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Australian Bureau of Statistics

Population Estimates: Concepts, Sources and Methods

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2009

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PREFACE

INTRODUCTION

As Australia's national statistical agency, one of the core functions of the Australian Bureau of Statistics (ABS) is the provision of regular estimates of the size, composition and distribution of the Australian population. These official population estimates are termed the estimated resident population, or ERP.

This publication provides a description of the concepts, sources and methods used by the ABS in the production of population estimates. Chapter 1 gives an overview of the range of population estimates produced by the ABS and outlines some of the major uses for these population estimates. Chapters 2 and 3 outline the methods and data used to produce population estimates at the national/state and statistical local area (SLA) levels, while Chapter 4 outlines the method used to produce population estimates for customised geography. Chapters 5 to 8 provide additional information of components of population growth and of selected sub-populations. Chapter 9 describes the data sources used to produce population estimates. Further technical details are provided in the Appendices.

RELATED PUBLICATIONS

This publication replaces population estimates sections of the earlier publication *Demographic Estimates and Projections: Concepts, Sources and Methods, 1999* (cat. no. 3228.0).

Following the release of this publication, the ABS will be working on the following publications:

- *Population Projections: Concepts, Sources and Methods* (cat. no. 3228.0.55.002)
- *Household Estimates and Projections: Concepts, Sources and Methods* (cat. no. 3228.0.55.003).

FURTHER INFORMATION

For further information on the concepts, sources and methods used to produce ABS population estimates, please contact:

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ASGC	Australian Standard Geographical Classification
Aust.	Australia
CD	collection district
DIAC	Australian Government Department of Immigration and Citizenship
DIMA	Australian Government Department of Immigration and Multicultural Affairs
DIMIA	Australian Government Department of Immigration and Multicultural and Indigenous Affairs
ERP	estimated resident population
LGA	local government area
NIM	net interstate migration
NOM	net overseas migration
NSW	New South Wales
NT	Northern Territory
OAD	Overseas Arrivals and Departures Collection
PES	Census of Population and Housing Post Enumeration Survey
Qld	Queensland
RBDM	Registrar of Births, Deaths and Marriages
RSE	relative standard error
RTO	resident temporarily overseas
SA	South Australia
SE	standard error
SLA	statistical local area
Tas.	Tasmania
TRIPS	Travel and Immigration Processing System
Vic.	Victoria
WA	Western Australia

CHAPTER 1 OVERVIEW

INTRODUCTION

1.1 The concept of a population can vary, depending on the specific situation at hand, the purpose for which the count or estimate is needed, and the methods used to collect or estimate data for that population. For example, a population could be counted in terms of:

- persons actually present in a particular location at a particular point in time (e.g. Census counts by place of enumeration)
- persons who usually live in a particular location at a particular point in time, irrespective of their actual location (e.g. Census counts by place of usual residence or estimates of the resident population)
- persons with a legal right to reside in a particular location, irrespective of their usual or actual location (i.e. a 'legal population')
- persons with an enduring economic link to a particular location, irrespective of their actual location (i.e. an 'economic population')
- persons who obtain particular goods and/or services in a particular location, irrespective of their usual or actual location (i.e. a 'service population').

1.2 This manual focusses on the concepts, data sources and estimation and compilation methods behind Australia's official estimates of the resident population, which are in turn based on counts derived from the five-yearly Census of Population and Housing. Other types of population concepts are discussed in paragraphs 1.35 to 1.47.

1.3 For additional information on population concepts, see *Information Paper: Population Concepts, 2008* (cat. no. 3107.0.55.006).

POPULATION MUSTERS AND COLONIAL CENSUSES

1.4 Basic enumerations of the population have been made since the early days of European settlement in Australia. These early enumerations were known as 'musters'. The first official 'muster' was taken in 1788 soon after a new settlement at Sydney Cove was formed, and in 1803 the first 'muster' of convicts in Van Dieman's Land (now Tasmania) was conducted.

1.5 A Census conducted in New South Wales in 1828 became the first in a regular series in that colony and periodic censuses were taken in the other Australian colonies. The dates of these colonial censuses are shown in Table 1.1. The first simultaneous censuses of all the Australian colonies were taken in 1881 – this also formed part of the first simultaneous Census of the British Empire. The first national Census for Australia was taken in 1911. This national Census was followed by others in 1921, 1933, 1947, 1954 and 1961. Since 1961 censuses have been conducted at five-yearly intervals.

1.6 Censuses provide comprehensive data on the Australian population, cross-classified by a wide range of socio-economic characteristics and for a variety of geographic areas. It is also the optimal source for small area data and sub-populations. These data are referred to as 'Census counts' and are available as at Census dates only.

1.1 POPULATION CENSUSES IN AUSTRALIA—1828 to 2006

CENSUS DATE

Year	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust.
1828	November	. .	. .	. .	. .	. .	. .	. .	. .
1833	2 September	. .	. .	. .	. .	. .	. .	. .	. .
1836	2 September	. .	. .	. .	. .	. .	. .	. .	. .
1841	2 March	. .	. .	. .	. .	27 September	. .	. .	. .
1844	. .	. .	. .	26 February	. .	. .	. .	. .	. .
1846	2 March	. .	. .	26 February	. .	. .	. .	. .	. .
1847	. .	. .	. .	. .	. .	31 December	. .	. .	. .
1848	. .	. .	. .	. .	10 October	. .	. .	. .	. .
1851	1 March	. .	. .	1 January	. .	1 March	. .	. .	. .
1854	. .	(a) 26 April	. .	. .	30 September	. .	. .	. .	. .
1855	. .	. .	. .	31 March	. .	. .	. .	. .	. .
1856	1 March	. .	. .	. .	. .	. .	. .	. .	. .
1857	. .	29 March	. .	. .	. .	31 March	. .	. .	. .
1859	. .	. .	. .	. .	31 December	. .	. .	. .	. .
1861	7 April	7 April	(a) 7 April	7 April	. .	7 April	. .	. .	. .
1864	. .	. .	1 January	. .	. .	. .	. .	. .	. .
1866	. .	. .	. .	26 March	. .	. .	(b). .	. .	. .
1868	. .	. .	2 March	. .	. .	. .	. .	. .	. .
1870	. .	. .	. .	. .	31 March	7 February	. .	. .	. .
1871	2 April	2 April	1 September	2 April	. .	. .	(b). .	. .	. .
1876	. .	. .	1 May	26 March	. .	. .	(b). .	. .	. .
1881	3 April	3 April	3 April	3 April	3 April	3 April	3 April	. .	3 April
1886	. .	. .	1 May	. .	. .	. .	. .	. .	. .
1891	5 April	5 April	5 April	5 April	5 April	5 April	5 April	. .	5 April
1901	31 March	31 March	31 March	31 March	31 March	31 March	31 March	. .	31 March
1911	3 April	3 April	3 April	3 April	3 April	3 April	3 April	(a) 3 April	3 April
1921	4 April	4 April	4 April	4 April	4 April	4 April	4 April	4 April	4 April
1933	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1947	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1954	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1961	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1966	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1971	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1976	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1981	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1986	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June	30 June
1991	6 August	6 August	6 August	6 August	6 August	6 August	6 August	6 August	6 August
1996	6 August	6 August	6 August	6 August	6 August	6 August	6 August	6 August	6 August
2001	7 August	7 August	7 August	7 August	7 August	7 August	7 August	7 August	7 August
2006	8 August	8 August	8 August	8 August	8 August	8 August	8 August	8 August	8 August

. . not applicable

(a) Previously included with New South Wales.

(b) The Northern Territory was included with South Australia for the censuses of 1866, 1871 and 1876. The Northern Territory was not transferred to the Commonwealth until 1 January 1911.

Source: Commonwealth Bureau of Census and Statistics, *Official Year Book of the Commonwealth of Australia, No. 53,* 1967; ABS, *Informing a Nation: the Evolution of the Australian Bureau of Statistics, 1905-2005,* cat. no. 1382.0, 2005; ABS, *Information Paper: Census of Population and Housing, ABS Views on Content and Procedure , 2006,* cat. no. 2007.0, 2003.

Publication of population estimates

1.7 In 1910, on the basis of the early 'musters' and other colonial records, an annual series of population totals for the states was published for all years commencing from 1788, the year of the first European settlement in Australia (Commonwealth Bureau of Census and Statistics, 1910). This series is still maintained by the ABS as the electronic product *Australian Historical Population Statistics* (cat. no. 3105.0.65.001). Population totals disaggregated by sex are available from 1796 onwards.

Publication of population estimates continued

1.8 Annual estimates of the population by single year of age and sex for Australia as a whole commenced in 1921 and for the states in 1961. Quarterly updates have been required by law for states since 1977 (see sub-section 9(2) of the *Census and Statistics Act 1905*).

1.9 Annual estimates of the total population in local government areas (LGAs) have been published for New South Wales from 1911, Victoria from 1875, Queensland from 1911, South Australia from 1915, Western Australia from 1926, Tasmania from 1923 and the Northern Territory from 1981. Estimates of the total population in localities for the Australian Capital Territory have been published from 1968.

1.10 Annual estimates of the total population in statistical local areas (SLAs) have been published since 1986.

1.11 The ABS is currently building a new Australian statistical geography. From 2011 this new statistical geography will replace the current Australian Standard Geographical Classification (ASGC). See the *Review of the Australian Standard Geographical Classification, 2007* (cat. no. 1216.0.55.001) for more information.

TREATMENT OF INDIGENOUS AUSTRALIANS IN OFFICIAL POPULATION ESTIMATES

1.12 Until 1967, section 127 of the *Commonwealth of Australia Constitution Act* required the exclusion of some Aboriginal people when estimating the population: '*In reckoning the numbers of the people of the Commonwealth or of a State or other part of the Commonwealth, Aboriginal natives shall not be counted*'. This was interpreted as requiring the exclusion of 'full-blooded' Aboriginal and Torres Strait Islander people (i.e. those persons with more than 50% Aboriginal or Torres Strait Islander blood). An exception to this rule occurred when Torres Strait Islanders were classified by the 1947 Census as Polynesian and by the 1954 and 1961 Censuses as South Pacific Islanders, resulting on these three occasions in their inclusion in the population. As counting of 'full-bloods' was not a prime purpose of the Census, remote areas of Australia which were only inhabited by Aboriginal people were not enumerated, although counts were sometimes derived. The quality of such counts is questionable. See the *Occasional Paper: Population Issues, Indigenous Australians, 1996* (cat. no. 4708.0) and *The Aboriginal Population of Australia* (Smith 1980) for more information.

1.13 This provision was repealed with the proclamation of the *Constitution Alteration (Aboriginals) Act 1967* so that since 10 August 1967 population statistics have included 'full-blooded' Aboriginal and Torres Strait Islander people. Population statistics prior to 10 August 1967 have also been revised to include these persons. Population statistics by single year of age and sex for Australia and the states and territories include Aboriginal and Torres Strait Islander people from 30 June 1966, and totals (not disaggregated by age) of the population for Australia and the states and territories include them from 30 June 1961.

1.14 In censuses from 1971 onwards Aboriginal people were no longer asked to state their degree of Aboriginal descent. For example, the 2006 Census question asked 'Is the person of Aboriginal or Torres Strait Islander origin?' Changing social attitudes, political developments, improvements in Census coverage and a broader definition of Aboriginal are likely to have contributed to the rapidly rising numbers of Aboriginal people that have been recorded since 1971. For further information on Census questions on

TREATMENT OF INDIGENOUS AUSTRALIANS IN OFFICIAL POPULATION ESTIMATES *continued*

Indigenous status, refer to Indigenous Status – Characteristics in the *Census Dictionary, 2006* (cat. no. 2901.0).

ESTIMATED RESIDENT POPULATION

1.15 After the 1981 Census the concept of what constitutes the population of Australia and the states and territories was changed so that it was defined in terms of the number of usual residents – these new estimates (termed the estimated resident population, or ERP) were adopted as the official population series. Prior to this the population had been defined as the number of people actually present at a given time – at the time of the Census this meant the number of people actually counted and therefore included foreign tourists but excluded Australians abroad. Population estimates based on the concept of usual residence were constructed back to 1971.

1.16 Estimates of the resident population are compiled initially at the Census date by firstly adjusting the Census count of residents upwards to compensate for net underenumeration in the Census, and then further adjusting (also upwards) to include an estimate of the number of Australian residents who were temporarily overseas on Census Night.

1.17 A detailed account of the introduction of the ERP series is available in *Methods and Procedures in the Compilation of Estimated Resident Population 1981 and in the Construction of the 1971–81 Time Series* (cat. no. 3103.0).

1.18 Estimates of the resident population are updated quarterly at the state/territory level and annually at the SLA and LGA levels.

1.19 During the 1980s these statistics were further expanded with the addition of three new annual series (included in the following table). A complete listing of the population estimates series now published by the ABS is given in Table 1.2, with additional unpublished estimates available as indicated in the footnotes.

ESTIMATED RESIDENT POPULATION *continued*

1.2 PUBLISHED POPULATION ESTIMATES SERIES, Geography by availability

Geography and population estimates series	*Availability of published estimates*(a)
National and state/territory	
Total population	Quarterly
Age and sex	Annual(b)
Age, sex and marital status	Five-yearly
Age, sex and country of birth	Annual(c)
Age, sex and Indigenous status	Annual experimental estimates(d)
Statistical local area (SLA) and local government area (LGA)	
Total population	Annual
Age and sex	Annual

(a) Quarterly estimates are available as at 31 March, 30 June, 30 September and 31 December. Annual and five-yearly estimates are available as at 30 June.
(b) Unpublished quarterly estimates also available.
(c) Population estimates by country of birth at the state/territory level are only available for Census years.
(d) Population estimates for the Indigenous population are experimental and are published every five years (after Census results are released).

Estimating population for the territories

1.20 Prior to the 1996 Census, no external territories were included in geographical Australia although Census data were collected for Christmas Island and the Cocos (Keeling) Islands. Following amendments to the *Acts Interpretation Act 1901* effective from July 1992, the two external territories of Christmas Island and Cocos (Keeling) Islands became part of geographical Australia. Since the 1996 Census, Christmas Island, Cocos (Keeling) Islands, and the Jervis Bay Territory (previously linked to the Australian Capital Territory for statistical purposes) comprise a pseudo 'ninth state/territory' of Australia. They are included in state nine 'Other Territories'.

1.21 Although the Census and Statistics Act does not require quarterly estimation of the population for the territories, estimates for the Northern Territory, the Australian Capital Territory and the Other Territories are produced as these territories are included in the geographical area of Australia, and, with the states, sum to the Australian population.

1.22 Estimates for the remaining Australian External Territories are updated annually as at 30 June unless a more recent estimate is required for electoral apportionment purposes under the *Commonwealth Electoral Act 1918*. Australian External Territories include Territory of Ashmore and Cartier Islands, Coral Sea Islands Territory, Australian Antarctic Territory and Territory of Heard and McDonald Islands. It does not include Norfolk Island which is a self-governing territory of Australia (see the *Norfolk Island Act 1979*).

USE OF POPULATION ESTIMATES

1.23 Population estimates are used for a wide variety of purposes, including:

- the distribution of Australian Government funds to state, territory and local governments
- the apportionment of the number of seats in the House of Representatives
- the formulation, monitoring and evaluation of government policy
- market research

USE OF POPULATION ESTIMATES *continued*

- academic research
- the denominator in per capita rates
- informing on issues such as:
  - population ageing
  - fertility (the ability of a population to replace itself)
  - international migration.

1.24 There are a number of different dimensions or ways of looking at a population which can inform on social issues. Of particular interest are:

- population size and trends
- population distribution (various geographic levels)
- population composition (age and sex)
- population size and distribution of sub-population groups such as:
  - Aboriginal and Torres Strait Islander population
  - Australian born population
  - overseas born population.

Legislative requirements

1.25 There are several legislative requirements for the Statistician to provide population estimates (as opposed to Census counts) – some important examples are shown in the following paragraphs. Other Acts may also reference official population estimates, without specifically referring to the Statistician.

1.26 Sub-section 9(2) of the Census and Statistics Act requires the quarterly estimation of the population for each state:

> "The Statistician shall collect such information as is necessary for the compilation and analysis... of statistics of the number of the people of each State as on the last day of March, June, September and December in each year..."

1.27 Section 7 of the *Federal Financial Relations Act 2009* requires the Statistician to provide estimates of the populations of each state as at 31 December of a year before 31 August in the following year.

> "The *estimated population* of a State on 31 December in a payment year is the population of the State on that date as determined by the Australian Statistician after that date and before 31 August in the following payment year."

1.28 Under the *Local Government (Financial Assistance) Act 1995*, funds are allocated by the Australian Government for local governments. This again requires the provision by the Statistician of estimates of the population. See Section 4A of the act for more information.

1.29 The Commonwealth Electoral Act (sections 46 to 48) requires the Statistician to supply all such population statistics as requested by the Australian Electoral Commission for the regular review of the number of seats each state is entitled to have in the House of Representatives. An amendment in 1989 to the Commonwealth Electoral Act requires the Statistician to supply on request the 'latest statistics' for territorial as well as state populations. In addition to the Northern Territory and Australian Capital Territory, population figures are required for Jervis Bay Territory, Cocos (Keeling) Islands, Christmas Island, Heard and McDonald Islands, Ashmore and Cartier Islands, the Australian Antarctic Territory and the Coral Sea Islands Territory.

Legislative requirements continued

1.30 Section 48 of the Commonwealth Electoral Act was also amended in 2004 such that (in addition to other changes), in certain circumstances, two standard errors of the measure of net undercount at the previous Census will be added to the populations of the Australian Capital Territory and Northern Territory in determining the seat entitlement in the House of Representatives. Further information may be found in the *Information Paper: Determining Seats in the House of Representatives – Legislative Requirements for Provision of ABS Statistics, 2005* (cat. no. 3107.0.55.002).

Policy requirements

1.31 There are few government programs at any level of government which do not use population estimates in some form. Population estimates are used in the formulation of most policies, particularly those involving service delivery and are also needed to monitor existing government programs. The major requirements are for annual estimates of the population by age and sex at the state/territory and/or SLA level. Some policy purposes also require estimates by other characteristics in addition to age and sex (e.g. country of birth, or Indigenous and non-Indigenous peoples of Australia).

Other requirements

1.32 Applications for population estimates in private enterprise and other non-government activities are too numerous to describe in detail, although they may be broadly described as 'market research' and 'academic/demographic research'. Requirements for these applications vary a great deal between individual clients, although the main needs are for estimates by composition and distribution. The demand for population data for very small geographic areas is generally satisfied by the five-yearly population Census.

1.33 Population estimates form the basis of benchmarks used to weight results from surveys conducted by ABS and other organisations. They are also used by the ABS and various Australian and state government agencies in the production of population projections. For further information on population projections, refer to the forthcoming publication *Population Projections: Concepts, Sources and Methods* (cat. no. 3228.0.55.002).

1.34 Finally, many statistical indices and rates have a population estimate as their denominator. These indices and rates range from per capita gross domestic product and labour force participation rates to fertility rates, life tables and educational participation rates. Most indices and rates are based on total populations by age and sex for states/territories, although in some cases disaggregation of the population by other characteristics is also required. For example, divorce rates calculated as a proportion of the estimated number of married people (that is, the at risk population) are more appropriate than as a proportion of estimated total persons.

OTHER POPULATION CONCEPTS

1.35 There are a range of other concepts (in addition to Census counts and the estimated resident population) that can be used to determine what the population of a given area is. The following paragraphs discuss some of the concepts behind legal populations, economic populations and service populations. However, the definitions of what these populations are may vary according to the particular situations and purposes for which they are needed.

Legal population

1.36 Conceptually, the legal population of Australia would primarily consist of persons with Australian citizenship, irrespective of whether these persons are actually resident in Australia at a given time. However estimation of what the legal population would be is complicated by the fact that there are other groups of people who have a legal right to live in Australia, whether permanently or for a set duration of time.

1.37 In Australia, the word 'citizen' can have a specific legal meaning, as defined under the *Australian Citizenship Act 2007*. This legal status confers a range of rights and responsibilities including the right to apply for public office, the right to apply for an Australian passport and the responsibility to enrol on the Electoral Register and vote (with the exception of prisoners and persons of unsound mind). Australian citizenship can be acquired through birth, descent, adoption or a grant of citizenship.

1.38 However, there are several other groups of people who have a legal right to live in Australia indefinitely, such as permanent residents who have not applied for citizenship and New Zealand citizens living in Australia (who, under the Trans Tasman Agreement, are not required to have a visa to travel to Australia). In addition, many overseas travellers possess visas which allow them to live in Australia for extended periods of time (e.g. those on student or business visas).

1.39 A legal population can apply to any legal status or entitlement conferred by the government. For example, British subjects that have been on the Commonwealth Electoral Roll since 1984 are not citizens of Australia, but are entitled to vote in Australian elections and so are included in a legal population of people entitled to vote. Likewise, people eligible to be covered by Medicare could be considered part of a legal population of people with Medicare entitlements.

Economic population

1.40 The ABS compiles a range of statistics relating to the Australian economy, including the national accounts, balance of payments, financial accounts and government finance statistics. These economic statistics are compiled according to international standards, and comply with the System of National Accounts 1993 (United Nations, 1993) as well as the fifth edition of the Balance of Payments Manual (International Monetary Fund, 1993). The scope of an economic population differs from that of the estimated resident population both in terms of definitions of what constitutes Australian territory, as well as definitions of what persons are included as resident individuals and households.

1.41 Conceptually, Australia's economy comprises economic entities (whether households, non-profit institutions, government units or corporations) that have a closer association with the territory of Australia than with any other territory. Australia's economic territory includes:

- territories lying within Australia's political frontiers and territorial seas, and in the international waters over which Australia has exclusive jurisdiction
- territorial enclaves abroad, whether owned or rented by Australian governments with the formal agreement of the countries where they are located (e.g. embassies, consulates, military bases, scientific stations, information or immigration offices and aid agencies). Similar foreign enclaves in Australia are excluded from Australia's economic territory.

