persons has actually worked during the reference week, not necessarily hours paid for.

Average duration of unemployment
For any group of unemployed persons, the aggregate duration of unemployment divided by the number of persons in the group.

Average hours worked
Aggregate hours worked by a group divided by the number of persons in that group.

Civilian population aged 15 years and over
All usual residents of Australia aged 15 years and over except members of the permanent defence forces, certain diplomatic personnel of overseas governments customarily excluded from census and estimated population counts, overseas residents in Australia, and members of non-Australian defence forces (and their dependants) stationed in Australia.

Confidence interval
A confidence interval is defined as an interval, centred on the estimate, with a prescribed level of probability that it includes the true population value.

Employed
Persons aged 15 years and over who, during the reference week:

- worked for one hour or more for pay, profit, commission or payment in kind, in a job or business or on a farm (comprising employees, employers and own account workers); or
- worked for one hour or more without pay in a family business or on a farm (i.e. contributing family workers); or
- were employees who had a job but were not at work and were:
  - away from work for less than four weeks up to the end of the reference week, or
  - away from work for more than four weeks up to the end of the reference week and received pay for some or all of the four week period to the end of the reference week, or
  - away from work as a standard work or shift arrangement, or
  - on strike or locked out, or
  - on workers' compensation and expected to return to their job; or
- were employers or own account workers who had a job, business or farm, but were not at work.

Full-time workers
Employed persons who usually worked 35 hours or more a week (in all jobs) and those who, although usually working less than 35 hours a week, worked 35 hours or more during the reference week.

Group jack-knife method
This method of calculating standard errors starts by dividing the survey sample into a number of equal-sized groups (replicate groups), containing one or more units. Pseudo-estimates of the population total are then calculated from the sample by excluding each replicate group in turn. The jack-knife variance is derived from the variation of the respective pseudo-estimates around the estimate based on the whole sample.

Labour force
For any group, persons who were employed or unemployed, as defined.

Median duration of unemployment
The duration which divides unemployed persons into two equal groups, one comprising persons whose duration of unemployment is above the median, and the other comprising persons whose duration is below it.

Non-sampling error
Arises from imperfections in reporting, recording or processing of the data that can occur in any survey or census.

Participation rate
For any group, the labour force expressed as a percentage of the civilian population aged 15 years and over in the same group.

Part-time workers
Employed persons who usually worked less than 35 hours a week (in all jobs) and either did so during the reference week, or were not at work in the reference week.

Population benchmarks Labour Force Survey estimates of persons employed, unemployed and not in the labour force are calculated in such a way as to add up to an independently estimated distribution of the usually resident civilian population aged 15 years and over by age and sex. The independent population estimates (benchmarks) are the latest available estimates at the time the Labour Force Survey is conducted, but they usually differ from the official population estimates subsequently published in *Australian Demographic Statistics* (cat. no. 3101.0) because they are derived from incomplete information about population changes.

Population value The value that would be obtained if the whole population were enumerated under the same procedures as used in the sample survey.

Relative standard error (RSE) The relative standard error is the standard error expressed as a percentage of the estimate to which it refers, and is useful when comparing the variability of population estimates of different sizes.

Sampling error The difference between an estimate based on a sample, and the (unknown) population value.

Standard deviation The square root of the variance of an estimate.

Standard error (SE) A measure of the variation among the estimates from all possible samples, and thus a measure of the precision with which an estimate from a particular sample approximates the average result of all possible samples (i.e. the population value). It is an estimate of the *standard deviation*. The units of the standard error are the same as the variable of interest.

Unemployed Persons aged 15 years and over who were not employed during the reference week, and:

- had actively looked for full-time or part-time work at any time in the four weeks up to the end of the reference week, and
  - were available for work in the reference week, or
  - were waiting to start a new job within four weeks from the end of the reference week, and could have started in the reference week if the job had been available then.

Unemployment rate For any group, the number of unemployed persons expressed as a percentage of the labour force in the same group.

Variance Variance is a measure of sampling error, defined as the average (over all possible samples) of the squared deviation of the estimate from the population value. By measuring the spread of estimates from all possible samples around the population value, it gives an indication of how close the estimate from any particular sample is likely to be to the population value. The variance of an estimate is not known (because it depends on unknown population values), but its value can be estimated from the sample.

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