Economic population continued

1.42 The external territories of Christmas Island, the Cocos (Keeling) Islands, the Australian Antarctic Territory and Norfolk Island are regarded as part of Australia's economic territory.

1.43 For balance of payments purposes, resident households and individuals include all persons residing in Australia's economic territory for one year or more, whose general centre of interest is considered to be Australia. Official diplomatic and consular representatives, armed forces and other government personnel stationed abroad (and their dependents), as well as Australian students studying abroad for one year or more are also considered to be Australian residents because their centre of economic interest remains Australia.

1.44 In general, persons visiting Australia for less than one year are regarded as non-residents for balance of payments purposes because their centre of economic interest is considered to be overseas. However, overseas students and medical patients are treated as residents of their country of origin, irrespective of the duration of their visit to Australia.

Service population

1.45 A service population comprises both resident and non-resident populations that happen to be in a specified area, and demand and/or use goods or services over a specified time. People in a service population may be permanent or temporary residents of the area from which the service is sought, or they may be daytime visitors (including commuters), overnight or short-term visitors to the area. Service populations could include:

- commuter populations
- daytrippers
- tourists and other overnight visitors
- temporary residents, such as:
  - seasonal workers (e.g. fruit pickers, other harvest and agricultural workers)
  - cyclical employees (e.g. fly-in/fly-out mine workers, members of parliament, senators and support staff in Canberra when Parliament is sitting)
  - winter-time visitors to sunbelt zones
  - residents of Aboriginal outstations in the dry season.

1.46 A significant issue associated with service population estimation is the diversity of service providers and service products. This means that there is a lack of conformity in user needs, as service population providers seek a diverse range of service population definitions. Specifically, considerable variability exists in the demographic and geographic characteristics of the target populations to which different services are intended. Other issues that complicate the estimation of service populations include definitional difficulties and difficulties in obtaining appropriate data sources.

1.47 The *Information Paper: Population Concepts, 2008* (cat. no. 3107.0.55.006) suggests that there are a number of indicators for which a rise and fall in the service population would create a corresponding rise and fall in the indicator. Examples of such indicators are household and personal consumption (such as water, electricity, gas) and measures of waste production (such as sewerage flows). Non availability and lack of uniformity of data are the major limitations to estimating the size of a service population.

CHAPTER 2 ESTIMATING NATIONAL AND STATE POPULATION

INTRODUCTION

2.1 Population estimates by sex for Australia and each of the states and territories are published quarterly as at 31 March, 30 June, 30 September and 31 December in *Australian Demographic Statistics* (cat. no. 3101.0). Estimates by single year of age and sex are compiled quarterly but are only published annually as at 30 June in *Population by Age and Sex, Australian States and Territories* (cat. no. 3201.0).

2.2 Two main steps are involved in estimating the national and state/territory population:

- calculating the base population (Census year population estimates)
- updating this base population (post-censal population estimates).

2.3 The post-censal population estimates are derived by bringing forward the base population by ageing the base, then adjusting for subsequent components of population growth, i.e. births, deaths, overseas and interstate migration. This method is called the cohort component method.

2.4 Population estimates are referred to as either preliminary, revised or final. Preliminary estimates are generally made available 5 to 6 months after the reference quarter. Revised estimates are generally published each March for the financial year ending 21 months previously (e.g. revised estimates for the 2006–07 financial year were available in March 2009). Final estimates are published for the previous five-yearly intercensal period after each Census.

2.5 The following equation is known as the demographic balancing equation (Shryock, Siegel and Associates, 1976) and is used to update the base population.

$$P_{t+1} = P_t + B_{t,t+1} - D_{t,t+1} + NOM_{t,t+1} + NIM_{t,t+1} + e_{t,t+1}$$

where:

P_t = the estimated resident population at the end of period t
P_{t+1} = the estimated resident population at the end of period $t+1$
$B_{t,t+1}$ = births occurring during the period t, $t+1$
$D_{t,t+1}$ = deaths occurring during the period t, $t+1$
$NOM_{t,t+1}$ = net overseas migration during the period t, $t+1$
$NIM_{t,t+1}$ = net interstate migration during the period t, $t+1$
$e_{t,t+1}$ = residual error for the period t, $t+1$

2.6 As complete component data (births, deaths, net overseas migration and net interstate migration) is often not available at the time an estimate is compiled, a residual error $e_{t,t+1}$ is included. This residual error encompasses measurement error for the components of population growth (births, deaths, overseas and interstate migration). The residual error can only be measured after each Census, and is referred to as intercensal discrepancy (see below).

CENSUS ESTIMATES

Census year population estimates

2.7 Census year population estimates are calculated for each state and territory by sex and single year of age (from 0 years to 115 years and over).

2.8 There are four steps involved in arriving at these estimates, the results of which are detailed in Table 2.1:

STEP 1

2.9 Census counts of residents are compiled for each state and territory by single year of age and sex ('counts of residents' means that people counted in the Census who usually reside overseas are excluded, such as visiting tourists). The question in the 2006 Census from which these data were derived is as follows:

Where does the person usually live?

- For persons who usually live in another country and who are visiting Australia for less than one year, mark 'Other country'.
- For other persons, 'usually live' means that address at which the person has lived or intends to live for a total of six months or more in 2006.
- For persons who now have no usual address, write 'NONE' in the 'Suburb/Locality' box.
- For boarders at boarding school, write the address of the boarding school or college.

STEP 2

2.10 The Census counts of residents are then adjusted upwards to compensate for Census net undercount. In 2006, about 3.0% of the population were not counted by the Census, while 0.3% were counted more than once. These two figures produced a net undercount rate of 2.7%. The precise degree of adjustment is based on estimates of undercount from the Census Post Enumeration Survey (PES) and to a lesser degree comparisons between Census results and independent 'demographic' and other estimates of the population – see Appendix 1 – Demographic adjustment.

2.11 The PES is a sample survey conducted shortly after the Census to estimate the number of people (and their characteristics) who did not complete or were not included on a Census form. It also detects instances of multiple counting of individuals but the number of such cases is far outweighed by the number of people who are not counted. The net undercount is therefore the excess of the undercount (people not counted) over the number of instances of multiple counting.

2.12 Net undercount for each category (i.e. state, SLA, sex, age, Indigenous status) is the net result of the PES estimate of gross undercount, gross overcount, differences in classification between the PES and Census (eg. age, sex, Indigenous status) and imputation error in the Census. Details of the 2006 PES are available in:

- *Census of Population and Housing – Undercount, 2006* (cat. no. 2940.0)
- *Census of Population and Housing – Details of Undercount, Aug 2006* (cat. no. 2940.0)
- *Information Paper: Measuring Net Undercount in the 2006 Population Census, 2007* (cat. no. 2940.0.55.001)
- *Research Paper: An Estimating Equation Approach to Census Coverage Adjustment* (cat. no. 1351.0.55.019).

Census year population estimates continued

STEP 2 *continued*

2.13 The 'demographic' estimates are an annual population series for Australia as a whole, compiled solely from registered births and deaths and overseas migration data from 1925 onwards (i.e. they are compiled irrespective of Census counts, see Appendix 1 – Demographic adjustment).

2.14 A detailed description of the 2006 adjustment for net undercount is contained in Chapter 9 – Data sources.

STEP 3

2.15 Estimates of the number of Australian residents temporarily overseas on Census Night (RTOs) are obtained from passenger card statistics for those Australian residents returning in the twelve month period subsequent to the Census date who were overseas on Census Night. The residency status is calculated using the improved net overseas migration (NOM) method (see Chapter 6 – Estimating net overseas migration), and the residents are added to the adjusted Census counts derived in Step 2 to give Census year population estimates. The population estimates are then converted from age to financial year of birth, which for the 8 August 2006 Census date required adjusting all cohorts for the 39 day period back to 30 June by taking 39/365 of each cohort and adding it to the next one.

STEP 4

2.16 As the Census does not fall on 30 June, a further adjustment is necessary to arrive at estimates for that date. For example, the 2006 Census was held on 8 August, and after Steps 1 to 3, the population estimates at 8 August were back-dated to 30 June. This used data from birth and death registrations, overseas arrivals and departures data and estimates of interstate migration for the period 1 July to 8 August.

2.1 ADJUSTMENT COMPONENTS OF ESTIMATED RESIDENT POPULATION, Final—30 June 2006

	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Aust. (a)
	'000	'000	'000	'000	'000	'000	'000	'000	'000
Persons									
Components as at 8 August 2006:									
Census count, actual location	6 585.7	4 915.3	4 046.9	1 509.0	1 986.2	470.8	217.1	327.9	20 061.6
plus – Residents absent interstate	74.8	87.7	38.1	28.4	19.2	13.0	4.5	10.5	276.3
less – Interstate visitors	54.3	36.2	107.5	13.8	25.1	5.5	22.1	11.4	276.3
less – Overseas visitors	57.0	34.4	72.9	9.2	21.3	1.8	6.7	2.9	206.4
equals – Census count, place of usual residence	*6 549.2*	*4 932.4*	*3 904.5*	*1 514.3*	*1 959.1*	*476.5*	*192.9*	*324.0*	*19 855.3*
plus – Allowance for under-enumeration	157.6	113.6	148.4	36.3	64.2	9.5	15.9	4.0	549.6
plus – Demographic adjustment	–5.1	–3.4	–2.8	–1.0	–1.3	–0.3	–0.2	–0.2	–14.3
plus – Residents temporarily overseas	124.3	94.6	50.5	20.2	42.5	4.6	2.5	6.8	346.0
equals – ERP as at 8 August 2006	*6 826.0*	*5 137.3*	*4 100.6*	*1 569.8*	*2 064.4*	*490.3*	*211.1*	*334.7*	*20 736.6*
Backdating components to 30 June 2006:									
less – Births	9.6	7.1	6.0	2.0	2.9	0.7	0.4	0.5	29.3
plus – Deaths	5.4	3.9	2.9	1.4	1.3	0.4	0.1	0.2	15.6
less – Net interstate migration	–2.4	–0.1	2.4	–0.2	0.4	–0.1	0.1	—	—
less – Net overseas migration	8.2	7.6	4.2	1.5	3.1	0.1	0.1	0.2	25.0
equals – final ERP 30 June 2006	*6 816.1*	*5 126.5*	*4 090.9*	*1 567.9*	*2 059.4*	*490.0*	*210.6*	*334.1*	*20 697.9*

— nil or rounded to zero (including null cells) (a) Includes Other Territories

POST-CENSAL POPULATION ESTIMATES

Estimates of the total population

2.17 Using the Census year (i.e. 30 June) population estimates as the base population, post-censal estimates at the national level are compiled in accordance with births, deaths, and overseas migration. At the state and territory level, an additional item, interstate migration, is included.

2.18 The demographic balancing equation (see paragraph 2.5) describes this process conceptually, however the operational definition used to compile population estimates assumes the error term equals zero.

2.19 The resulting population estimates (P_{t+1}) then become the base population in the calculation of estimates for the following period. Estimation of the separate components of population change is detailed in Chapter 5 – Estimating births and deaths, Chapter 6 – Estimating net overseas migration and Chapter 7 – Estimating interstate migration.

Population estimates by age

2.20 The procedure outlined above, estimates the total population by updating the base population with the components of population change by sex and financial year of birth, then aggregating to state or territory. This requires data for the components to be classified by financial year of birth in order to match each event to its corresponding cohort in the population. (Population estimates by single year of age at 30 June in effect are a classification of the population according to financial year of birth.)

2.21 Prior to 30 September 2007, classification by financial year of birth was only available for two of the three components of change i.e. births and migration. It was not available for deaths because, apart from a few exceptions (each state and territory has its own notification form), death certificates only required notice of the deceased person's age at the time of death; they did not require date of birth. Knowledge of a person's age is not sufficient information to determine whether that person's birthday has already occurred in the current financial year. Since ABS could not capture information for all

Population estimates by age continued

states and territories on date of birth of the deceased from death certificates, financial year of birth had to be estimated from age at death.

2.22 The procedures used to create population estimates by age prior to 30 September 2007 can be found in the previous edition of this publication, *Demographic Estimates and Projections: Concepts, Sources and Methods, 1999* (cat. no. 3228.0).

2.23 From October 2007, date of birth was available on death certificates from all states and territories, therefore financial year of birth could be calculated for all components of change.

OTHER ESTIMATES

Population estimates by marital status

2.24 Prior to 30 June 1998, annual estimates of the population by marital status were compiled quarterly and published annually as at 30 June by single year of age and sex for Australia as a whole. They were based on Census year estimates and were updated using the component method (i.e. using data from births, deaths, marriages, divorces and migration records).

2.25 The procedures used to create population estimates by marital status prior to 30 June 1998 can be found in the previous edition of this publication, *Demographic Estimates and Projections: Concepts, Sources and Methods, 1999* (cat. no. 3228.0).

2.26 From July 1998, data on the marital status of overseas arrivals and departures were only provided on visa applications (and only for certain visa classes). Since these data were not available for a high proportion of movers, mainly Australian and New Zealand citizens, the 1997–98 distribution of overseas arrivals and departures by age, sex and marital status was used for the overseas migration component of ERP estimates by marital status for 30 June 1999 and 30 June 2000.

2.27 From 30 June 2001, estimates by marital status were only calculated after each Census. State and territory-level estimates were also calculated for Census years only.

2.28 The marital status categories for which the estimates are produced (i.e. single, married, widowed and divorced) refer to 'registered' marital status. People who state at the Census that they are 'separated but not divorced', for example, are classified in the estimates as 'married'. People in de facto relationships were classified according to their response to Question 6 "What is the person's present marital status?" in the most recent Census (i.e. never married, widowed, divorced, separated but not divorced, married).

CENSUS YEAR POPULATION ESTIMATES BY MARITAL STATUS

2.29 In 2006 population estimates by marital status, single year of age and sex were produced using the following steps:

Step 1

2.30 Census counts of residents are compiled by single year of age and sex for each marital status category. ('Census counts of residents' means that overseas visitors who are counted in the Census are excluded.) Marital status is imputed for people who did not respond to this question on the Census form. (In 2006 marital status was imputed from other details supplied on the Census form or, failing that, information provided by the Census collector.)

Population estimates by marital status continued

Step 2

2.31 Net undercount rates derived from the PES for each marital status category, are applied to the Census counts in Step 1 and scaled to state/territory or Australian-level PES-adjusted Census counts for each age and sex.

Step 3

2.32 In 2006, RTOs by age and sex for each marital status were added to the adjusted Census counts derived in Step 2 to give Census date age/sex marital status population estimates. These RTOs were synthetically derived from RTOs by state/territory, sex and age, 2006 PES data by marital status and sex and 2006 PES data by state/territory, age and sex, using an iterative proportional fitting procedure (see Appendix 5 – The iterative proportional fitting procedure).

Step 4

2.33 Census data for ages 15 to 19 are particularly susceptible to anomalies from such things as stray marks on the Census form, imputation procedures and mischievous responses. When compared with data from the state and territory Registrars of Births, Deaths and Marriages, numbers of young divorcees, widows and married persons in the Census appear high. To overcome this, demographic estimates are used for this age group. This involved 2001–06 registration data by age for brides and grooms, divorces and deaths. Age of surviving spouse (i.e. widows' age) is derived using a Census matrix of relative spouse ages. The marital status of recent overseas migrants to Australia aged 15 to 19 is also included after minor demographic adjustment.

Step 5

2.34 As the Census does not fall on 30 June, a further adjustment is necessary to backdate these estimates to 30 June. For example, the 2006 Census was held on 8 August, and after Steps 1 to 4 were finalised the population estimates at 8 August were back-dated to 30 June. This was accomplished using death registrations and interstate migration data for the period 1 July to 8 August 2006. Finally the figures were constrained to state/territory and Australian-level 30 June population estimates by age and sex. This also helps overcome the lack of overseas migration data for backdating and introduces the age adjustment for persons with birthdays between 30 June and Census night described earlier.

Population estimates by country of birth

2.35 Quarterly population estimates by country of birth are compiled and published annually as at 30 June for Australia as a whole. These estimates, produced by single year of age and sex, classify the population according to countries of birth.

CENSUS YEAR POPULATION ESTIMATES BY COUNTRY OF BIRTH

2.36 Population estimates by country of birth at 30 June in the Census year are compiled as follows:

Population estimates by country of birth continued

Step 1

2.37 Census counts of residents (i.e. excluding overseas visitors) are compiled by single year of age and sex for each country of birth. Country of birth is imputed for those people who did not respond to this question on the Census form. This is achieved using the distribution of country of birth from the PES.

Step 2

2.38 Net undercount rates are derived from the PES for the 10 countries with the highest Census representation (including Australia), plus a *remainder* category. These rates are applied to the results from Step 1 and constrained to total Australian age and sex PES-adjusted Census counts. This yields Census counts adjusted for undercount and not-stated country of birth. The eleventh, that is the *remainder*, country category then serves as a constraint for scaling all other (i.e. non top-10) country of birth Census counts.

Step 3

2.39 RTOs by sex and country of birth are added to the adjusted Census counts derived in Step 2 to give Census year country of birth population estimates. These RTOs are derived from aggregated passenger card information originally provided by the Department of Immigration and Citizenship (DIAC).

Step 4

2.40 As the Census does not fall on 30 June, a further adjustment is necessary to produce estimates as at the nearest 30 June reference date. For example, the 2006 Census was held on 8 August, and after Steps 1 to 3, the population estimates at 8 August was back-dated to 30 June. This was accomplished using data on birth and death registrations and overseas arrivals and departures for the period 1 July to 8 August 2006.

Step 5

2.41 Data from Step 4 are converted to financial year of birth then forced (see Appendix 5 – The iterative proportional fitting procedure) to add to the 30 June population estimates of all residents by financial year of birth and sex (as described in paragraph 2.20).

Step 6

2.42 Population in non-specific country of birth categories (e.g. "United Kingdom - Not Further Defined") are redistributed pro rata across the countries in that region.

2.43 For 30 June estimates in Census years only, population estimates by country of birth, age and sex are also cross-classified by state/territory. This was achieved using a similar approach to that outlined above, and included an interstate migration backdating component and simultaneously constraining by age and sex to both Australian-level country of birth estimates and state/territory level estimates. Post-censal country of birth estimates by state and territory are not available as there is insufficient data on interstate migration by country of birth.

Population estimates by country of birth continued

POST-CENSAL POPULATION ESTIMATES BY COUNTRY OF BIRTH

2.44 Quarterly population estimates by country of birth for post-censal years are compiled by updating the Census year estimates in accordance with births, deaths and overseas migration. Each component of change is first converted to financial year of birth. The population for each country of birth by birth cohort are then updated as follows:

For the Australia-born population

$$P_t^a = P_{t-1}^a + B_t - D_t^a + NOM_t^a$$

For all other countries of birth

$$P_t^b = P_{t-1}^b - D_t^b + NOM_t^b$$

where:

P_t^b = the population at the end of quarter t born in country b
P_{t-1}^b = the population at the end of quarter $t-1$ born in country b
B_t = births in quarter t
D_t^b = deaths in quarter t of persons born in country b
NOM_t^b = net overseas migration in quarter t of persons born in country b

2.45 For each component, persons with non-specific country codes are distributed pro rata across the countries in their region.

2.46 Prior to the introduction of the new NOM method (see Chapter 6 – Estimating net overseas migration), there had been concern about the reliability of long-term overseas migration data, including the manifestation of some countries with many long-term arrivals but far fewer departures. Therefore between

2001 and 2006 overseas migration by country of birth was derived from permanent flows only, constrained to net Australian levels.

Experimental estimates of the Indigenous population

2.47 After each Census, estimates of the Indigenous (Aboriginal and Torres Strait Islander) population by age and sex for the states and territories and Australia are compiled for the Census year and ten or fifteen preceding years. Therefore while estimates are available from 1986, at the time of publishing only 1991–2001 are on the same basis (2001 Census-base), and 1991–2006 on the 2006 Census-base are expected to be released later in 2009.

2.48 The estimates are 'experimental' in that the standard approach to population estimation is not possible because satisfactory data on births, deaths, overseas and internal migration are not generally available. Furthermore, there is significant intercensal volatility in Census counts of the Indigenous population, thus adding to the problem of estimating the true Indigenous population. This volatility can in part be attributed to the change in propensity for persons to be identified as Indigenous as recorded on a Census forms.

Experimental estimates of the Indigenous population continued

2.49 Since 2001, Census year Indigenous estimates have been produced concurrently with statistical local area (SLA) population estimates. This is so the Indigenous estimates better reflect undercount rates by Indigenous status and that SLA estimation by Indigenous status is not a post-hoc process. This is described in greater detail in Chapter 3 – Estimating population for statistical local areas.

2.50 The process involved apportioning usual residence Census counts of persons with not-stated Indigenous status to Indigenous or non-Indigenous, by SLA, age, sex and Census form-type. Applied to these were synthetic net undercount adjustments by state/territory, age, sex and Indigenous status, then age structures adjusted to correspond to 30 June. SLA by Indigenous status estimates were finally derived through constraining by age and sex to synthetic capital city/balance of state/territory population estimates and SLA age-sex totals, adjusting for RTOs and backdating population components from Census date to 30 June.

2.51 For 30 June 2001, Australian and state/territory Indigenous estimates were 'survived' back to 30 June 1991 using life tables. This method is known as the reverse survival method and assumes zero net internal and zero overseas migration.

2.52 For more information see Chapter 8 – Estimating the Indigenous population.

INTERCENSAL REVISION OF POPULATION ESTIMATES

2.53 When the Census year (i.e. 30 June) population estimates become available for the states and territories and Australia they can be compared with the alternative estimates for the same date already produced by updating the previous Census year estimate in quarterly steps using births, deaths and migration data. The estimate calculated using the current Census-based estimate is commonly referred to as the 'rebased' estimate, whereas the estimate calculated using the previous Census-based estimate is called the 'unrebased' estimate. The difference between the two estimates for each state and territory and Australia is called the 'intercensal error'.

2.54 Of these two estimates, the new Census-based estimate is customarily adopted as the true estimate.

2.55 The intercensal error can be explained in two different ways;

- as a residual error from the previous Census (calculated by the unrebased estimate less the rebased estimate), or
- as an indicator of how much the unrebased estimate over or under-estimated the true estimate (calculated by the rebased estimate less the unrebased estimate).

2.56 All references to intercensal error in this publication use the first interpretation, i.e. a positive number indicates that the unrebased estimate was higher than the rebased estimate and a negative number indicates than it was lower than the rebased estimate.

2.57 To overcome the break in continuity that using the new (rebased) estimate would entail, all intercensal population estimates using the previous Census as their base are then revised. In doing so, it is assumed that the error is accumulated by an equal number each quarter over the intercensal period. For example, in the case of a five-year intercensal period, (i.e. 20 quarters), the population at the end of the first quarter is adjusted up or down by 1/20 of the intercensal error, the second quarter is adjusted by 2/20, the third by 3/20 etc.

INTERCENSAL REVISION OF POPULATION ESTIMATES *continued*

2.58 Details of the intercensal error for the states and territories and Australia at 30 June 1991, 1996, 2001 and 2006 are shown in Table 2.2.

2.2 INTERCENSAL ERROR, State/territory of usual residence—at 30 June

	1986-1991	*1991-1996*	*1996-2001*	*2001-2006*
	PERSONS ('000)			
New South Wales	2.4	–15.8	–27.0	2.8
Victoria	7.0	–20.9	35.6	–36.2
Queensland	11.1	15.9	5.8	–24.0
South Australia	10.4	4.5	–9.6	–12.8
Western Australia	(a)29.9	–3.3	11.5	–7.3
Tasmania	–6.3	–1.1	–1.8	–0.8
Northern Territory	–6.7	(b)–5.2	–0.2	–2.9
Australian Capital Territory	4.2	–1.2	–4.3	–4.7
Australia(c)	**51.9**	**–27.5**	**10.6**	**–85.7**
	PERCENT OF POPULATION			
New South Wales	0.04	–0.25	–0.41	0.04
Victoria	0.16	–0.46	0.74	–0.71
Queensland	0.34	0.48	0.16	–0.59
South Australia	0.72	0.31	–0.63	–0.82
Western Australia	(a)1.83	–0.19	0.60	–0.35
Tasmania	–1.35	–0.23	–0.39	–0.16
Northern Territory	–4.05	(b)–2.86	–0.11	–1.40
Australian Capital Territory	1.45	–0.39	–1.36	–1.40
Australia(c)	**0.30**	**–0.15**	**0.05**	**–0.41**

(a) Approximately 9,000 persons of the intercensal error caused by PES over-adjustment in 1986.

(b) 1,045 persons of the intercensal error for the NT can be attributed to an under-estimate of the 1991 NT estimated resident population.

(c) Includes a small component of intercensal error for Other Territories.

2.59 The accuracy of Australia's post-censal population estimates compares favourably with that of other countries (see Table 2.3).

INTERCENSAL REVISION OF POPULATION ESTIMATES *continued*

2.3 INTERNATIONAL COMPARISON OF ABSOLUTE INTERCENSAL DISCREPANCY, Percent of population—1981 to 2006

Country	*1981*	*1986*	*1991*	*1996*	*2001*	*2006*
Australia						
National	0.3	0.3	0.3	0.2	0.1	0.4
State/territory(a)	1.6	1.2	1.2	0.4	0.6	0.7
Canada(b)						
National	0.4	0.4	0.1	0.6	0.2	0.3
Province(a)	1.8	1.2	1.2	0.9	0.7	1.0
USA (1980, 1990 and 2000)(b)						
National	2.1	-	0.5	-	2.4	-
State(a)	2.5	-	1.5	-	2.6	-
England and Wales						
England and Wales(a)	0.2	-	0.4	-	0.4	-
Constituent Counties and Unitary Authorities(a)(c)	1.8	-	2.5	-	1.8	-
New Zealand(d)						
National	0.4	0.3	0.6	0.1	(e)0.8	1.1

(a) Average absolute error.
(b) Equates with error of closure which is the difference between population estimates produced prior to a Census and corresponding Census counts. (No account is taken of variations in undercount between censuses)
(c) Unitary authorities, single tier authorities, were introduced between 1995–98. These superseded a number of county districts although many areas retained the two tiered structure.
(d) Intercensal discrepancies from 2001 are based on the resident population concept, while figures for earlier years are based on the de facto population concept and equate with Census error of closure.
(e) Intercensal discrepancy for 2001 is calculated from the published estimates at the time, so does not reflect the revision to the base population at 30 June 1996 which occurred in 2002 following revision to estimated net undercount in the 1996 Census. Using the revised 1996 base population yields a 2001 intercensal discrepancy of 0.4%.

2.60 There are two areas which contribute to the intercensal error:

- errors in the Census-based estimates of the population at the current or previous Census date (a one-off error at the time of compiling the estimates); and/or
- errors in the estimates of any of the components of population change since the previous Census (an error which compounds over the intercensal quarters).

2.61 After the intercensal error at the state/territory level is adjusted for revisions using Census data on interstate migration, the remaining unattributable portion is referred to as the intercensal discrepancy. The intercensal discrepancy acts as a balancing item, that when combined with births, deaths and migration equals the difference between the two 30 June Census year population estimates.

2.62 The final intercensal error is the preliminary intercensal error adjusted for finalised estimates of births and deaths which occurred between 2001 and 2006. As there is a lag before finalisation of these components of population change, final intercensal error is calculated considerably later than the preliminary levels.

INTERCENSAL REVISION OF POPULATION ESTIMATES *continued*

2.63 The final intercensal discrepancy is equivalent to the final intercensal error but with the interstate migration revisions introduced to account for intercensal error. They are therefore identical at the Australian, but not state and territory level.

2.4 DEFINITIONS OF INTERCENSAL ERROR AND INTERCENSAL DISCREPANCY

Definition	*Unrebased estimate*	*Rebased estimate*
Preliminary intercensal error	Preliminary	Preliminary
Final intercensal error	Revised	Final
Final intercensal discrepancy	Final(a)	Final

(a) Revisions to interstate migration on the basis of the current Census.

2.64 An assessment of the accuracy of Census date population estimates and the components of population change is given in Chapter 9 – Data sources.

Intercensal revision 2001–06

2.65 For the 2001–06 state and territory intercensal estimates, the 2006 Census allowed an assessment of how much of the intercensal error was due to inaccuracies in estimates of interstate migration. The 2006 Census data which allowed this assessment were from the two Census questions on usual residence 1 year ago and 5 years ago. Estimates of interstate migration based on Census data were used to revise the interstate migration component of population updates for the intercensal period, before the intercensal discrepancy was calculated.

(A) REVISIONS OF INTERSTATE MIGRATION

2.66 Comparisons of the 2006 Census counts of 2001–06 interstate migration (adjusted for undercount and to include an estimate for ages 0 to 4) with the Medicare-based estimates of interstate migration (see Chapter 7 – Estimating interstate migration) for the 2001–06 period are shown in Table 2.5.

Intercensal revision 2001–06 continued

(A) REVISIONS OF INTERSTATE MIGRATION *continued*

2.5 NET INTERSTATE MIGRATION, Comparison between Census-based and Medicare-based estimates—2001 to 2006

	INTERSTATE MIGRATION 2001–06			*Final intercensal error 30 June 2006*(a)
	Census(b)	*Medicare*(c)	*Difference*	
New South Wales	–125 465	–136 330	10 865	2 767
Victoria	–13 121	–2 197	–10 924	–36 229
Queensland	147 890	164 362	–16 472	–24 034
South Australia	–10 192	–12 639	2 447	–12 780
Western Australia	3 993	–1 399	5 392	–7 259
Tasmania	4 113	3 105	1 008	–793
Northern Territory	–4 514	–8 474	3 960	–2 948
Australian Capital Territory	–2 375	–6 428	4 053	–4 673
Australia(d)	—	—	—	**–85 715**

— nil or rounded to zero (including null cells)
(a) A positive number indicates that unrebased ERP as at 30 June 2006 was higher than the rebased ERP. A negative number indicates it was lower than than the rebased ERP.
(b) Census counts have been adjusted for net undercount.
(c) Medicare-based estimates accumulated quarterly.
(d) Includes a small component of intercensal error for Other Territories.

2.67 The approach used for revising population estimates for the intercensal period assumes that intercensal error is primarily due to errors in estimating interstate migration (as it is the most difficult component to estimate – unlike births, deaths and overseas migration, there is no direct measure), to the extent that this is supported by the Census-based migration data.

2.68 The Census is considered the best measure of interstate migration at the time of the Census, so assuming it does not increase the intercensal error, this is the preferred base for migration estimates. Putting this into practice, if the difference between Census-based and Medicare-based migration estimates is the opposite sign as a state or territory's intercensal error, then that migration difference is interpreted as accounting for the intercensal error.

2.69 The 2001–06 revised net interstate migration levels were derived by:

Step 1 – Adjust interstate migration levels

2.70 *Step 1a* – For states and territories where the difference and intercensal error have the same sign, set migration levels to Medicare-based migration estimate.

2.71 For example, the intercensal error for New South Wales was not explained at all by the Census-based migration data, so the Medicare-based migration estimate was not altered. The intercensal error of New South Wales was 2,767 (i.e. the 2001-based 30 June 2006 population estimate was 2,767 too high), but Census-based migration indicated that, in net terms, fewer people departed the state. As such, if New South Wales' migration estimate was adjusted according to Census-based migration, its intercensal error would increase.

Intercensal revision 2001–06 continued

Step 1 – Adjust interstate migration levels continued

2.72 *Step 1b* – For states and territories where the difference and intercensal error have opposite signs and intercensal error is larger (further from zero) than the difference set migration levels to Census-based migration estimate.

2.73 For example, the Australian Capital Territory's intercensal error of -4,673 could be entirely attributed to interstate migration being 4,053 lower in Medicare-based migration than Census-based migration. The Census-based migration estimate of -2,375 is used, which reduces the intercensal error from -4,673 to -620.

2.74 *Step 1c* – For states and territories where the difference and intercensal error have opposite sign and intercensal error is smaller (closer to zero) than the difference set migration levels to Medicare-based migration estimate minus the intercensal error.

2.75 For example, Tasmania's final intercensal error of -793 could be entirely attributed to interstate migration being 1,008 lower in Medicare-based migration than Census-based migration. As an adjustment of only 793 is required to explain the intercensal error, that was the amount the Medicare-based estimates were altered by (giving 3,898 in Table 2.6), rather than the Medicare-based migration difference of 3,105.

Step 2 – Scale interstate migration to sum to zero

2.76 Finally, these new interstate migration levels are scaled to sum to zero according to the state or territory's proportion of 2001–06 Medicare-based interstate arrivals and departures.

2.6 REVISIONS TO 2001–06 NET INTERSTATE MIGRATION

	INTERSTATE MIGRATION 2001–06			INTERCENSAL DISCREPANCY 30 JUNE 2006	
	After adjustment to minimise intercensal discrepancy	*After zero-sum adjustment (final)*	*Medicare movements*(a)	*Preliminary*	*Final*
New South Wales	–136 330	–140 564	1 024 676	2 037	–1 467
Victoria	–2 197	–5 086	699 243	–39 685	–39 118
Queensland	164 362	160 495	935 834	–29 906	–27 901
South Australia	–10 192	–11 346	279 275	–12 001	–11 487
Western Australia	3 993	2 715	309 291	–3 405	–3 145
Tasmania	3 898	3 329	137 759	–561	–569
Northern Territory	–5 526	–6 196	162 178	–660	–670
Australian Capital Territory	–2 375	–3 169	192 098	–1 460	–1 414
Australia(b)	**15 468**	—	**3 743 429**	**–85 587**	**–85 715**

— nil or rounded to zero (including null cells)

(a) The number of interstate movements registered by Medicare between 30 June 2001 and 30 June 2006.

(b) Includes a small component of intercensal discrepancy for Other Territories.

Intercensal revision 2001–06 continued

2.77 The 2001–06 revised interstate migration estimates were then divided into two parts:

(1) Net movement for 2005–06. This used data from the Census question on usual address one year ago (adjusted for undercount and to include an estimate for age zero).

(2) Net movement for 2001–05. These data were obtained by subtracting the figures for 2005–06 from the totals for 2001–06.

2.78 Quarterly interstate arrival and departure estimates for 2005–06 and for the four years 2001–05 were calculated by spreading the total net gain/loss for each state/territory over the 4 quarters for 2005–06 and the 16 quarters for 2001–05 proportionally according to the original quarterly Medicare-based estimates.

(B) DISTRIBUTION OF THE INTERCENSAL DISCREPANCY

2.79 The 2001–06 intercensal discrepancy was distributed evenly over the intercensal period for each state/territory, sex and birth cohort as follows:

2.80 For cohorts born prior to the 30 June 2001, i.e. the start of the intercensal period,

$ID_q = \frac{ID}{20}$ for each quarter q of the intercensal period (20 quarters)

where:

ID_q is the intercensal discrepancy for quarter q
ID is the total intercensal discrepancy

2.81 For cohorts born between the two censuses, the intercensal discrepancy was split over those quarters including and following the financial year of birth, that is,

$ID_q = \frac{ID}{4n}$ for each quarter q of the intercensal period (20 quarters)

where:

n = the number of financial years that the cohort has been represented in the population including the financial year of birth of the cohort. For example the discrepancy for the cohort born in the 2005–06 financial year can only be distributed over the 2005–06 period, while the discrepancy for those born in 2004–05 can only be distributed over the two financial years (i.e. 8 quarters) 2004–05 and 2005–06.

2.82 These formulae were also used for distributing the intercensal discrepancy over the quarterly population estimates by marital status and country of birth.

(C) FINAL REVISED INTERCENSAL POPULATION ESTIMATES

2.83 The revised estimates of the population for the intercensal period were calculated by the quarterly adjustment of the population, starting with the 30 June 2001 (Census-based) population, for subsequent births, deaths, overseas migration, interstate migration and intercensal discrepancy. This was the same procedure as outlined in paragraph 2.17 for post-censal estimation, except that finalised components of change were available and the intercensal discrepancy component was also included.

CHAPTER 3 ESTIMATING POPULATION FOR STATISTICAL LOCAL AREAS

INTRODUCTION

3.1 In Australia, the statistical local area (SLA) is the base spatial unit used to collect and disseminate statistics other than those collected from the Census of Population and Housing. In non-Census years, the SLA is the smallest unit defined in the Australian Standard Geographical Classification (ASGC). In aggregate, SLAs cover the whole of Australia without gaps or overlaps. SLAs generally conform to, or combine to form, local government areas (LGAs), statistical subdivisions (SSDs) and statistical divisions (SDs).

3.2 Populations estimates for SLAs are published as at 30 June each year in *Regional Population Growth, Australia* (cat. no. 3218.0). Estimates by five-year age group and sex are published as at 30 June in *Population by Age and Sex, Regions of Australia* (cat. no. 3235.0). Population estimates for LGAs, SSDs, SDs, etc. are generally built up from SLA-level estimates.

3.3 The base populations from which subsequent annual estimates are derived are provided by the Census, and are called Census year population estimates. The traditional method used to update these estimates, called the cohort component method, brings forward the population in quarterly steps by ageing the base, then adjusting for subsequent births, deaths and overseas and interstate migration. All estimates at SLA level are constrained to sum to state and territory population estimates.

CENSUS ESTIMATES

Census year population estimates

3.4 The method used to compile Census date SLA population estimates is similar to that used for national and state/territory estimates.

3.5 Census counts of usual residents by SLA are adjusted for net undercount using data from the Census Post Enumeration Survey (PES) and demographic analysis. The small sample size of this survey relative to the large number of SLAs (approximately 1,400 in 2006) restricts the reliability of the PES as a direct measure of net undercount for SLAs. Consequently, net undercount for SLAs is estimated using an iterative proportional fitting method (see Appendix 5 – The iterative proportional fitting procedure) using the higher level PES data as the marginals. Based on the premise that net undercount is related to age, sex, location and Indigenous status, it is assumed that differentials for these characteristics at the SLA level reflect differentials for Census counts by age, sex, Indigenous status, state or territory, and (aside from the ACT) capital city/balance of state or territory. The Census counts by SLA, age, sex and Indigenous status are forced to add to higher-level marginal totals adjusted for undercount, using the iterative proportional fitting technique.

Census year population estimates continued

3.6 Estimates of the number of Australian residents temporarily overseas on Census Night (RTOs), derived from coded addresses of residence to SLA from a sample of incoming passenger cards are added to their respective SLAs. (All persons arriving in Australia, including Australian residents returning, are required to report their intended address which is taken to be the usual residence.)

3.7 As the Census is held on a date other than 30 June (the 2006 Census was held on 8 August), further adjustments taking into account births, deaths and migration for the intervening period are made to obtain the ERP at 30 June. For births and deaths, the actual events registered as occurring between these dates are taken into account. Net migration is estimated based on the relevant proportion of the population who moved within the previous 12 months as recorded in the 2006 Census. Inter-SLA migration is constrained to sum to net interstate migration levels while overseas arrivals is similarly constrained, using overseas migration data. As the Census does not collect data on overseas departures, SLAs are assumed to have the same proportion of state/territory overseas departures as they had of arrivals.

3.8 For some areas, demographic adjustments are made to these estimates. Finally, the SLA population estimates are constrained to sum to 30 June estimates for their respective states or territories.

POST-CENSAL ESTIMATES

Post-censal SLA population totals

3.9 For post-censal years, the absence of migration data at the SLA level means that it is not possible to estimate SLA populations by taking into account the components of population growth (natural increase and net migration). Instead, ERPs for most SLAs are calculated using a mathematical (multiple linear regression) model, where relationships are established between changes in population and changes in indicators between the two most recent censuses for groups of SLAs. More up-to-date indicator data is then applied to the regression equation to estimate changes in the population of each area since the last Census.

3.10 Population indicator data are data that can be used to estimate total population change over time. In addition to being indicative of population change, to be suitable for regression modelling, indicator data should ideally be:

- available for the entire regression and estimation period
- consistently defined over this period – any trend-breaks need to be properly accounted for
- available at the relevant geographic level – if not, then the data need to be confidently converted to the relevant geography
- timely – i.e. available soon after the reference period for estimation.

3.11 The regression models use an area's share of indicator data to estimate the share of the state or territory's population for that area. More correctly, the change in share of state/territory of the indicator data is used to estimate the change in share of state/territory population since the base year.

3.12 All population and indicator data need to be on the same boundaries, therefore adjustments are made to indicator data to account for changes to SLA boundaries over the regression or estimation periods.

Post-censal SLA population totals continued

3.13 The choice of indicators varies across the states and territories, depending on availability and indicative ability. The predominant indicator data sources currently used are dwelling approvals, Medicare enrolments and Electoral enrolments.

DWELLING APPROVALS

3.14 Dwelling approvals data are collected on an ongoing basis by the ABS, with summaries released frequently. Dwelling counts from the latest Census are used as the base number of dwellings by SLA. Updated estimates of dwellings are prepared by adding approvals to the Census base. Under the assumption that it takes several months for the dwelling to be constructed and people to move in after it has been approved, lags are incorporated into the approvals data – dwellings approved six to twelve months before the estimation reference period are incorporated in the regression models, with provision made for some longer lags, in particular for large approval jobs.

MEDICARE ENROLMENTS

3.15 Medicare enrolments, by postcode, are provided to the ABS by Medicare Australia. Changes to the number of Medicare enrolments provide an indication of total population change, which can be incorporated into the regression models used to estimating population change. Under the assumption that it takes a few months for a person to change their address on the Medicare system, a lag is incorporated into the Medicare data used in the regression model. Because Medicare data are only available by postcode, it is converted to SLA using a postcode to SLA concordance. The quality of the Medicare data is therefore highly dependent on the quality of the postcode to SLA concordance. One issue with creating this concordance, is determining which SLA to concord unmappable postcodes with.

ELECTORAL ENROLMENTS

3.16 Counts of people on the Commonwealth electoral roll, are provided to the ABS by the AEC. These data are provided by Census collection district (CD), which are then aggregated to SLA. Under the assumption that it could take a few months for a person to change their address on the electoral roll, a lag is incorporated into the Australian Electoral Commission (AEC) data used in the regression model. One potential concern here, which needs to be accounted for when using AEC data for population estimation, is the annual variability of the size of the electoral roll, especially around election time when rolls tend to be updated more than at other times.

3.17 In areas where indicator data are unreliable and migration can be assumed to be insignificant, population change since the previous Census may be estimated by adding estimates of natural increase (births minus deaths) since the previous Census. In some very small areas population change since the previous Census may be assumed to be zero in the absence of any reliable indicator data for these areas.

3.18 All estimates are scrutinised and validated by population analysts. Local knowledge, including that advised by local governments, may be used to adjust the figures for particular SLAs.

3.19 All estimates at SLA level are constrained to sum to state/territory level population estimates.

Disaggregation of post-censal SLA population totals by age and sex

3.20 Post-censal estimates of the age and sex distributions of SLA populations are made by updating the population by age and sex for the Census year using annual births (by sex), deaths (by age and sex) and derived age and sex profiles of migration. SLA estimates by age and sex are released by five year age groups (0–4, 5–9, ... 80–84, and 85 and over), and are also available by single year of age (0,1,... 84, 85+).

3.21 While annual data on births and deaths by age and sex are available for each SLA, data on migration into and out of SLAs for post-censal years are not available and are derived indirectly. This is done as follows:

STEP 1

3.22 The estimate of total population growth for each SLA (see above) for the twelve months is split into natural increase and net migration components. Natural increase is derived for each SLA from birth and death registration statistics. Net migration is derived for each SLA as the difference between total population growth and natural increase. Net migration is then split into internal and overseas migration components. This is done by apportioning according to the relative contributions based on one-year migration data from the most recent Census, in conjunction with state/territory level estimates of interstate migration and overseas migration.

STEP 2

3.23 The SLA age/sex profiles of internal migration are derived from Census data on the SLA of usual residence one year ago. These profiles are produced for:

- inter-SLA arrivals: persons residing in the SLA whose usual residence one year ago was in another SLA
- inter-SLA departures: persons whose SLA of usual residence one year ago was that SLA but whose residence at the date of the Census was another SLA.

3.24 The SLA age/sex arrival and departure profiles are then constrained so that, for each age and sex, the net effect across all SLAs in a state/territory equals the finalised interstate migration estimate for the financial year prior to the Census.

STEP 3

3.25 The age/sex profile of overseas arrivals for a SLA is derived from Census counts for that SLA of people whose usual residence one year ago was overseas. The overseas departure profile for each SLA is assumed to be the same as the overseas arrival profile (in the absence of data on overseas departures at the SLA level from either the Census or outgoing passenger cards). For overseas arrivals, the total of all SLAs within a state/territory is constrained to sum to the age/sex profile of permanent and long-term arrivals for the financial year prior to the Census for the state/territory. For overseas departures, the total of all SLAs within a state/territory is constrained to sum to the age/sex profile of permanent and long-term departures for the financial year prior to the Census for the state/territory. Migration for those aged zero is assumed to be half that of one year olds.

3.26 For greater detail, see Appendix 3 – Estimating migration for SLAs.

Disaggregation of post-censal SLA population totals by age and sex continued

STEP 4

3.27 Having established estimates of the migration component, the Census date population estimates for each SLA by age and sex are then updated in the normal way, (i.e. after converting to financial year of birth – by adding births, subtracting deaths and adding net migration). A more detailed account of this procedure at the national and state/territory level is given in Chapter 2 – Estimating national and state population.

INTERCENSAL REVISION OF SLA POPULATION ESTIMATES

3.28 When SLA population estimates as at 30 June in a Census year are prepared, based on that year's Census, they can be compared with the preliminary estimates for the same date already produced by updating the previous Census (using the methods described above). Differences between these two sets of estimates are referred to as intercensal errors.

3.29 Preparing estimates for the same reference date but using different methods and sources can result in a break in the time-series of these estimates. To overcome the break in continuity between these two types of estimates all population estimates updated from the previous Census are recalculated. These estimates, referred to as rebased estimates, are derived for each SLA by apportioning the intercensal error evenly across the five years, while constraining the rounded SLA level estimates to sum to state and territory estimates. For example, rebased 2002 to 2005 estimates were derived by adding one-fifth of the 2006 intercensal error to the previous estimates of the 2002 population, two-fifths to the previous estimate of the 2003 population, and so on.

3.30 These intercensal total population estimates are broken down into age and sex components by interpolating ERP by cohort between the previous Census and current Census by SLA, age and sex (although for some particular age/sex cohorts within some SLAs the interpolation takes place based on the same age at the previous and current censuses, rather than a cohort-approach). All age/sex cells within each state/territory are forced to sum to the predetermined state/territory age/sex totals (see Appendix 5 – The iterative proportional fitting procedure).

CHAPTER 4 ESTIMATING POPULATION FOR CUSTOMISED GEOGRAPHY

INTRODUCTION

4.1 Estimated resident population (ERP) for customised geography are not standard ABS output, but rather are for satisfying clients who require data for customised geographic areas. They are created by splitting the statistical local area (SLA) ERP into Census collection districts (CDs), then aggregating to the required geography, e.g. postal area, commonwealth electoral district (CED), remoteness area (RA), etc.

4.2 CD ERP are calculated following the creation of SLA ERP (as at 30 June), with preliminary, revised and rebased/final versions of CD ERP prepared accordingly.

4.3 In Census years, CDs are entirely contained within SLAs and do not change boundaries until the following Census. However SLA boundaries can change annually (for example wherelocal government area boundaries change). This means that CDs may be split between two or more SLAs in intercensal years.

Accuracy

4.4 Due to the disaggregation process and the inherent volatility of smaller cells, CD ERP generally does not have the same reliability as SLA ERP.

4.5 It can generally be assumed, however, that the accuracy of CD-based ERP increases with the level of aggregation. ERPs for geographic areas formed by the aggregation of many CDs can generally be regarded as being more reliable than areas that consist of just one or two CDs.

Postal areas

4.6 Postal areas (or CD-derived postcodes) are the most commonly requested customised geography. Postcode boundaries are constructed using whole CDs on a 'best-fit' basis from the most recent Census. This means that some CD-derived postcodes are different to Australia Post postcodes and some Australia Post postcodes are omitted altogether.

4.7 Postal areas exclude non-mappable Australia Post postcodes such as:

- post office box postcodes
- some delivery route postcodes, which are also covered by other postcodes (a situation which often occurs in rural areas)
- some postcodes which, because of the application of the best-fit principle, are not allocated any CDs.

4.8 See *ABS Postal Area Concordances, Aug 2006* (cat. no. 2905.0.55.001) for more information.

CONFIDENTIALITY

4.9 A procedure is applied to the CD ERP to avoid the release of numbers which could potentially be the same as corresponding unconfidentialised usual residence Census counts. This procedure applies small and randomly allocated adjustments to the ERP at the age and sex level, while maintaining closeness to the unconfidentialised ERPs and ensuring that the net effect of these adjustments are minimised within the CD.

ERP TOTALS

4.10 The method to calculate ERP totals (i.e. not disaggregated by age or sex) for customised geography converts Census usual residence CD counts into CD ERPs, i.e. combining adjustments for net Census undercount, Australian residents temporarily overseas on Census Night (RTOs) and backdating components from the Census date to 30 June. In post-censal years, forcing (using iterative proportional fitting, see Appendix 5 – The iterative proportional fitting procedure) to post-censal SLA ERP implicitly adjusts the CD population for post-censal births, deaths and migration.

4.11 Adjustments for other known issues with Census data may also be made. For example, if a dwelling is counted in one CD, but should have been counted in another (within the same SLA) and this is not discovered in time to correct this record in the Census, adjustments can be made so the people in this dwelling are included in the correct CD for ERP purposes.

Method

STEP 1

4.12 Calculate CD of usual residence population counts as at Census Night (from Census data), and adjust for any known issues with Census data.

STEP 2

4.13 Extract SLA ERP totals from those published in *Regional Population Growth, Australia* (cat. no. 3218.0).

STEP 3

4.14 Adjust the CD total population for post-censal years to reflect changes in the population implied by changes in the CD electoral enrolments since the Census year.

STEP 4

4.15 Using iterative proportional fitting, force the updated CD totals to sum to the SLA ERP total.

STEP 5

4.16 Aggregate CDs to the required geography.

ERP BY AGE AND SEX

4.17 Once the total population estimates are prepared for CDs, they are later broken down into age and sex components. The method to calculate ERP by age and sex for customised geography converts Census usual residence CD counts by age and sex into CD ERP by age and sex, i.e. combining adjustments for net Census undercount, RTOs and backdating components from Census Night to 30 June. In post-censal years, forcing (using iterative proportional fitting, see Appendix 5 – The iterative proportional fitting procedure) to SLA ERP and CD totals with growth applied implicitly adjusts the CD age/sex population for post-censal births, deaths, migration and ageing.

Method

STEP 1

4.18 Calculate CD of usual residence population counts by age and sex as at Census Night (from Census data), and adjust for any known issues with Census data. This forms the body of the matrix for iterative proportional fitting.

STEP 2

4.19 Adjust the CD ERP for post-censal years to reflect population growth from indicator data (in 2007 electoral roll data was used). This forms the column marginal in the matrix for iterative proportional fitting.

STEP 3

4.20 Extract SLA ERP by age and sex from those published in *Population by Age and Sex, Regions of Australia* (cat. no. 3235.0). This forms the row marginal in the matrix for iterative proportional fitting.

STEP 4

4.21 Using iterative proportional fitting, force the CD age/sex distribution to sum to the CD totals and SLA age/sex ERPs.

STEP 5

4.22 Aggregate CDs to the required geography.

CHAPTER 5 ESTIMATING BIRTHS AND DEATHS

INTRODUCTION

5.1 Birth and death statistics are an estimate of the number of births and deaths that have actually occurred. They are estimated for two distinct purposes – as a component of population growth in *Australian Demographic Statistics* (cat. no. 3101.0) and for analysis of fertility and mortality in *Births, Australia* (cat. no. 3301.0) and *Deaths, Australia* (cat. no. 3302.0) respectively.

5.2 Two separate conceptual bases are used for measuring births and deaths – period of registration and period of occurrence. Data by registration are available 5 to 6 months after the end of the reference quarter and are directly measurable (as the registrations close off at the end of the quarter), whereas data by occurrence theoretically never closes so are not directly measurable. The time at which the estimate is required determines which concept is used.

5.3 For preliminary estimates, births and deaths by quarter of registration are used as a proxy for quarter of occurrence. For revised estimates, a factor has been applied to the number of occurrences to allow for those occurrences which were yet to be registered at the time of revision. For final estimates, year/quarter of occurrence data are used.

5.4 The scope of the births and deaths collections are:

- all births that were live born and were not previously registered
- all deaths registered for the first time
- births and deaths to temporary visitors to Australia (including visitors from Norfolk Island)
- births and deaths that occurred within Australian Territorial waters
- births and deaths that occurred in Australian Antarctic Territories and other external territories (excluding Norfolk Island)
- births and deaths that occurred in transit (i.e. on ships or planes) if registered in the state or territory of "next port of call"
- births and deaths to Australian nationals employed overseas at Australian legations and consular offices (i.e. children born overseas to Australian diplomats or their families)
- births and deaths that occurred in earlier years that have not been previously registered (late registrations).

ACCURACY

5.5 A difficulty in accurately estimating the number of births and deaths stems from the fact that while the vast majority are registered promptly, a small proportion of registrations are delayed for months or even years. Lags or accumulations in birth and death registrations can be caused by either:

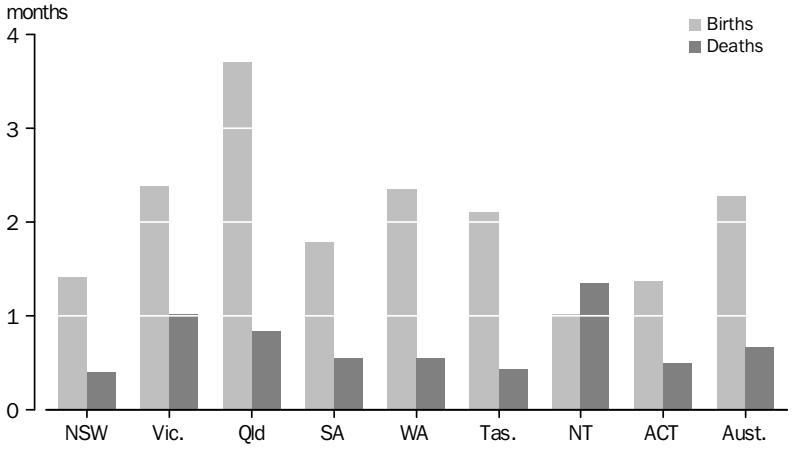
- late notification of a birth or death to a state or territory registry
- delays arising from incomplete information supplied for a registration
- procedural changes affecting the processing cycles in any of the state and territory registries

ACCURACY *continued*

- resolution of issues that may arise within the ABS or registry processing systems.

5.6 The following graph shows the variability between states/territories, and the greater lags for births than for deaths.

5.1 BIRTHS AND DEATHS, Average interval between occurrence and registration—2007



PRELIMINARY ESTIMATES OF BIRTHS AND DEATHS

5.7 Each quarter, preliminary estimates of birth and death occurrences are estimated directly as the number of births and deaths registered in the reference period. The aim is to estimate the number of birth and death occurrences with the data available 5 to 6 months after the reference quarter.

5.8 Preliminary quarterly estimates can be an underestimate or an overestimate of the true numbers of births and deaths occurring in a reference period due to the accumulation or lag of registrations (see above).

5.9 Preliminary estimates of births and deaths by state/territory as a component of population growth are published quarterly in *Australian Demographic Statistics* (cat. no. 3101.0). The births and deaths data in this publication are not necessarily consistent with the data found in *Births, Australia* (cat. no. 3301.0) and *Deaths, Australia* (cat. no. 3302.0). This is because the revision cycle necessary to produce ERP results in a mix of preliminary births and deaths data, based on date of registration, and revised data which are modelled estimates of births and deaths by date of occurrence. By contrast, the main tables of data in the births and deaths publications are based wholly on registration in the reference year, with some tables and analysis based wholly on occurrence data.

5.10 Birth estimates for each calendar year are published the following October in *Births, Australia* (cat. no. 3301.0) and are disaggregated by:

- geography
- sex
- age of parents
- nuptuality (marital status of parents)
- year and month of occurrence
- country of birth of parents
- Indigenous status of child/parents.

PRELIMINARY ESTIMATES OF BIRTHS AND DEATHS *continued*

5.11 Death estimates for each calendar year are published the following November in *Deaths, Australia* (cat. no. 3302.0) and are disaggregated by:

- geography
- sex
- age at death
- marital status
- country of birth
- year and month of occurrence
- Indigenous status.

REVISED ESTIMATES OF BIRTHS AND DEATHS

5.12 Revised estimates of quarterly birth and death occurrences are calculated by applying an inflation factor to birth and death occurrence data. They are published in *Australian Demographic Statistics* (cat. no. 3101.0) released 21 months after the end of each financial year.

Registration lags

5.13 There are two types of registration delays, or lags for births and deaths in a given period. The historical lag is the delay between births or deaths registered in the relevant period and their date of occurrence (i.e. looks into the past). Conversely, a future lag is the delay between births or deaths occurring in the target period and their (eventual) date of registration (i.e. it looks into the future).

5.14 The main principle behind the method used for revising birth and death occurrence estimates is that the historical and future registration lags for a quarter are similar, although this can change if registration procedures change. In other words, the historical lag derived from registration data can be used to indicate the future lag for occurrence data.

Estimating occurrences not yet registered

5.15 To determine the revised estimate for a particular period, the occurrence data that will be subject to inflation needs to be determined. To enable publication by 21 months after the financial year involved, registration data for the 15 months after the end of the financial year are available. For example, to publish revised data in March 2009, only registrations up to and including the September quarter 2008 were available for births and deaths which occurred in the 2006–07 financial year. This corresponds to 9 quarters (September quarter 2006 to September quarter 2008) in which births and deaths occurring in the 2006–07 financial year could have been registered. Thus, when inflating September quarter 2006 data, occurrence data with a future registration lag of less than or equal to 9 quarters are available.

5.16 Occurrence data for a particular quarter in the year (i.e. September, December, March or June) are adjusted based on registration data for the same corresponding quarter in the most recent year. This is so the most recent registration lag patterns available can be used. In the case of September quarter 2006 occurrences, a historical lag of 9 quarters is applied to registrations in the September quarter 2007 to obtain an inflation factor.

5.17 The proportion, p, of all registrations for the quarter that occurred within the historical lag period is determined by:

$$p = \frac{\text{Number of events registered within historical lag period}}{\text{Total number of events registered}}$$

Estimating occurrences not yet registered continued

5.18 The inflation factor, f, for the quarter can be calculated such that:

$$f = \frac{1}{p}$$

5.19 For example, the inflation factor for births occurring in September quarter 2006 (termed f_{S06}) would be:

$$f_{S06} = \frac{BReg_{S07}}{BReg_{S07,-9q}}$$

where:

$BReg_{S07}$ = the total number of births registered in the September quarter 2007; and

$BReg_{S07,-9q}$ = the number of births registered in the September quarter 2007 with an historical lag <= 9 quarters (i.e. occurring between the September quarter 2005 and September quarter 2007)

5.20 The estimate is calculated by applying the inflation factor to the count of births/deaths by state/territory on file. The birth estimate is expressed as:

$$B = f \times BOccReg$$

where:

B = the estimate of births

$BOccReg$ = the births occurring in the quarter and registered within the future lag period

5.21 For example, the estimate of births occurring in September quarter 2006 is:

$$B_{S06} = f \times BOcc_{S06}Reg_{S08,-9q}$$

where:

B_{S06} = the estimate of births occurring in September quarter 2006

$BOcc_{S06}Reg_{S07,-9q}$ = the number of births which occurred in September quarter 2006 registered in the period September quarter 2006 to September quarter 2008

5.22 This method is detailed further in *Demography Working Paper: 1998/2 – Quarterly Birth and Death Estimates* (cat. no. 3114.0), although the previous historical lag period of 7 quarters is discussed (in March 2009, the publication of the revised financial year data changed from 15 months after the end of the financial year to 21 months).

FINAL ESTIMATES

5.23 Birth and death estimates are finalised after each Census (i.e. five-yearly cycle) and published in *Australian Demographic Statistics* (cat. no. 3101.0) released around 22 months after the Census.

5.24 Final estimates of birth and death occurrences are estimated directly as the number of birth and death occurrences in the reference period that have been registered by the December quarter in the year following the Census.

CHAPTER 6 ESTIMATING NET OVERSEAS MIGRATION

INTRODUCTION

6.1 According to recommendations of the United Nations an international migrant is defined as "*any person who changes his or her country of usual residence*" (United Nations 1998). For the purposes of net overseas migration (NOM), and thereby Australia's official estimated resident population (ERP) counts, a person is regarded as a usual resident if they have been (or expected to be) residing in Australia for a period of 12 months or more. As such, NOM and ERP estimates include all people, regardless of nationality or citizenship, who usually live in Australia, with the exception of foreign diplomatic personnel and their families.

6.2 The ABS has developed and introduced an improved method for estimating NOM. It has been used in calculating Australia's official ERP since September quarter 2006. The improved method is a result of reviewing the treatment of temporary migrants (both long-term and short-term) who are away from or resident in Australia for a period of 12 months or more.

6.3 Conceptually the term NOM is based on an international travellers' duration of stay being in or out of Australia for 12 months or more. It is the difference between the number of incoming travellers who stay in Australia for 12 months or more and are added to the population (NOM arrivals) and the number of outgoing travellers who leave Australia for 12 months or more and are subtracted from the population (NOM departures). With the introduction of the improved methods for estimating NOM this 12 months *does not have to be continuous* and is measured over a 16 month reference period. For example whether a traveller is in or out of the population is determined by their exact duration of stay in or away from Australia over the subsequent 16 months after arrival or departure.

6.4 To be able to accurately measure people that have contributed to NOM estimates there are three main issues for consideration:

- Is the person in or out of Australia's population prior to the overseas movement?
- Is the actual duration of stay within (or away from) Australia for at least 12 months?
- Is the person arriving or departing Australia?

6.5 Estimates of NOM based on the previous methods and those based on the improved methods are not comparable. The key change is the introduction of a '12/16 month rule' for measuring a person's residency in Australia, replacing the previous '12/12 month rule'.

6.6 For further information on the improved methods see *Information Paper: Improved Methods for Estimating Net Overseas Migration* (cat. no. 3107.0.55.003) and *Information Paper: Statistical Implications of Improved Methods for Estimating Net Overseas Migration, Australia, 2007* (cat. no. 3107.0.55.005).

INTRODUCTION
continued

6.7 For information on the previous methods see the Technical Note in *Migration, Australia, 2006–07* (cat. no. 3412.0) – Measuring Net Overseas Migration, Method Used September quarter 2001 to June quarter 2006.

Estimating NOM with 12/16 rule

6.8 The method for estimating NOM was reviewed in 2004 in response to issues arising with the previous estimation of category jumping, i.e. changes between stated intention and actual duration of stay of travellers to/from Australia. The review also addressed the changing patterns of travel into and out of Australia, in particular the increased propensity for travellers to interrupt longer periods of stay or absence with short-term trips.

6.9 The improved NOM estimation methods employ a 12/16 rule where the traveller can be added or subtracted from NOM if they have stayed in or been absent from Australia for a period of 12 months or more over a 16 month period. This 12 months does not have to be continuous. Although a traveller states their intended duration of stay on a passenger card, for NOM purposes the ABS now measures an individuals' actual travel behaviour.

6.10 To measure a travellers actual duration of stay the ABS uses a unique personal identifier provided with the administrative data supplied by the Department of Immigration and Citizenship (DIAC). To be able to apply the 12/16 rule the personal identifier is used to match a travellers movements over time and construct a movement history for each arrival and departure record. For more information on the administrative data used see paragraph 9.62 in Chapter 9 – Data sources.

6.11 At the time preliminary estimates are required (5 to 6 months after the end of the reference quarter), the actual duration of stay in Australia (or overseas) for a traveller in the reference quarter is not known. Hence their contribution to NOM cannot be explicitly determined at this time using the 12/16 rule. Since full movement histories are not available within this timeframe, preliminary NOM estimates are therefore modelled on patterns of traveller behaviours observed in final NOM estimates for the same period two years earlier. More detailed information on preliminary NOM estimation is available later in this chapter.

Travellers vs movements

6.12 Conceptually, NOM estimates should be based on counts of travellers, rather than counts of overseas movements, since travellers may have more than one movement in a particular reference period. Under the previous system of NOM estimation, a number of adjustments to overseas arrivals and departures were required. These mainly comprised adjustments designed to reflect differences between stated travel intentions and actual travel behaviour. However, adjustments were also required to transform numbers of overseas movements into numbers of travellers.

6.13 One of the central changes with the improved methodology is that all estimation is based on actual individual travellers and their travel histories (using de-identified data), rather than in the previous methodology when an aggregation of movements represented travellers.

FINAL NOM ESTIMATES

6.14 It is with the final NOM estimates that the 12/16 month rule can be fully applied. A traveller's actual duration of stay can only be calculated when data on overseas movements becomes available for the 16 months following a reference period. Final NOM estimation methods use ERP flags to determine if a traveller, through their actual duration of stay in or out of Australia, should be included or excluded from NOM estimates and consequently ERP estimates.

Duration of stay

6.15 At the time a person arrives in (or departs from) Australia, it is not empirically known how long they will actually stay in Australia (or overseas). As a consequence, a key issue when estimating NOM is the difference between stated travel intention and actual travel behaviour after the passage of time.

6.16 In the improved methods, for final estimates, the total duration of stay/absence for each traveller is determined by adding durations of stay/absence as shown by movement histories over the 16 month period following an overseas movement. The 12/16 month rule can only be fully applied when data on overseas movements are available for the 16 months following a reference quarter.

6.17 Therefore, the 12/16 month rule is only applied in compiling final NOM estimates, with these estimates based around the construction of detailed movement histories for each overseas traveller.

6.18 For both preliminary and final estimation under the improved NOM methods, each movement is assigned one of ten categories:

- Permanent Arrival (PA)
- Long-term Resident Return (LTRR)
- Long-term Visitor Arrival (LTVA)
- Short-term Resident Return (STRR)
- Short-term Visitor Arrival (STVA)
- Permanent Departure (PD)
- Long-term Resident Departure (LTRD)
- Long-term Visitor Departure (LTVD)
- Short-term Resident Departure (STRD)
- Short-term Visitor Departure (STVD)

6.19 Travellers arriving in Australia mark their incoming passenger cards with an indication of their intended duration of stay as:

- a permanent arrival (a migrant)
- a visitor or temporary entrant
- a resident returning to Australia without any indication of their intended duration of stay in Australia.

6.20 Travellers departing Australia are required to indicate whether they are:

- a visitor or temporary entrant departing
- an Australian resident departing temporarily
- an Australian resident departing permanently.

6.21 Australian residents departing are required to indicate their intended length of stay overseas, so as to distinguish between long-term resident departures (LTRD) and short-term resident departures (STRD).

Duration of stay continued

6.22 The categories of long-term resident return (LTRR) and short-term resident return (STRR) are based on actual (continuous) duration of stay overseas. Incoming and outgoing passenger cards are matched and this information is supplied to the ABS by DIAC. Similarly the categories of long-term visitor departure (LTVD) and short-term visitor departure (STVD), are based on actual (continuous) duration of stay in Australia. A record of departure is matched with their last arrival to calculate duration of stay. ABS then converts this duration into short-term (under 12 months) and long-term (12 months or more).

6.23 While each traveller may make a number of movements during a reference quarter, for the purpose of measuring NOM under the improved methods, they are assigned one and only one category of travel for the reference quarter. See Step 2 below for a description of how this is determined.

Implausible travel sequences

6.24 There are circumstances where implausible travel sequences appear in the data. For example, a traveller is recorded as having two sequential arrivals in Australia without a departure in between, or conversely, two departures from Australia without an arrival. In these instances the implausible travel sequences are repaired using a logical imputation. The repair of implausible sequences is necessary in order to derive an estimate of duration of stay or absence, since time spent in Australia is derived by summing up the duration between each arrival and departure pair.

Final estimates calculation steps:

6.25 Final NOM estimates are calculated in the following sequential order.

STEP 1: DERIVE PERSON-LEVEL DATA ON OVERSEAS MOVEMENTS

6.26 Data from the Overseas Arrivals and Departures (OAD) collection, along with additional data obtained from the Travel and Immigration Processing System (TRIPS) which is sourced from DIAC.

6.27 Each OAD file contains information derived from incoming and outgoing passenger cards, and is matched for each movement to selected TRIPS data items through a unique personal identifier. OAD files do not include records where a passenger card has not been matched to TRIPS (e.g. if the traveller records incorrect passport details on their passenger card, and the mismatch between this and the TRIPS record has not yet been resolved). Records from TRIPS relating to these unmatched movements are extracted and added to the quarterly OAD files for NOM estimates.

6.28 The quarterly files used for NOM estimates also contain a number of logical edits and imputations, mainly at the movement level. Person-level data are constructed from these movement data by matching movements using personal identifiers.

STEP 2: DETERMINE THE CATEGORY OF TRAVEL FOR EACH OVERSEAS TRAVELLER

6.29 Travellers are assigned to one, and only one, category of travel during a reference quarter. The algorithm used to assign a category of travel to each traveller is based on:

- the last movement during the reference quarter where the traveller stated an intention to remain in Australia or overseas for 12 months or more (i.e. permanent arrival, permanent departure, long-term visitor arrival or long-term resident departure movements); otherwise,

Final estimates calculation steps: continued

STEP 2: DETERMINE THE CATEGORY OF TRAVEL FOR EACH OVERSEAS TRAVELLER *continued*

- their first movement during the reference quarter (i.e. long-term resident return, short-term resident return, short-term visitor arrival, long-term visitor departure, short-term resident departure and short-term visitor departure) during the reference quarter.

STEP 3: DERIVE ERP FLAG AT START OF REFERENCE QUARTER

6.30 An 'ERP flag' is used to indicate whether a traveller is 'IN' or 'OUT' of the ERP at the start of the reference quarter. During the start-up period for the improved NOM methods, this flag has been determined by looking at the individual's previous travel history.

6.31 For subsequent periods, a traveller's ERP flag at the start of a reference quarter will be carried forward from their flag at the end of the previous quarter. If the traveller has no flag in any of the previous six quarters, their ERP flag at the start of the reference quarter will be imputed based on the direction of their first movement within the quarter i.e. 'OUT' of ERP if they are arriving in Australia; 'IN' ERP if they are departing from Australia.

STEP 4: DERIVE MOVEMENT HISTORY AND REQUIRED DATA ITEMS FOR EACH OVERSEAS TRAVELLER

6.32 Movement histories are constructed for each traveller based on their overseas arrivals and departures during the 16 months following an overseas movement that takes place in the reference quarter. In addition, a number of key demographic data items are derived for each traveller, including their financial year of birth (used to calculate age at 30 June), sex, country of birth and country of citizenship. In most cases these derived items are available from the source OAD and/or TRIPS datasets. In cases where required demographic data items are missing, logical imputations similar to those applied in existing OAD and ERP systems are used.

STEP 5: IDENTIFY IMPLAUSIBLE MOVEMENT SEQUENCES, AND IMPUTE 'MISSING' MOVEMENTS

6.33 Implausible movement sequences appear in the data for a number of reasons, but are mainly due to non-matches between travel information (i.e. visa applications or passport information) and existing TRIPS information. Non-matches can occur when a traveller's personal details change (e.g. marital status, family name), or when their travel documentation is updated (e.g. new passport and country of passport, perhaps combined with changes to personal details). When a non-match occurs, the DIAC processing systems assign a new personal identification number to the movement before referring it to a resolution process. While most non-matches are resolved at a later date, administrative data provided to the ABS for the OAD or from TRIPS may not include all revisions relating to this process.

6.34 Some travellers with implausible movement sequences in the data will also have a sequence (before and/or after the implausible sequence) of plausible movements over the 16 month period studied. In these cases, an assumption is made that the proportion of a traveller's time spent in Australia during the implausible movement sequence was

Final estimates calculation steps: continued

STEP 5: IDENTIFY IMPLAUSIBLE MOVEMENT SEQUENCES, AND IMPUTE 'MISSING' MOVEMENTS *continued*

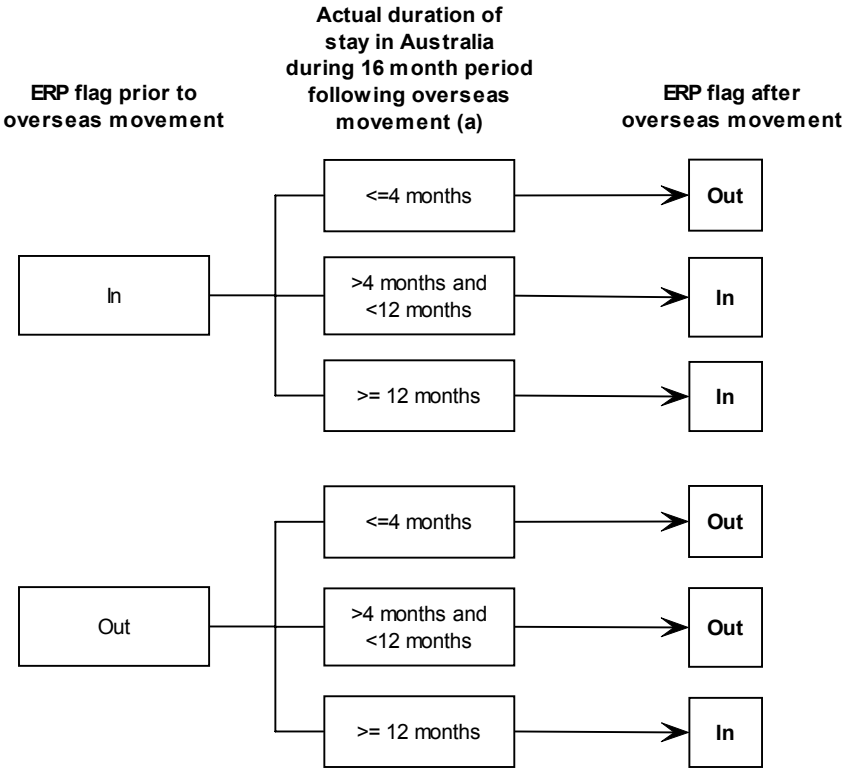
consistent with their proportion of time spent in Australia during plausible movement sequences. Using their plausible movement sequences, a ratio of their time spent in Australia to their time spent overseas is calculated and applied to the implausible sequence to impute a 'proxy' arrival or departure movement.

6.35 For a very small number of travellers, there may be no plausible movement sequence in the data during the 16 month period analysed (e.g. a movement history may only show two or more overseas arrivals, or only show two or more overseas departures). It is assumed that these travellers spent 50% of the time between movements in Australia.

STEP 6: DETERMINE THE TOTAL DURATION OF STAY FOR EACH TRAVELLER AND CALCULATE ERP FLAGS

6.36 The total duration of stay/absence for each traveller is determined by adding durations of stay/absence as shown by movement histories over the 16 month period following an overseas movement.

6.37 As shown in the following diagram, these durations of stay are used to calculate whether a traveller who is 'IN' or 'OUT' of the ERP before the movement is 'IN' or 'OUT' of the ERP after the movement, regardless of their category of travel.



(a) For the purposes of duration of stay calculations, 4 months is defined as 121.5 days and 12 months is defined as 365 days.

Final estimates calculation steps: continued

STEP 7: CALCULATE NOM ESTIMATES AND FINAL IMPACT ON THE ERP

6.38 Each traveller moving into the ERP during a reference quarter (i.e. an ERP flag of 'OUT' at the start of the quarter and a flag of 'IN' at the end of the quarter) is added to the total NOM estimate for the quarter. Similarly, each traveller moving out of the ERP is subtracted from the NOM estimate. Travellers whose initial and final ERP flags for the quarter are the same make no contribution to NOM. As in current publication tables, NOM estimates can be broken down according to the demographic characteristics of travellers (e.g. state or territory of usual residence, age or sex).

STEP 8: MIGRATION ADJUSTMENT VALUE

6.39 For final estimation, a 'migration adjustment' (MA) value is derived for each traveller in the reference quarter, as a by-product. The MA value is equal to the difference between the traveller's actual contribution to NOM for the quarter (i.e. -1, 0 or +1) and their initial contribution to NOM based solely on their category of travel (i.e. +1 for a permanent or long-term arrival, -1 for a permanent or long-term departure, and 0 for a short-term arrival or departure). The MA value is not required to determine final NOM estimates for the reference quarter, but is used for estimating preliminary NOM for the corresponding quarter two years later.

State or territory of usual residence

6.40 The distribution of improved NOM estimates across states and territories is based on information as reported by travellers on incoming and outgoing passenger cards. There are two data items (State 1 and State 2) that are derived to determine a traveller's state or territory of residence/stay.

STATE 1

6.41 Derivation of the first data item (State 1) is dependent upon the direction of travel (either arrival or departure) and on the type of traveller (either visitor or a resident). For a visitor arrival the state or territory of residence (State 1) is the state or territory where they intend to stay (as indicated on the incoming passenger card). For a visitor departure it is the state or territory in which the traveller states they spent the most time. For a resident arrival it is the state or territory of their intended address in Australia, and for a resident departure it is the state or territory in which they lived. This information is obtained from incoming and outgoing passenger cards.

STATE 2

6.42 As a short-term visitor to Australia may move state or territory during their time in Australia, the second data item (State 2) is used to code them to the state or territory where they spent the most time as reported on their subsequent outgoing passenger card.

6.43 For example, if a short-term visitor arrives in June 2005 and this is their first arrival in Australia, they are allocated to the state or territory they have indicated on their passenger card as their state of intended stay (State 1). However, it is only possible to finalise their contribution to ERP for a reference quarter through the collection of future data i.e. the 16 months following the reference quarter. Therefore, a traveller history is collected over 16 months after the June 2005 reference quarter. If it is found through the traveller's history that they have stayed 12 out of 16 months, then in the June 2005 reference quarter this traveller would be allocated a State 2 value based on their outward

State or territory of usual residence continued

STATE 2 *continued*

movement subsequent to their category of travel movement (i.e. as stated on their passenger card). This would occur regardless of whether they had made numerous arrivals and departures during the 16 month period.

6.44 If it is found over time that the traveller has not stayed in Australia 12 out of 16 months they keep their State 1 allocation for the reference quarter, and as they have not met the required length of time for residency they will not be counted in final NOM.

6.45 State 2 is also derived for short-term visitor arrivals who did not leave Australia at all during the 16 months follow-up period. State or territory of residence for this group is imputed using the State 1 and State 2 distributions of long-term and short-term visitors who have spent more than 12 months, out of 16, in Australia and have made a subsequent departure movement.

PRELIMINARY NOM ESTIMATES

6.46 Preliminary estimates using the improved method for estimating NOM were implemented in official ABS population estimates for September quarter 2006 and onwards with the release of the December quarter 2006 issue of *Australian Demographic Statistics* (cat. no. 3101.0).

6.47 Preliminary estimates of NOM are required 5 to 6 months after the reference quarter for the production of quarterly estimates of the population of Australia, states and territories. At that time, complete traveller histories for the 16 months following a reference quarter cannot be produced. Migration adjustments are calculated from changes in behaviour from final estimates two years earlier for the same groups of travellers. These migration adjustments are applied to travellers who are grouped according to age, sex, country of citizenship and state/territory, and account for differences between their intended duration of stay and their actual duration of stay.

6.48 Category of travel is determined by a number of dimensions:

- whether the traveller considers themselves to be a visitor or a resident
- the direction of travel (whether an arrival or a departure)
- the stated intended duration of stay or absence (for visitors arriving and residents departing)
- actual duration of stay or absence since the previous Australian border crossing (for visitors departing and residents returning).

6.49 Each traveller is then given an additive migration adjustment (MA) value which represents the difference between their initial contribution to NOM (+1, -1 or 0 as above) and their expected contribution to NOM if actual duration of stay could be determined. The MA value is derived during final estimation for the corresponding quarter two years previously, with an average MA value derived for each group of travellers. The group of travellers is defined by the cross-classification of category of travel by age by citizenship by state/territory. The average MA value is calculated within each group of travellers by summing their MA values and dividing by the number of travellers within the group. See Step 8 (in final estimates steps) for a definition of MA value. Each traveller in the current reference quarter (at preliminary estimation) receives the average MA value from its corresponding group of travellers two years previously. Preliminary NOM estimates for the reference quarter are then obtained by adding each

PRELIMINARY NOM ESTIMATES *continued*

traveller's MA value to their initial contribution to NOM, and aggregating to the desired level (such as state/territory).

6.50 In forming the cross-classified groups of travellers for which the average MA values are derived at final estimation (for later use in preliminary estimates), the following categories are used:

- category of travel has the 10 categories of travel listed earlier in this chapter
- state is divided into eight categories (New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, Northern Territory and the Australian Capital Territory). Other Territories (see paragraph 1.20 in Chapter 1 – Overview) are not included
- country of citizenship is divided into five groups:
  - Australia including external territories
  - New Zealand
  - South-east and North-east Asia
  - North-west Europe and North America
  - Other
- age is divided into eight groups (0–4, 5–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55+).

6.51 At present the preliminary estimation method does not provide assumptions of changes from State 1 to State 2. The method used for estimating preliminary NOM will be reviewed when a longer time series of estimates become available.

ENHANCEMENTS

6.52 Australia's ERP and estimates of NOM include all people, regardless of nationality or citizenship, who usually live in Australia, with the exception of foreign diplomatic personnel and their families. Therefore, foreign diplomatic personnel and their families are considered out of scope and were removed from NOM estimates. The previous methodology for estimating NOM was unable to exclude diplomatic personnel and their families. However, with the improved NOM methodology, refinements to the NOM processing system have enabled this to occur through the use of visa information. All diplomatic personnel and their families will be excluded from new NOM estimates with the September quarter 2008 release of *Australian Demographic Statistics* (cat. no. 3101.0) on the 18 March 2009 for the reference period September quarter 2006 and onwards.

CHAPTER 7 ESTIMATING INTERSTATE MIGRATION

INTRODUCTION

7.1 At the national level, population change is the result of births, deaths and net overseas migration. At the state/territory level, an extra component of population change exists – net interstate migration. This is the net difference between arrivals to a state/territory from the rest of Australia and departures from that state/territory to the rest of Australia. Interstate migration is therefore an important determinant of population growth and distribution of the states and territories.

7.2 Within Australia there is no requirement for a person who changes their state of usual residence to register their move. Unlike overseas movements, which are recorded at Australia's borders, there are no direct quarterly measure of arrivals and departures between the states and territories. To be able to measure state/territory population change on a quarterly basis estimates of interstate migration are therefore required.

7.3 The Census is one source of information, with people being asked where they lived one year ago and five years ago. However, as the Census is held only every five years, this is insufficient for producing quarterly interstate migration estimates. Another source of data is therefore necessary.

7.4 Over time, the ABS has used a number of administrative (indirect) data sources to produce quarterly estimates of interstate migration, including electoral roll registrations and family allowance payments. Currently, quarterly estimates of interstate migration are modelled using Medicare information in conjunction with Census data and combined with defence force data. The data used by the ABS are information on interstate change of address advised to Medicare Australia and administrative data from the Department of Defence in the case of the military. For more information refer to the interstate migration section of Chapter 9 – Data sources.

7.5 The Medicare-based model used for generating post-censal estimates of interstate migration is largely superseded when new Census information becomes available. For example, every five years, after data from the following Census have been finalised, the modelled estimates are reviewed against, and potentially replaced by, the interstate migration estimates that are calculated from the Census (i.e. rebased to the Census). This is known as the re-derivation of interstate migration.

REBASING AND RE-DERIVATION OF INTERSTATE MIGRATION

7.6 Due to incomplete coverage and the non-compulsory nature of available administrative (indirect) data sources, post-censal quarterly estimates of interstate migration have long been considered the weakest measure of a component of population change. For this reason, the model for generating post-censal estimates of interstate migration is largely superseded when new Census information becomes available (i.e. rebased to the Census).

REBASING AND RE-DERIVATION OF INTERSTATE MIGRATION *continued*

7.7 Part of the process of rebasing Census counts for the estimated resident population (ERP) of the states and territories is the re-derivation of interstate migration for the intercensal period. The overall approach is to minimise state intercensal discrepancy using information from the two Census questions on usual residence one-year ago and five year ago to estimate interstate movements. Where this Census information does not reduce the intercensal discrepancy, the rebased interstate migration estimates remain largely unchanged from the Medicare-based model.

7.8 For example, during rebasing of interstate migration estimates to the 2006 Census as seen in Table 7.1, for New South Wales, Victoria and Queensland the Medicare-based estimate was used in the re-derivation as it reduced intercensal discrepancy. Whereas for South Australia, Western Australia and the Australian Capital Territory the Census-based estimate was used in the re-derivation. For Tasmania and the Northern Territory a combination of Medicare and Census-based estimates were used to reduce the intercensal discrepancy. In these cases where the intercensal error was negative and closer to zero than the difference then the intercensal error was subtracted from the Medicare-based estimate and used for the re-derivation. For more information on the revision of interstate migration estimates, see paragraphs 2.66 to 2.76.

7.9 Interstate flows however, must always sum to zero, as for each arrival there should always be a corresponding departure. Therefore, an additional change is made to scale interstate migration levels for each state and territory so the total will sum to zero at the Australia level as seen in Table 7.1. This adjustment also takes into account all movements for each state and territory before prorating.

7.10 When the intercensal discrepancy is finalised the difference between the original interstate migration estimates and the rebased estimates is apportioned across all quarters by single year of age, sex and movement direction (arrivals/departures) in the intercensal period in order to minimise quarterly change.

7.1 REBASING INTERSTATE MIGRATION ESTIMATES—2001–06

		COMPARE CENSUS AND MEDICARE DATA			PROCESS FOR INTERCENSAL DISCREPANCY		
	Final intercensal error	*Census-based migration estimate*(a)	*Medicare-based migration estimate*(b)	*Difference*(c)	*Re-derivation*	*Zero-sum adjustment*	*Final intercensal discrepancy*
New South Wales	2 767	–125 465	–136 330	10 865	–136 330	–140 564	–1 467
Victoria	–36 229	–13 121	–2 197	–10 924	–2 197	–5 086	–39 118
Queensland	–24 034	147 890	164 362	–16 472	164 362	160 495	–27 901
South Australia	–12 780	–10 192	–12 639	2 447	–10 192	–11 346	–11 487
Western Australia	–7 259	3 993	–1 399	5 392	3 993	2 715	–3 145
Tasmania	–793	4 113	3 105	1 008	3 898	3 329	–569
Northern Territory	–2 948	–4 514	–8 474	3 960	–5 526	–6 196	–670
Australian Capital Territory	–4 673	–2 375	–6 428	4 053	–2 375	–3 169	–1 414
Other Territories	234	–329	. .	–329	–165	–178	56
Australia	**–85 715**	**0**	**0**	**0**	**15 468**	**0**	**–85 715**
Sum(d)	. .	. .	. .	. .	. .	. .	85 771

. . not applicable
(a) Census estimates have been adjusted for net undercount.
(b) Medicare-based estimates accumulated quarterly.
(c) Difference between Census-based and Medicare-based estimates.
(d) Sum of absolute values for states and territories excluding Other Territories.

INTERSTATE MIGRATION METHOD

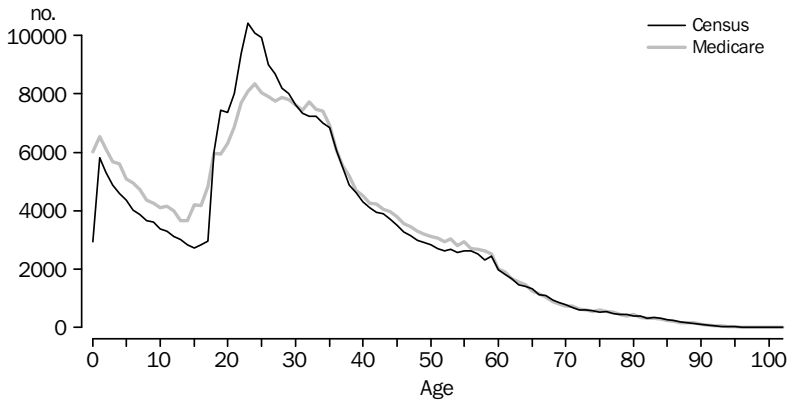
7.11 Post-censal quarterly estimates of net interstate migration are created for the states and territories using interstate change of address advised to Medicare Australia and to the Department of Defence in the case of the military. Medicare data are adjusted by means of expansion factors. These expansion factors are used to account for an under coverage of Medicare data by various ages and sex. For example, it is known that some people, particularly younger card holders, do not register changes of address with Medicare, or do so long after the fact.

7.12 Expansion factors are used in the calculation of post-censal quarterly estimates of net interstate migration and remain constant throughout the intercensal period until once again they are reviewed after final data from the following Census of Population and Housing becomes available. They are calculated for each state and territory, single year of age, sex and movement direction (i.e. arrivals or departures).

Calculating expansion factors for Medicare data

7.13 Expansion factors applied to Medicare data are based on the estimated proportion of the population covered. To calculate this proportion, Medicare movement data are compared with Census data (based on persons' usual residence one year ago). In the graph below the example is based on the 2006 Census. The period of Medicare data chosen (October 2005 to September 2006) reflects the assumption that there is a lag in the registration of change of address through Medicare.

7.2 INTERSTATE MOVEMENTS(a), Australia—Census vs Medicare data



(a) Measured by change of address data from the 2006 Census or from Medicare data.

7.14 Expansion factors were estimated for each state and territory, by single year of age, sex and movement direction (arrivals/departures). As shown in the equation below Census data were adjusted for multiple movers before dividing by the annual Medicare data. These expansion factors are used to account for an under coverage of Medicare data by various ages (particularly young adults) as seen in the previous graph.

Calculating expansion factors for Medicare data continued

$$\text{ExpFactor}^{sa,m} = \frac{\text{Census}^{sa,m} \times \text{MM}^{sa,m}}{\text{Medi}^{sa,m}}$$

where:

ExpFactor^{sa,m} is the expansions factor for state s and age-sex a, and movement direction status m (i.e. arrival or departure)

Census^{sa,m} is the Census movers for state s, age-sex a, and movement direction status m from 8 August 2005 to 8 August 2006, adjusted for net undercount and using iterative proportional fitting to calibrate the Census population to ERP

MM^{sa,m} is the proportion of multiple movers for state s and age-sex a, and movement direction status m. Calculated using data on Medicare multiple movements

Medi^{sa,m} is the Medicare movers for state s and age-sex a, and movement direction status m from October 2005 to September 2006 (allowing for a small lag of Medicare change of address data)

7.15 Analysis showed, based on the 2006 Census, that for all states and territories expansion factors on average, were greater than 1 (i.e. suggesting 'undercoverage' in Medicare data) for males aged 17–30 years and females aged 17–25 years. These age ranges were chosen as they decreased intercensal discrepancy the most when compared to any other range and are used in the 2006–11 model. Expansion factors are applied universally for all states and territories to Medicare data with these age-sex characteristics. For all other age groups, it is assumed that Medicare data provides a full coverage (i.e. an expansion factor of 1 is used).

7.16 Based on the 2006 Census the complete process undertaken can be summarised according to the following equations:

$$\text{T}^{t,sa,m} = \text{Medi}^{t+1,sa,m} \times \left(\frac{\text{Census}^{sa,m} \times \text{MM}^{sa,m}}{\text{Medi}^{sa,m}} \right) + \text{Def}^{t,sa,m}$$

where:

T^{t,sa,m} is the estimated interstate movers for quarter t, state s, age-sex a, and movement direction status m (i.e. arrival or departure)

Medi$^{t+1,sa,m}$ is the Medicare movers for quarter $t+1$ (to allow for one quarter lag), state s, age-sex a, and movement direction status m

Def^{t,sa,m} is the defence force movers for state s, age-sex a, and movement direction m

7.17 For the 2006–11 model all ages other than males aged 17–30 years and females aged 17–25 years were set to 1 as a default value. In addition any expansion factors within these age ranges which may be calculated as being less than one for a particular state/territory, single year of age, sex or movement direction are also set to one. If an expansion factor has been adjusted to 1 (i.e. no expansion factor applied) then the following equation is used:

$$\text{T}^{t,sa,m} = \text{Medi}^{t+1,sa,m} + \text{Def}^{t,sa,m}$$

Calculating expansion factors for Medicare data continued

7.18 To calculate net interstate migration for quarter t for state s and age-sex a then the following equation is the next one to be used:

$$T^{t,sa} = T^{t,sa,arrivals} - T^{t,sa,departures}$$

Defence force adjustment

7.19 As seen in the equations above adjustments to compensate for interstate defence force movements not covered by Medicare are applied to the quarterly interstate migration estimates. These adjustments are estimated using counts of defence force personnel by age, sex and state/territory, obtained from the Department of Defence, with 70% of any change in quarterly defence force numbers assumed to be due to interstate migration not otherwise covered by the Medicare model.

Multiple movers and Census data

7.20 Some people will move more than once during a given time period, including some who move to one location, then return to their original location. However, the Census asks for each person's address one year ago without reference to multiple moves which could have occurred over the one year period.

7.21 Since Medicare data do include information on multiple/return movements, these were used as a proximate to adjust data from the 2006 Census for calculating the expansion factors. The proportion of multiple movers identified using Medicare data was calculated by dividing all quarterly movements by the number of final annual movements for each state or territory, by sex, single year of age and movement direction (arrivals/departures). Calculations showed that 7% of all movements within the year were multiple movements. Those who had moved twice represented 6% of all movements whereas those who moved more than twice only represented 1% of all movements.

Lagging of Medicare data

7.22 The Medicare model assumes an average lag of 3 months (one quarter) between a person moving address and them registering the move with Medicare Australia. Analysis has shown that registration of changes of address through Medicare generally occurs some time after the actual move. Comparison of the outcomes of most scenarios tested for choosing the 2006 expansion factors indicated that the use of lagging was better as it reduced intercensal discrepancy.

7.23 Interstate migration models for both 1996–2001 and 2001–06 assumed an average registration lag of three months, so Medicare information for a particular quarter was used to estimate interstate migration for the previous quarter. It is not possible to lag these data further (i.e. to assume a delay in registration of more than three months) as this would impact on the production and publication of population estimates which are released within 6 months after the reference period.

Smoothing

7.24 Using Census data on address one year ago do introduce some potential problems because a relatively short (and therefore potentially more volatile and less representative) time period is used to estimate expansion factors. Smoothing used in generating the expansion factors helps to address these problems.

Smoothing continued

7.25 By calculating the expansion factors individually for each single year of age by sex, separately for arrivals and departures for each state and territory, the expansion factors can be relatively volatile. Furthermore, it is reasonable to expect that consecutive ages would have similar expansion factors. As such, smoothing adjustments are made to the expansion factors to reduce this volatility and increase the similarity in expansion factors for consecutive ages.

7.26 First, all the separate input components used to calculate the expansion factors (i.e. Census movers data, Medicare movers data and multiple movers data) are smoothed across single years of age for both male and female; arrivals and departures; and for each state and territory using a 3 term moving average.

7.27 Second, all expansion factors which are calculated as being less than one (i.e. fewer Census movers than Medicare movers) are set to one. Expansion factors less than one represent Medicare coverage of greater than 100% with movers registered through Medicare outnumbering adjusted Census movers. As such, expansion factors less than one are considered non-intuitive, instead reflecting inconsistencies between the Census and Medicare data.

7.28 These two steps generate smoothed expansion factors for all ages. Then, an additional step is applied which assign expansion factors of one for most age groups. From analysis based on the 2006 Census, the Medicare model expansion factors for males aged less than 17 or greater than 30 are all set to one (i.e. assumes a coverage of 100%). Likewise, expansion factors for females aged less than 17 or greater than 25 are also all set to one (i.e. assumes a coverage of 100%).

7.29 A further smoothing option is to smooth the actual output (expansion factors) using a 3 term moving average. This was used in the 1996–2001 method. However, for both the 2001–06 and 2006–11 methods smoothing of expansion factors produced only small improvements in the estimated levels of intercensal discrepancy; in some cases, results were worsened when the factors were smoothed.

7.30 Greater improvements were gained by smoothing the input data of Medicare, Census and multiple movers used to produce the expansion factors. For most states and territories, the best results were found from expansion factors using smoothed input data and un-smoothed output data (i.e. un-smoothed expansion factors).

Capping expansion factors

7.31 In the interstate migration model used for 1996–2001, expansion factors calculated as being greater than 2 (i.e. less than 50% coverage estimated for Medicare data) were set to 2. The rationale for 'capping' expansion factors was that this would reduce the influence of outlying extreme results, such as unusually low registrations in particular age/sex groups. In the 2001–06 model analysis of capping applied to the expansion factors did not produce improvements in the intercensal discrepancy and was therefore not used.

7.32 For the 2006–11 model analysis of capping applied to the expansion factors did produce improvements in the intercensal discrepancy and was therefore used. In the 2006–11 model the only outlying group of interstate movers for which capping did apply was males aged 23 to 25 departing the Northern Territory.

Medicare based model for 2006–11

7.33 The Medicare based model used for the 2006–11 intercensal period for calculating interstate migration contain the following characteristics:

- lagging of Medicare input data by three months (both for calculating expansion factors and for estimating progressive quarters of interstate migration)
- smoothing of input data (Census, Medicare and multiple movers) used to produce expansion factors
- capping applied to expansion factors
- expansion factors applied to males aged 17 to 30 years and females aged 17 to 25 years.

7.34 The ABS is using this model to produce interstate migration estimates each quarter for the intercensal period September quarter 2006 to June quarter 2011 and onwards until once again a review is undertaken after data from the 2011 Census of Population and Housing have been finalised. A defence force adjustment will continue to be applied to estimates produced by this model to compensate for movements of defence force personnel not covered by Medicare.

FURTHER INFORMATION

7.35 For more information, refer to the *Information Paper: Review of Interstate Migration Method, March 2009* (cat. no. 3106.0.55.001) and *Information Paper: Evaluation of Administrative Data Sources for Use in Quarterly Estimation of Interstate Migration, 2006 to 2011* (cat. no. 3127.0.55.001).

7.36 For more information on the method used for estimating interstate migration for the intercensal period 1996 to 2001 see: *Demography Working Paper: 1999/2 – Estimating Interstate Migration, 1996–2001* (cat. no. 3116.0). The method used in estimating interstate migration for the intercensal period 2001 to 2006 is detailed in *Demography Working Paper: 2004/1 – Review of Interstate Migration Method* (cat. no. 3106.0.55.001).

CHAPTER 8 ESTIMATING THE INDIGENOUS POPULATION

INTRODUCTION

8.1 Estimates of the Indigenous, non-Indigenous and total populations are published after each Census in *Experimental Estimates of Aboriginal and Torres Strait Islander Australians* (cat. no. 3238.0.55.001). Estimates are disaggregated by age (5-year age groups) and sex for state and territory, remoteness areas (RAs) and Indigenous regions. Estimates for statistical local areas (SLAs) are available as a total for all ages only.

8.2 Estimates of the Indigenous population are experimental in that the standard approach to population estimation is not possible because satisfactory data on births, deaths and internal migration are not generally available. Furthermore, there is significant volatility in Census counts of the Indigenous population, thus adding to the estimation problems. This volatility can in part be attributed to changes in the propensity of persons to identify as being of Indigenous origin. As a result, a method based on the use of life tables is used to produce time series data.

METHOD OF ESTIMATION

8.3 Estimated resident population (ERP) by Indigenous status are compiled using Census, the Census Post Enumeration Survey (PES) and other demographic information. Starting with Census counts by place of usual residence, a number of steps are involved. These include:

- imputation of Indigenous status for Census records with unknown Indigenous status as a result of either non-response to the Aboriginal and Torres Strait Islander origin question in the Census, or unknown Indigenous status on Census records imputed by the ABS when a form could not be obtained from occupied dwellings identified in the field
- an allowance for Census net undercount: in a complex exercise such as the Census, it is inevitable that some people will be missed and some will be included more than once. The PES, conducted shortly after Census Night, collects information about where people were on Census Night and their characteristics to estimate Census net undercount
- an estimate of the number of Australian residents temporarily overseas on Census Night (RTOs)
- backdating from the Census date to the ERP reference date of 30 June using data on births, deaths, overseas and interstate migration for the intervening period
- minor demographic adjustments designed to address any anomalies in age and sex composition (see Appendix 1 – Demographic adjustment for more information).

Indigenous status

8.4 The Indigenous population of Australia comprises people who are of Aboriginal origin, Torres Strait Islander origin or both Aboriginal and Torres Strait Islander origin. The Commonwealth definition of an Aboriginal or Torres Strait Islander person is:

- a person of Aboriginal or Torres Strait Islander descent
- who identifies as being of Aboriginal or Torres Strait Islander origin, and
- who is accepted as such by the community with which the person associates.

Indigenous status continued

8.5 The 2006 Census of Population and Housing (Household Form) asked the following question of each person:

Is the person of Aboriginal or Torres Strait Islander origin?

- For persons of both Aboriginal and Torres Strait Island origins, mark both 'yes' boxes.

No
Yes, Aboriginal
Yes, Torres Strait Islander

Census Post Enumeration Survey

8.6 The 2006 PES introduced several methodological changes including extending the scope of the survey to remote areas of Australia and discrete Indigenous communities. A new estimation method was also introduced. For more details on the PES, see:

- *Census of Population and Housing – Undercount, 2006* (cat. no. 2940.0)
- *Census of Population and Housing – Details of Undercount, Aug 2006* (cat. no. 2940.0)
- *Information Paper: Measuring Net Undercount in the 2006 Population Census* (cat. no. 2940.0.55.001)
- *Research Paper: An Estimating Equation Approach to Census Coverage Adjustment* (cat. no. 1351.0.55.019).

CALCULATING PRELIMINARY ERP

8.7 The Census provides detailed information on the age-sex structure and location of the population, but it misses some people who should have been counted in the Census. In addition, while Census records with unknown Indigenous status remain not stated on the Census file, for the purposes of population estimation they are allocated to either Indigenous or non-Indigenous according to the distribution of stated responses within each age group, sex, Census form-type and SLA.

8.8 Preliminary PES estimates of net undercount for Indigenous persons in the 2006 Census were used at the national level and for five jurisdictional groups. These were;

- New South Wales/Australian Capital Territory
- Victoria/South Australia/Tasmania
- Queensland
- Western Australia
- Northern Territory.

8.9 Some level of geographic grouping was considered necessary because of the high sampling error for some states/territories.

8.10 The geographic level to which the preliminary 2006 PES results were disaggregated for ERP purposes was determined after consideration of the sampling error and possible bias resulting from the groupings. The relative standard error (RSE) of the estimates of the Indigenous population in the five jurisdictional groups ranged from 3.5% for the Northern Territory to 7.3% for Western Australia. The RSE for Australia (excluding Other Territories) was 2.6%.

CALCULATING FINAL ERP

8.11 To address the issues of the high standard errors on the preliminary undercount rates (using the five group method) and high sampling error for the state/territory ERP estimates, particularly the high Indigenous undercount in Western Australia (a single-state group) the Empirical Bayes method was applied for final ERP.

Empirical Bayes estimation

8.12 The Empirical Bayes method was applied to the undercount adjustment rate for 15 regions (each state and the Northern Territory split into capital city and balance of state/territory, and the Australian Capital Territory). The undercount adjustment rate is the ratio between the PES estimate of the Indigenous population and the value obtained from the Census after assigning an Indigenous status to records where it was unknown (as described in paragraph 8.3). The Empirical Bayes method assigned each state and territory a mix of its own PES estimate of the undercount adjustment rate, and an overall estimate based on the 15 regions mentioned above..

8.13 The mix used was dependent on the standard error of the PES estimate, with regions having high standard errors being more influenced by the overall estimate, while regions with lower standard errors receive a greater proportion of their individual region estimate.

8.14 The overall amount of smoothing used was determined by a smoothing constant. The ABS used the 'method of moments' constant from a technique developed by Morris (1983), after checking that the indicated value gave estimates with a suitably low standard error conditional on the chosen constant. For more information on Empirical Bayes and its use in estimating the Indigenous population, see Appendix 2 – Empirical Bayes estimation of Indigenous undercount.

8.15 Estimates of the Indigenous population of the states and territories for 8 August 2006, as a result of adopting the Empirical Bayes method, are shown in the table below.

8.1 RESULTS FROM EMPIRICAL BAYES ESTIMATION(a), States and territories

	CENSUS COUNT(b)	INDIGENOUS POPULATION AT CENSUS DATE			UNDERCOUNT RATE	
	no.	*no.*	*Standard error*	*Relative standard error (%)*	*%*	*Standard error (%)*
New South Wales	138 505	151 510	5 707	3.8	8.6	3.4
Victoria	30 144	33 266	976	2.9	9.4	2.7
Queensland	127 581	144 375	4 289	3.0	11.6	2.6
South Australia	25 556	27 954	895	3.2	8.6	2.9
Western Australia	58 710	70 371	2 669	4	16.6	3.2
Tasmania	16 767	18 386	510	2.8	8.8	2.5
Northern Territory	53 662	63 864	1 764	2.8	16.0	2.3
Australian Capital Territory	3 874	4 250	118	2.8	8.9	2.5
Australia(c)	**454 799**	**513 977**	**13 309**	**2.6**	**11.5**	**2.3**

(a) Conditional on the method of movements value of A = 0.0044142.
(b) With no imputation.
(c) Excludes Other Territories.

Empirical Bayes estimation continued

8.16 Estimates of the Indigenous (and non-Indigenous) population were then adjusted to include RTOs and backdated to 30 June 2006 using data on births, deaths, overseas and interstate migration. However, for the Other Territories (which are not included in the PES), a combined net undercount estimate for New South Wales and the Australian Capital Territory was applied to the Census count of Indigenous people identified as being usually resident in those territories. This estimate is used as the majority of Indigenous people in the Other Territories reside in Jervis Bay Territory.

Sub-state/territory Indigenous estimates

8.17 The PES is the best available data source for determining what the Indigenous population should have been on Census Night, if the whole population was counted. However, as standard errors on the PES are too high for producing reliable estimates of the Indigenous population at sub-state/territory levels, Census is the only data source for calculating estimates of the Indigenous population for geographic areas smaller than a state or territory.

8.18 In producing estimates of the Indigenous and non-Indigenous populations of SLAs, PES estimates produced by the Empirical Bayes method for each state/territory were used as upper level constraints on the SLA-level Indigenous populations as at Census Night. State/territory net undercount was distributed pro rata to individual SLAs, having regard to capital city/balance of state/territory undercount for the total population according to their demographic characteristics such as age and sex.

8.19 At the sub-state/territory level, differences between Census counts and estimates of the Indigenous population are not indicative of, nor should be interpreted as, the true level of undercount; rather, these differences are a by-product of the assumptions that contribute to the estimation process.

PREVIOUS CENSUS-BASED ESTIMATES

8.20 For details on previous Census-based experimental Indigenous estimates please refer to the following:

- 2001 Census-based estimates: *Experimental Estimates and Projections, Aboriginal and Torres Strait Islander Australians, 1991 to 2009* (cat. no. 3238.0) and *Experimental Estimates of Indigenous Australians, Electronic Delivery, Jun 2001* (cat. no. 3238.0.55.001)
- 1996 Census-based estimates: *Experimental Estimates of the Aboriginal and Torres Strait Islander Population, 1991 to 1996* (cat. no. 3230.0)
- 1991 Census-based estimates: Previously published in *Experimental Estimates of the Aboriginal and Torres Strait Islander Population, June 1986 to June 1991* (cat. no. 3230.0) and subsequently revised in *Experimental Estimates of the Aboriginal and Torres Strait Islander Population, 1991 to 1996* (cat. no. 3230.0)
- 1986 Census-based estimates: *Experimental Estimates of the Aboriginal and Torres Strait Islander Population, June 1986 to June 1991* (cat. no. 3230.0)

CHAPTER 9 DATA SOURCES

INTRODUCTION

9.1 The accuracy of population estimates is dependent on the quality of population Census data, the estimates of Census net undercount derived from the Census Post Enumeration Survey (PES) and statistics on the components of population change which are used to update the Census year population. This chapter discusses these various sources of data and their accuracy.

BASE POPULATION

9.2 The base population for population estimates is derived from the latest available Census of Population and Housing and comprises Census counts by place of usual residence.

9.3 Since 1961, a Census of Population and Housing has been conducted every five years. The objective of the Census is to measure accurately the number and key characteristics of people in Australia on Census Night, and the dwelling in which they live.

Scope and coverage of the Census

9.4 The Census aims to count all people actually located in Australia on Census Night. This includes Australian residents in Antarctica and people in the territories of Jervis Bay, Cocos (Keeling) Islands and Christmas Island. The other Australian External Territories (Norfolk Island and minor islands such as Heard and McDonald Islands) are outside the scope of the Census. The only group of people who spend Census Night in Australia but are excluded from the Census are foreign diplomatic personnel and their families.

9.5 The Census includes people on vessels in or between Australian ports, on board long-distance trains, buses or aircraft and on oil or gas rigs off the Australian coast. People entering Australia before midnight on Census Night are counted while people leaving an Australian port for an overseas destination before midnight on Census Night are not. Visitors to Australia are included regardless of how long they have been in the country or how long they plan to stay.

Census counts by place of usual residence

9.6 Census counts are available by either place of enumeration (sometimes referred to as 'de facto counts') or place of usual residence (sometimes referred to as 'de jure' counts), based on responses to the Census question on address (see paragraph 2.9). For the purposes of producing population estimates, counts by place of usual residence are used.

9.7 Usual residence is defined in the Census as the place at which a person has lived or intends to live for six months or more. While for most people their usual residence will be the same as their actual location on Census Night, some people will spend Census Night at a place other than their usual residence. This means that their place of enumeration will differ from their place of usual residence.

Census counts by place of usual residence continued

9.8 People visiting Australia on Census Night (i.e. those who usually reside overseas) are included in Census counts by place of enumeration, but are not included in counts by place of usual residence.

Non-response to Census questions

9.9 Besides the question on address, questions on age, sex, marital status, country of birth and Indigenous origin are particularly important in the production of population estimates. Instances in which people do not answer these questions therefore have a bearing on the accuracy of Census counts, although information is imputed by the ABS from other details supplied on the Census form or, failing that, information provided by the Census collector. Details are imputed for all instances in which there is no response to questions on age, sex, marital status and usual address.

9.10 Table 9.1 shows that non-response to the questions which are of importance to population estimates has increased in recent censuses.

9.1 RATE OF NON-RESPONSE TO CENSUS QUESTIONS—1991 to 2006

	CENSUS			
	1991	*1996*	*2001*	*2006*
Variable	percent	percent	percent	percent
Sex(a)	na	na	na	na
Age	2.0	2.2	3.6	(b)5.0
Usual residence	5.8	0.2	0.2	4.1
Marital status(c)	6.8	2.0	2.7	5.0
Country of birth	2.2	3.5	5.5	6.9
Indigenous origin	3.2	3.0	4.1	5.7

na not available
(a) Not available but believed to be insignificant.
(b) In 2006, respondents were given the choice of providing their date of birth or age last birthday. These were combined to calculate their age on Census Night.
(c) As a per cent of the population of all ages. However a considerable proportion of non-responding persons were aged under 15 years and never married. All persons aged under 15 were coded to never married.

CENSUS UNDERCOUNT

9.11 The level of coverage of the Australian Census is considered to be excellent, and compares favourably with censuses in other countries. Census data are used for a variety of purposes, without prior adjustment for undercounting. However, because population estimates are used in important ways such as government funding and electoral representation (paragraph 1.23), and given that the level of undercounting is related to important variables such as geographic area, age and sex which are used for population estimates, it was decided that as from 1971, for the purpose of estimating population, adjustments should be made to compensate for undercounting.

9.12 Census undercounting is measured primarily by the PES, a sample survey conducted immediately after the Census. While the first PES was run in 1966, the 1976 PES was the first to be used for population estimates. Although population estimates from 1971 onwards have taken account of the undercount, due to inadequacies in the

CENSUS UNDERCOUNT *continued*

1971 PES the 1971 estimate was derived by working back from the 1976 estimate using the intercensal data on births, deaths and net overseas movement.

9.13 Note that in this publication, references to the undercount rate always refer to the net undercount rate and not the undercount adjustment factor. The undercount adjustment factor was developed in 2006 to be applied directly to Census counts to inflate them to a PES consistent number.

9.14 The undercount adjustment factor is defined in the Glossary of *Census of Population and Housing – Details of Undercount, Aug 2006* (cat.no. 2940.0) as:

> The undercount adjustment factor is the ratio of the PES population estimate to the Census count. This factor can be applied to the Census counts to indicate how many people should have been counted in the Census for that category.

9.15 Mathematically, this is expressed as:

$$\text{undercount adjustment factor} = \frac{\text{PES estimate - Census count (i.e. net undercount)}}{\text{PES estimate}}$$

9.16 However, the net undercount rate as reported in previous PES summary results, expresses the net undercount as a percentage of the PES estimate of the number of people who should have been counted in the Census.

9.17 Mathematically, this has traditionally been defined as:

$$\text{net undercount rate} = \frac{\text{PES estimate}}{\text{Census count}}$$

9.18 In both cases, the PES estimate represents the weighted survey estimate of how many people *should* have been counted in the Census whereas the Census count represents the number who *were* counted. The reason we have reported both is that the net undercount rate is referred to in the *Commonwealth Electoral Act 1918*.

9.19 Details of the 2006 survey are available in:

- *Census of Population and Housing – Undercount, 2006* (cat. no. 2940.0)
- *Census of Population and Housing – Details of Undercount, Aug 2006* (cat. no. 2940.0)
- *Information Paper: Measuring Net Undercount in the 2006 Population Census* (cat. no. 2940.0.55.001)
- *Research Paper: An Estimating Equation Approach to Census Coverage Adjustment* (cat. no. 1351.0.55.019).

9.20 Interim population estimates as calculated using the PES are subject to adjustments based on demographic analysis ('demographic adjustments'). These demographic adjustments are explained in more detail in Appendix 1 – Demographic adjustment.

Census undercount in states/territories

9.21 As shown in Table 9.2, there is variation in the rate of undercount for the individual states and territories. New South Wales, Victoria, South Australia and the Australian Capital Territory have shown relatively small variations. In Queensland there has been a considerable and consistent increase – from 1.7% in 1996 up to 3.7% in 2006. In the Northern Territory the rate was relatively low in 1996 (2.9%) but has risen steadily to 7.6% in 2006. The Northern Territory has consistently shown the highest rate of undercount of all states and territories.

Census undercount in states/territories continued

9.2 NET UNDERCOUNT RATE, State/territory of usual residence—1991 to 2006

	1991 CENSUS		1996 CENSUS		2001 CENSUS		2006 CENSUS	
	%	SE	%	SE	%	SE	%	SE
New South Wales	1.9	0.1	1.5	0.2	2.0	0.2	2.4	0.4
Victoria	1.8	0.1	1.6	0.3	1.4	0.2	2.3	0.4
Queensland	1.8	0.1	1.7	0.3	1.9	0.2	3.7	0.4
South Australia	1.6	0.1	1.3	0.3	1.6	0.2	2.3	0.4
Western Australia	2.1	0.2	1.6	0.3	2.0	0.3	3.2	0.6
Tasmania	1.7	0.2	1.4	0.4	1.6	0.3	2.0	0.6
Northern Territory	2.9	0.7	3.1	1.6	4.0	0.6	7.6	1.5
Australian Capital Territory	1.4	0.2	1.1	0.3	1.0	0.4	1.2	1.0
Australia	**1.8**	**0.1**	**1.6**	**0.1**	**1.8**	**0.1**	**2.7**	**0.2**

Census undercount by age and sex

9.22 As has been observed in previous censuses in Australia, as well as censuses overseas, undercount is greatest in the young adult range, from approximately 15 to 35 years. Older adults are much more likely to be enumerated than younger adults.

9.23 At all ages undercounting is greater for males than females, averaging 3.3% and 2.1% respectively in 2006. The highest rate observed in 2006 was 8.1% for males aged 25–29. The highest rate for females was 6.0% for the 20–24 year age group.

9.3 NET UNDERCOUNT RATE, Sex by age group—2006

	MALES		FEMALES		PERSONS	
Age group (years)	%	SE	%	SE	%	SE
0–4	2.9	0.8	3.9	0.9	3.4	0.6
5–9	1.8	0.9	3.0	0.8	2.4	0.6
10–14	2.3	0.8	1.9	0.9	2.1	0.6
15–19	3.7	0.9	3.3	0.8	3.5	0.6
20–24	7.5	1.2	6.0	1.1	6.8	0.8
25–29	8.1	1.1	5.7	0.9	6.9	0.8
30–34	5.4	1.0	2.5	0.9	3.9	0.7
35–39	4.2	0.9	1.0	0.8	2.6	0.6
40–44	3.4	0.9	1.5	0.8	2.5	0.6
45–49	2.3	0.8	1.2	0.7	1.7	0.6
50–54	2.5	0.8	0.7	0.8	1.6	0.6
55+	0.6	0.3	0.3	0.3	0.5	0.2
Total all ages	**3.3**	**0.2**	**2.1**	**0.2**	**2.7**	**0.2**

Census undercount by marital status and country of birth

9.24 The 2006 undercount rates and their standard errors for the marital status categories and for selected countries of birth are shown in Table 9.4. To a certain extent the rates reflect the age structures of the various categories. For example, the never married category, which has the highest undercount rate in the marital status classification, includes a higher proportion of people in the 15–19, 20–24 and 25–29 year age groups, for whom the rate of undercounting is higher.

Census undercount by marital status and country of birth continued

9.25 Similarly, in the country of birth classification, the population of the older source (of immigrants) countries, such as England and Scotland, have older age profiles and lower undercount rates. On the other hand, immigrants born in China and India include a higher concentration in the young adult age groups.

9.4 NET UNDERCOUNT RATE, Marital status and country of birth—2006

	%	SE
Registered marital status		
Never married(a)	4.6	0.3
Widowed, divorced or separated	1.2	0.5
Married	1.0	0.2
Country of birth		
Australia	2.5	0.2
New Zealand	3.3	1.5
England	–1.7	0.8
Scotland	–0.3	2.2
Italy	1.7	1.5
Greece	3.0	2.7
Vietnam	4.4	2.8
Phillipines	5.5	2.9
China	11.5	2.7
India	11.7	3.5
Other overseas	3.6	0.6

(a) Includes those who are living with a de facto partner and have never been in a registered marriage.

Census undercount by Indigenous status

9.26 In 2006, the Indigenous undercount rate was significantly higher than the non-Indigenous undercount rate. For more information on Indigenous undercount see the Technical Note in *Experimental Estimates of Aboriginal and Torres Strait Islander Australians, Jun 2006* (cat. no. 3238.0.55.001).

9.5 NET UNDERCOUNT RATE, Indigenous origin—2006

	Rate %	Standard Error
Indigenous	6.5	2.4
Non-Indigenous	2.6	0.2

BIRTHS AND DEATHS

9.27 The registration of births and deaths in Australia has been compulsory since the middle of the nineteenth century, when legislation was passed by the various colonies. Since Federation, each state and territory has maintained its own system of registration governed by independent legislation.

9.28 Registration of births and deaths in Australia is a state/territory responsibility rather than an Australian Government responsibility. Each state and territory has its own legislation covering the birth and death registration processes, as well as the roles and responsibilities of the Registrars of Births, Deaths and Marriages (RBDMs).

BIRTHS AND DEATHS *continued*

9.29 While the Registrars have the responsibility of administering the registration process (collection and processing), the ABS is responsible for producing statistics from relevant data. This cooperation between Registrars and the ABS has a long history and has resulted in the availability of a long time series.

Birth registrations

9.30 The process of birth registration is closely linked with the administration of hospitals and maternity clinics where the overwhelming majority of births in Australia take place. Although no national statistics are kept on home births these are believed to comprise a very small portion of all births. By arrangement with the Registrars, birth registration forms are supplied to hospitals and clinics for distribution to parents following the birth of a child.

9.31 Completed registration forms are either sent in by post or delivered to the relevant state or territory Registrar. While some hospitals assist with the dispatch of completed forms to Registrars, most are forwarded through the mail.

9.32 The Registrars are sometimes further assisted by hospitals and clinics which, in addition to distributing registration forms to parents, notify Registrars regularly of births which occur in those institutions. Midwives and doctors are also required to report births which they deliver away from hospitals and clinics. For those births known to Registrars through the notification system and from other sources but not registered within a prescribed time period, the Registrars remind the parent(s) or other qualified informants of their duty to register the birth. Reminders are sent by post to the persons concerned – if there is no response the Registrar may register the birth with the information available. This reminder system together with the general recognition among the population that a birth certificate is an essential identification document, ensures almost complete registration of births.

9.33 Despite this, there are still births which are registered later than the year they occur – of the 285,200 births registered in Australia in 2007, 2% had occurred in 2005 or earlier years.

PERINATAL DATA COLLECTION

9.34 Birth registrations are not the only source of births data in Australia. The National Perinatal Statistics Unit of the Australian Institute of Health and Welfare (AIHW) also collects birth data from midwives and other health professional who attend births. These data are published annually in *Australia's Mothers and Babies* (AIHW 2008).

9.35 Statistics obtained from the Perinatal Data Collection varies from that obtained from birth registrations. For example, the Perinatal Data Collection reported the occurrence of 282,200 live births in Australia in 2006, 5.7% more than the 266,800 live births registered in the same year. The 2007 issue of *Births, Australia* (cat. no. 3301.0) contains an appendix analysing the differences between birth registrations and the Perinatal Data Collection.

Death registrations

9.36 The primary purpose of death registrations is to allow for the legal identification of persons who are deceased and to ascertain the cause of death. Information about the deceased is supplied by a relative or other person acquainted with the deceased or by an official of the institution where the death occurred.

Death registrations continued

9.37 As part of the registration process, information on the causes of death is either supplied to the RBDM by the medical practitioner certifying the death on a Medical Certificate of Cause of Death, or supplied as a result of a coronial investigation. Death records are provided electronically to the ABS by individual registrars, on a monthly basis. Information from coronial investigations are provided to the ABS through the National Coroners Information System (NCIS).

9.38 There are three components of a death registration and all components must be completed in order for the RBDM to consider a registration finalised:

- Death Notification Form – completed by a funeral director, based on information supplied by relatives/friends of the deceased. This form is submitted to the RBDM.
- Medical Certificate of Cause of Death – this is either completed by a doctor who attended the patient prior to death and forwarded to the RBDM or, if the death is suspicious or due to an unnatural cause (approximately 14% of all deaths), a Coroner will be responsible for investigating and determining the cause of death. Coroners pass this information on to the National Coronial Information System (NCIS) and to the RBDM.
- Certificate of Burial or Cremation – completed by the funeral director. This form is submitted to the RBDM.

9.39 The ABS only collects a subset of data items from the registration process. Only data items which are required for statistical purposes are forwarded to the ABS by the RBDM.

Preliminary, revised and final estimates

9.40 There are three stages in the production of birth and death estimates for the purpose of compiling population estimates. These result in the production of preliminary, revised and final figures, based on the amount and type of data available at the time the estimates are produced.

9.41 Preliminary population estimates are used for a wide variety of purposes, including the distribution of government funds and services and the determination of each state and territories' number of seats in the House of Representatives (see Chapter 1 – Overview). Due to the importance of these estimates, it is vital that preliminary estimates of all components of population growth produced using limited data (including births and deaths), be as close as possible to those which will be produced at a later date using more complete data.

9.42 Conceptually, estimates of births and deaths used in quarterly post-censal population estimates should relate to the numbers of births and deaths occurring in each particular quarter. However, at the time preliminary population estimates are required (5 to 6 months after the end of each quarter), data to produce occurrence-based estimates are incomplete. Instead, the ABS uses data received from Registrars relating to the numbers of births and deaths registered in a quarter as a proxy for the number of occurrences. These preliminary estimates of births and deaths are based on 'raw' (i.e. unadjusted) counts of registrations for each quarter.

9.43 Preliminary estimates of births and deaths are revised using occurrence data 21 months after the end of each financial year, with adjustments applied to these occurrence-based estimates to reflect known trends in the delay in registration of births and deaths. These adjustments are termed 'inflation factors'. Further information on how

Preliminary, revised and final estimates continued

these inflation factors are calculated is provided in Chapter 5 – Estimating births and deaths. Revised estimates are released in each September quarter issue of *Australian Demographic Statistics* (cat. no. 3101.0). For example, revised estimates of births and deaths for the 2006–07 financial year would be released in the September quarter 2008 issue of *Australian Demographic Statistics* (cat. no. 3101.0).

9.44 Estimates of births and deaths for each intercensal period are finalised after the following five-yearly Census of Population and Housing, based on the latest available occurrence data.

Accuracy

9.45 Information on births and deaths are obtained from a complete enumeration of births and deaths registered during a specified period and are not subject to sampling error. However they are subject to non-sampling error which can arise from inaccuracies in collecting, recording and processing of data. Every effort is made to minimise error by working closely with data providers, the careful design of forms, training of processing staff and efficient data processing procedures.

9.46 Sources of non-sampling error include:

- incompleteness of an individual record
- incompleteness of the dataset (e.g. impact of registration lags, processing lags and duplicate records)
- lack of consistency in the application of questions or forms used by Registrars, both through time and between different states/territories.

9.47 The quality of preliminary births and deaths data, as measured by the differences between preliminary and revised estimates, are affected by delays between the occurrence of these events and their registration. These can be caused by a range of factors, and could include:

- (in the case of births) delays in parents registering the birth of a child
- (in the case of deaths) delays in the submission of a death certificate to a registrar
- delays in the processing of forms at registry offices
- delays in the processing of data received from registrars at ABS offices
- other ad-hoc delays or processing problems.

9.48 Preliminary estimates can also be subject to sudden 'shocks', e.g. processing lags due to peak workloads, holiday periods, or technical issues.

9.49 The delays (or lags) in registration are a greater problem for births than for deaths and are the main cause of differences between preliminary and revised estimates of natural increase. More information on these lags, and how adjustments are made to compensate for them, is provided in Chapter 5 – Estimating births and deaths.

Indigenous births and deaths

9.50 Although it is considered likely that most Aboriginal and/or Torres Strait Islander (Indigenous) births and deaths are registered, a proportion of these are not registered as being of Indigenous origin. Birth registrations classify a birth as being of Indigenous origin where at least one parent identified themselves as being of Indigenous origin on the birth registration statement. Death registrations classify a death as being of Indigenous origin where the person completing the registration form (be it a relative or other person acquainted with the deceased, or by an official of the institution where the death occurred) identifies the deceased person as Indigenous.

Indigenous births and deaths continued

9.51 There are several data collection forms (including birth and death registration forms) on which information on the Indigenous origin of the person in question is requested. Due to a number of factors, the results are not always consistent. The likelihood that a person will identify, or be identified, as Indigenous on a specific form is known as their propensity to identify as Indigenous.

9.52 Propensity to identify as Indigenous is determined by a range of factors, including:

- how the information is collected
- who completes the form
- the perception of how the information will be used
- education programs about identifying as Indigenous
- cultural issues associated with identifying as Indigenous
- emotional reaction to identifying as Indigenous.

9.53 The way in which a person identifies, or is identified as Indigenous on a specific form can also change over time (this change in propensity to identify as Indigenous is detailed further in Chapter 8 – Estimating the Indigenous population). Together with delays in registration and uncertainty in the first place, these can lead to unexpected changes in Indigenous statistics. Over-precise analysis of Indigenous deaths and mortality should be avoided.

9.54 By linking registered deaths to Census records, the Census Data Enhancement (CDE) project allowed calculation of the expected number of Indigenous deaths. The Indigenous deaths identification rate was then calculated by taking the ratio of the number of deaths reported as Indigenous in death registrations to the number of deaths expected to be recorded as Indigenous in Census using results from the CDE project. The *Experimental Life Tables for Aboriginal and Torres Strait Islander Australians, 2005–2007* (cat. no. 3302.0.55.003) publication found that the Indigenous deaths identification rate for Australia in 2006–07 was quite high (around 92%).

9.6 INDIGENOUS DEATHS IDENTIFICATION RATES, State/territory and Australia—2006–07

	Number of Indigenous deaths according to death registrations	*Expected number of Indigenous deaths*(a)	*Identification rate*
	no.	no.	%
NSW	372	427	87.1
Qld	351	372	94.4
WA	254	228	111.4
NT	204	188	108.5
Vic., SA, Tas., ACT, OT	146	226	64.6
Aust.(b)	**1 327**	**1 441**	**92.1**

(a) In Census if weighted PES Indigenous propensities are used.
(b) Includes all states/territories.

9.55 See the *Information Paper: Census Data Enhancement – Indigenous Mortality Quality Study, 2006–07* (cat. no. 4723.0) for more information on the CDE project.

MARRIAGES AND DIVORCES

9.56 Unlike the registration of births and deaths, the provisions for the registration of marriages and divorces are governed by Commonwealth Acts. The *Matrimonial Causes Act 1959* and the *Marriage Act 1961* replaced state and territory legislation and provided uniformity in the legislative basis for the registration of marriages and divorces.

9.57 The Matrimonial Causes Act was later replaced by the *Family Law Act 1975*. (Western Australia passed a State Family Law Act based on the Commonwealth Act). Although state and territory Registrars are responsible for the registration of marriages celebrated in their areas, the procedure of registration and the particulars required for registration are common to all.

Marriages

9.58 Under the Marriage Act, marriages may be celebrated by a minister of religion registered as an authorised celebrant, by a state/territory Registrar, or by other persons authorised by the Attorney-General. Notice of the intended marriage must be given to the celebrant at least one month but not more than six months before the marriage. A celebrant is required to transmit within 14 days an official certificate of the marriage for registration to a district registrar in the state/territory in which the marriage took place.

9.59 The Marriage Act also introduced uniform minimum ages at marriage of 18 for males and 16 for females. Marriages of minors (for males aged 16 or 17 and for females aged 14 or 15) were allowed only if a judge or magistrate issued an order permitting the marriage. Further amendments to the Marriage Act in 1991 brought the minimum ages for females into line with those for males. They designated the minimum age at which persons are legally able to marry to be 18 years. Persons aged 16 and 17 years may marry a person aged 18 years or over with parental or guardian consent and an order from a judge or magistrate.

Divorces

9.60 Divorce statistics are derived from legal records kept by the Family Court which administers the Family Law Act. Under the Family Law Act the concept of fault which was incorporated in the Matrimonial Causes Act and relevant previous state legislation was abandoned and only one ground of divorce is now recognised – irretrievable breakdown of a marriage. This is established under the law if the husband and wife are separated and have been living apart from each other for 12 months or more and there is no reasonable likelihood of reconciliation.

NET OVERSEAS MIGRATION AND OVERSEAS ARRIVALS AND DEPARTURES

9.61 Comprehensive statistical records on overseas arrivals and departures (OAD) have been maintained since the colonial days. This has been made possible by the relative isolation of Australia, the absence of direct land links with other countries, and the limited number of ports of entry. These natural advantages have been reinforced by government control of arrivals and departures.

9.62 The ABS statistics on overseas migration are calculated using administrative data collected and compiled by the Department of Immigration and Citizenship (DIAC) under the authority of the Migration Regulations (*Migration Act 1958*). At present, the main source of data on overseas migration is the incoming and outgoing passenger cards completed by all persons arriving in or departing from Australia. Data from passports and visa (entry permit) applications and approvals are also provided by DIAC's Travel and Immigration Processing System (TRIPS). These three data sources (i.e. passenger cards, passports and visa applications) are collected, compiled and matched together by DIAC.

NET OVERSEAS MIGRATION AND OVERSEAS ARRIVALS AND DEPARTURES *continued*

Reproduced copies of the current passenger cards are available in Appendix 1 with each issue of *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0).

9.63 The OAD statistics are sourced from files of monthly extracts of matched TRIPS records provided by DIAC. Statistics on overseas arrivals and departures relate to the number of movements of travellers rather than the number of travellers (i.e. multiple movements of individual persons during a given reference period are each counted separately). The statistics exclude the movements of operational air and ships' crew, transit passengers who pass through Australia but are not cleared for entry, passengers on pleasure cruises commencing and finishing in Australia, and unauthorised arrivals. OAD statistics are published on a monthly basis in *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0).

9.64 Net overseas migration (NOM) quarterly estimates are sourced from the processed OAD data (that has used matched TRIPS data) and monthly extracts of unmatched TRIPS records. These NOM estimates contribute to quarterly ERP and are released in *Australian Demographic Statistics* (cat. no. 3101.0).

NOM accuracy

9.65 All migration data sources are subject to non-sampling error which can arise from inaccuracies in collecting, recording and processing the data. The ABS does not have control over any non-sampling error associated with data from DIAC.

9.66 Another dimension of non-sampling error is the fact that the measures of migration estimates become more accurate as more time elapses after the reference period. The trade-off between timeliness and accuracy means that a user can access more accurate data by using the revised or final data.

OAD accuracy

9.67 The OAD statistics are derived from a combination of full enumeration and sampling of movement records. All permanent movements and all movements with a duration of stay of one year or more are fully enumerated. The number of movements where the duration of stay is less than one year are fully enumerated, however their characteristics are sampled. From January 2005, 4.9% of all short-term movements have been selected for sample. Statistics relating to these movements are therefore weighted estimates.

9.68 As NOM estimates are based on a sample, they are subject to sampling error in addition to non-sampling error as mentioned previously.

NON-SAMPLING ERRORS

9.69 These arise from inaccuracies in collecting, recording and processing the data. Every effort is made to minimise such errors, both through careful design of the passenger cards and through checks on the information once it is received. During the edit process some items are corrected where they conflict with other known information. Missing replies to certain items such as age, state/territory and country of previous residence and main country of intended destination are also imputed by reference to other related items. For further information on non-response rates and data imputation see the Data Quality Issues appendix of *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0).

OAD accuracy continued

SAMPLING ERRORS

9.70 Estimates based on a sample are subject to sampling variability, that is, they may differ from those that would be obtained from full enumeration. One measure of the likely difference resulting from not fully enumerating the OAD collection is provided by the standard error. There are about two chances in three that the sample estimate will differ by less than one standard error from the figure that would have been obtained from full enumeration, and about nineteen chances in twenty that the difference will be less than two standard errors. For further information on standard errors applied to OAD movements see the Standard Errors section of *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0).

Changes to source data over time

9.71 From July 2001, Department of Immigration and Multicultural and Indigenous Affairs (DIMIA – now DIAC) adopted a new passenger card processing system which involved electronic imaging of passenger cards and intelligent character recognition of the data stored in the images. This process has yielded several improvements to the processing of passenger card data, most notably the detailed information about missing values.

9.72 In July 1998, the Department of Immigration and Multicultural Affairs (DIMA – now DIAC) revised the incoming and outgoing passenger cards and associated procedures as well as computer systems. Following these changes, some questions on the passenger cards were not compulsory and answers to these questions were not checked by Customs officers. The question on marital status was deleted. Data on marital status is now derived from visa applications (only for certain visa classes) and is therefore not available for Australian or New Zealand citizens. The changes also affect the data for 'previous country of residence' which is imputed for Australian and New Zealand citizens. For more information see the May 1998 issue of *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0). Since July 1998, there have been additional minor changes to both incoming and outgoing passenger cards. Information on age, sex and country of birth is obtained through matching to passport and visa data, while information on time spent in Australia (for visitors and temporary entrants) and time spent abroad (for Australia residents) is calculated through comparison of arrival and departure dates which are accessed through the movements database, maintained by DIAC.

Historical overview

9.73 Early migration statistics were derived from passenger lists (manifests) which masters of ships were required to submit to the authorities on arrival or departure from Australia. Migration statistics were published in varying detail in Statistical Registers or Year Books of the Colonies, and after 1901 also in the Commonwealth Year Book and statistical bulletins.

9.74 With the advent of air travel, people arriving in or departing from Australia lodged a passenger card containing information identical to that previously provided on shipping manifests.

9.75 In 1965, the use of shipping manifests for statistical purposes was abandoned. The control of all passenger movement became the responsibility of the immigration authorities and incoming and outgoing passenger cards were prescribed for use by all sea and air passengers. From January 1974 responsibility for processing passenger cards was transferred from the ABS to DIAC.

Historical overview continued

9.76 More information on the history of overseas migration statistics is contained in '*Immigration and Ethnicity*' (Price 1996) and '*Trans-Tasman Migration: Trends, Causes and Consequences*' (Carmichael 1993).

INTERSTATE MIGRATION

9.77 Interstate migration is a key determinant of the accuracy of state and territory population estimates. Data on interstate migration cannot be directly estimated unlike that of natural increase and net overseas migration. Instead, post-censal quarterly estimates of interstate migration are modelled using administrative by-product data. Over time, the ABS has used a number of administrative data sources to produce quarterly estimates of interstate migration, including electoral roll registrations and family allowance payments. Currently the data used by the ABS is information on interstate change of address advised to Medicare Australia and to the Department of Defence in the case of the military.

9.78 The Medicare-based model used for generating post-censal estimates of interstate migration is largely superseded when new Census information becomes available. For example, every five years, after data from the following Census has been finalised, the modelled estimates are reviewed against, and potentially replaced by, the interstate migration estimates that are calculated from the Census (i.e. rebased to the Census). This is known as the re-derivation of interstate migration and is mentioned in Chapter 7 – Estimating interstate migration.

9.79 Due to incomplete coverage and the non-compulsory nature of available administrative (indirect) data sources, post-censal quarterly estimates of interstate migration have long been considered the weakest measure of a component of population change.

Criteria for data source selection

9.80 In Australia there exist a range of administrative data sources that might be considered for modelling interstate movements. These include Medicare data, electoral roll enrolments, social security, taxation data and drivers licence information. However, to be of use these data sources must meet a number of criteria. These include:

- population and coverage – the source must provide complete, or near complete, coverage of the usually resident population of Australia
- data content – individual data records must include certain data items (such as age/date of birth, sex, date of move, origin and destination)
- geographic level – data must be available at the state/territory level
- timeliness – data must be available shortly after the end of the reference period
- historical availability – to be able to model, a relatively long time-series of data is required
- consistency – there must be no or minimal definitional changes to the data over time (or at a minimum, changes must be quantifiable)
- electronic capture – current and past data must be available in electronic format.

Strength of Medicare data as an indicator

9.81 The ABS evaluates the range of potential sources of administrative data for its effectiveness in estimating quarterly interstate migration. Medicare Australia data supplying change of address information was found to be the most effective source currently available. For more information, refer to the *Information Paper: Evaluation of*

Strength of Medicare data as an indicator continued

Administrative Data Sources for Use in Quarterly Estimation of Interstate Migration, 2006 to 2011 (cat. no. 3127.0.55.001).

9.82 Medicare card holders are required to register changes of address when they make claims, or when their cards are replaced. However, it is known that some people, particularly younger card holders, do not register changes of address with Medicare, or do so long after the fact. Comparison of Medicare change of address with Census data on the address of respondents one year prior to the Census suggests that the level of undercoverage in Medicare is fairly constant over time. In addition, this under-reporting seems to be similar for interstate arrivals and interstate departures, as well as for each sex by various ages.

9.83 The undercoverage of interstate movers within Medicare data is adjusted by the ABS for each sex at specific ages through the use of expansion factors. These expansion factors scale up Medicare data for these specific ages to reflect the higher levels measured by information provided by the most recent Census. For the intercensal period 2006 to 2011 expansion factors are to be applied to males aged 17–30 years and females aged 17–25 year universally for each state and territory for both arrivals and departures. For more information see Chapter 7 – Estimating interstate migration.

9.84 Medicare theoretically covers all Australian usual residents as well as those non-Australian residents granted temporary registration. However, there are a range of Australian usual residents who do not access the Medicare system, primarily due to access to alternative health services, such as defence force personnel, prisoners, persons eligible for the Department of Veterans Affairs Health Services and Indigenous Australians. Strategies have been put in place however, to enrol Indigenous Australians with Medicare Australia who would normally just use an Aboriginal medical service.

Defence force adjustment

9.85 Adjustments to compensate for interstate defence force movements not covered by Medicare are applied to the quarterly interstate migration estimates. These adjustments are estimated using counts of defence force personnel by age, sex and state/territory, obtained from the Department of Defence, with 70% of any change in quarterly defence force numbers assumed to be due to interstate migration not otherwise covered by the Medicare model.

Changes to source data over time

9.86 The first attempt to compile interstate migration estimates was made for a period prior to 1966 when interstate arrivals and departures were estimated from records of all movements (including short-term movements) by sea, air and rail. From June 1966 to 1981, interstate movements were based on records of interstate changes of address on child endowment (family allowance) registers and electoral rolls. Holiday, business and other short-term movements were no longer taken into account. The change was made in the recognition that estimates based on air, sea and rail travel were inadequate as measures of total net interstate movements (travel by car, for example, was not recorded) and that measuring all movements including short-term moves was neither necessary nor practicable.

Changes to source data over time continued

9.87 At the time, the family allowance was paid universally (to all mothers of children under the age of 17 years) but in November 1987 means testing was introduced. An upper income limit for entitlement was set, graduated according to the number of children in the family.

9.88 The Department of Social Security (DSS) was unable to estimate the impact of means testing. In October 1987 there were 2.1 million families collecting the allowance, one month later it declined to 1.8 million. It then started to gradually increase, reaching 1.9 million in August 1989. At the time of introduction of means testing the Department had no data on income of parents. As a result, the department could not exactly explain whether the decline since November 1987 was due to:

- income testing; or
- families with the youngest child turning 17 years (and therefore becoming ineligible).

9.89 Whatever the answer, it was clear that means testing, by reducing coverage of the population, reduced the effectiveness of the family allowance register as an indicator of interstate migration. In addition, effectiveness was subject to changes over the years to the age limit of children for which family allowance was applicable.

9.90 Electoral roll data were used in conjunction with family allowance data, but were much less reliable as a source of interstate migration statistics. While the registration of electors, voting, and notification of a change of address are compulsory in law, several factors affect the quality of the data. First, a proportion of the population are not entitled to vote and are therefore not on the electoral roll. Second, registration of persons entitled to vote is incomplete. Third, the timing of elections has affected the timing of notification of change of address. Fourth, the timing of Electoral Office surveys to check the coverage of their rolls (called 'habitation' reviews) also affect the timing of notification of change of address.

9.91 All these factors affected both the coverage of the data and the reliability of the interstate migration estimates. The electoral data usually showed a much lower level of residential moves and very large fluctuations reflecting the timing of elections. The quality of electoral transfer data deteriorated after 1976 and by 1981 was no longer considered a reliable source of interstate migration statistics.

9.92 Because the combined scope of electoral data and family allowance data did not provide full coverage of the entire population, adjustments were made to allow for the persons not covered, namely persons over 15 years of age but below voting age, and others not eligible to vote.

9.93 The deterioration of the electoral change of address data led to their abandonment in 1981. From 1981 to 1986, family allowance data only were used but in October 1987, when the means test for family allowance payments was introduced, it was also replaced.

9.94 A detailed assessment of the quality of the family allowance data, the internal migration survey (a former annual survey on change of usual residence) and, the electoral roll transfer data, are presented in the *Occasional Paper: Post-censal interstate migration estimates 1966–1981* (ABS & Di Iulio 1984).

Changes to source data over time continued

9.95 As from 1986, change of address data became available from the nationwide compulsory Medicare system and they were assessed to be of high quality. They have been used since then, in place of family allowance data, to estimate interstate migration. Chapter 7 – Estimating interstate migration describes the method being used to generate interstate migration statistics from Medicare change of address data.

9.96 Until June 1996, only Medicare change of address data for those aged 1–14 were used, as most other ages had significant under-registration of interstate movements. These movements were then expanded with adult to child expansion ratios based on information from the latest available Census being applied to Medicare change of address data for ages 1–14 for each interstate flow.

9.97 From July 1996, estimates for interstate migration have used Medicare change of address data for all ages as a result of improvement in registrations. Medicare data for each age have been used to represent total movements for that age, after making adjustments for under-registration (i.e. applying expansion factors) by comparing Medicare data with that from the latest available Census. For both intercensal periods 1996 to 2001 and 2001 to 2006 expansion factors were applied to males age 16–29 and females aged 18–24 universally for each state and territory for both arrivals and departures.

9.98 For the 2001–06 period, Medicare data were also supplemented by Defence Force data to compensate for interstate movements of defence force personnel not in the Medicare change of address dataset.

APPENDIX 1 DEMOGRAPHIC ADJUSTMENT

INTRODUCTION

A1.1 Interim population estimates as calculated using the method specified in Chapter 2 – Estimating national and state population, are subject to adjustments based on demographic analysis ('demographic adjustments'). Most of these demographic adjustments (DAs) are made to the interim estimates at the Australian level, on the basis of a number of checks against other sources (data confrontation) as well as internal checks on both Census and undercount from the Census Post Enumeration Survey (PES).

A1.2 Although most DAs are one-off adjustments, some are regularly required, these include:

- cohort size and sex ratio check versus other sources
- age/sex internal consistency for undercount
- consistency against other Census years' undercount adjustments
- checks of ages imputed in the Census
- checks for Census 'faux-old' (formerly 'vandals') in upper ages
- assorted other issues that arise during processing, including SLA-specific adjustments.

A1.3 The overall approach to making DAs is to make conservative, minimally intrusive adjustments.

DATA CONFRONTATION

A1.4 The data confrontation process compares the population and sex ratio in each age group (both single year and 5-yearly age groups) of this interim estimate with the same data from a range of other sources. These include:

- Demographic estimates derived from the National Demographic Databank (see below). This represents the total population best in older ages and sex ratios in younger ages (ages less than about 28 years).
- Medicare registrations. The scope is close to the Australian resident population, so this represents population size and sex ratios well.
- ERP for the current Census year based on the previous Census. Note however that the ERP based on the previous Census is sometimes correlated with the other two sources due to adjustments made on the previous Census. Used for comparing both population counts and sex ratios.
- Current Census counts by usual residence. These are useful for showing what raw Census data gives before PES, RTOs, backdating, etc. are applied. Used for comparing both population counts and sex ratios.
- ERP for the previous Census year, offset 5 years. As it excludes components of population change over the last intercensal period, this is mainly used for sex ratio analysis – particularly if there are concerns about the reliability of intercensal net overseas migration (NOM).
- Previous Census counts by usual residence, offset 5 years. Mainly used for sex ratio analysis.
- AEC enrolments. Not as useful for comparison with population counts as the scope is narrower than the Australian resident population, but useful for sex ratio analysis.
- Births. The population count and sex ratio of 0-year olds is compared to those of births over the year preceding the Census.

DATA CONFRONTATION
continued

A1.5 Prior to 2006, there appeared to be a clear pattern in which the numbers of people aged 30, 40, 50, 60 and 70 were slightly high, and the numbers of people aged 31, 41, 51, 61 and 71 were slightly low in comparison with the independent sources. As a result of this 'age heaping', the population in these pairs of consecutive ages were combined and then redistributed according to the Demographic Databank age distribution.

A1.6 In the 2006 Census, respondents were given the option of providing their age in years or giving date of birth. The majority chose to answer the date of birth option, which is not easy to generalise, therefore in 2006 no adjustment was required to correct age heaping.

UNDERCOUNT CONSISTENCY

A1.7 The PES undercount rate is checked for internal consistency by comparing age/sex undercount rates with the four previous PES-based rates, comparing the male with the female undercount rate, and comparing the undercount rate by sex in successive age groups.

A1.8 It is worth noting that the PES is designed to adjust for missing and erroneous Census reporting, but can never hope to perfectly do so. The reasons for this limitation include:

- correlation bias of PES and Census non-response (i.e. the reasons which contribute to a person being missed in the Census may also cause them to be missed in the PES), see correlation bias in the Glossary for more information
- issues of matching/searching to non-contact dwellings (there is no corresponding person in the Census for the PES to match to)
- sample size (PES estimates of the population in the non-contact sector have relatively high sampling error because of the small sample size)
- non-universal scope of PES (people included in the Census that were not able to be sampled in the PES, e.g. homeless people, people in non-private dwellings such as hotels, motels, hospitals, etc.).

A1.9 For more information see:

- *Census of Population and Housing – Undercount, 2006* (cat. no. 2940.0)
- *Census of Population and Housing – Details of Undercount, Aug 2006* (cat. no. 2940.0)
- *Information Paper: Measuring Net Undercount in the 2006 Population Census* (cat. no. 2940.0.55.001)
- *Research Paper: An Estimating Equation Approach to Census Coverage Adjustment* (cat. no. 1351.0.55.019).

MAGNITUDE OF DEMOGRAPHIC ADJUSTMENTS

A1.10 For final rebasing following the 2006 Census, the demographic adjustments netted to -14,300 or 0.07% of the population (-15,200 in preliminary rebasing), and in effect alter the population as defined by the PES estimates. This compares with net adjustments of -24,900 and -8,700 for preliminary and final rebasing respectively after the 2001 Census. To set some perspective, note that PES net undercount adjustment totals 550,000 and RTOs are 346,000. See the table below for the effect of DAs.

A1.1 ADJUSTMENT COMPONENTS OF ESTIMATED RESIDENT POPULATION, Final—30 June 2006

	NSW	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT*	*Aust.* (a)
	'000	'000	'000	'000	'000	'000	'000	'000	'000
Persons									
Components as at 8 August 2006:									
Census count, actual location	6 585.7	4 915.3	4 046.9	1 509.0	1 986.2	470.8	217.1	327.9	20 061.6
plus – Residents absent interstate	74.8	87.7	38.1	28.4	19.2	13.0	4.5	10.5	276.3
less – Interstate visitors	54.3	36.2	107.5	13.8	25.1	5.5	22.1	11.4	276.3
less – Overseas visitors	57.0	34.4	72.9	9.2	21.3	1.8	6.7	2.9	206.4
equals – Census count, place of usual residence	*6 549.2*	*4 932.4*	*3 904.5*	*1 514.3*	*1 959.1*	*476.5*	*192.9*	*324.0*	*19 855.3*
plus – Allowance for under-enumeration	157.6	113.6	148.4	36.3	64.2	9.5	15.9	4.0	549.6
plus – Demographic adjustment	–5.1	–3.4	–2.8	–1.0	–1.3	–0.3	–0.2	–0.2	–14.3
plus – Residents temporarily overseas	124.3	94.6	50.5	20.2	42.5	4.6	2.5	6.8	346.0
equals – ERP as at 8 August 2006	*6 826.0*	*5 137.3*	*4 100.6*	*1 569.8*	*2 064.4*	*490.3*	*211.1*	*334.7*	*20 736.6*
Backdating components to 30 June 2006:									
less – Births	9.6	7.1	6.0	2.0	2.9	0.7	0.4	0.5	29.3
plus – Deaths	5.4	3.9	2.9	1.4	1.3	0.4	0.1	0.2	15.6
less – Net interstate migration	–2.4	–0.1	2.4	–0.2	0.4	–0.1	0.1	—	—
less – Net overseas migration	8.2	7.6	4.2	1.5	3.1	0.1	0.1	0.2	25.0
equals – final ERP 30 June 2006	*6 816.1*	*5 126.5*	*4 090.9*	*1 567.9*	*2 059.4*	*490.0*	*210.6*	*334.1*	*20 697.9*

— nil or rounded to zero (including null cells) (a) Includes Other Territories

NATIONAL DEMOGRAPHIC DATABANK

A1.11 In the 1960s, before the PES was fully operational, a computer file was created by H.P.Brown of the Australian National University (ANU) to enable an assessment of Census undercounting and age mis-statement by demographic analysis. Called the ANU Demographic Databank, this file contained a time-series of national demographic events (births, deaths and overseas arrivals and departures) and Census counts of population for all years back to 1921. The data, which were by age and sex, were obtained from the ABS, as were additional data used by A. R. Hall of the ANU to update the file for the period 30 June 1966 to 30 June 1976 (Hall 1980).

A1.12 The purpose of this file was to construct population counts that were independent of the Census by by-passing censuses and the adjustments made from time to time to conform to Census counts of the population. For example, it was possible to estimate the population at 30 June 2006 by commencing from the 1921 Census count and, using the cohort component method, updating only for subsequent demographic events (i.e. births, deaths and migrations). Any Census could be used as the base, and, once chosen, could be updated for any required number of years. In particular, though, these independent populations were compiled for Census dates to enable comparison with the Census count at that date.

A1.13 For the years since 1976, the Databank has been maintained and updated by the ABS, and is now called the National Demographic Databank. It is a useful supplement to the PES as a measure of the quality of Census data.

A1.14 Revisions have been made to the database to conform to the changes, as from 1971, in the definition of 'population', i.e. defining population as the number of people who usually reside in Australia (see Chapter 1 – Overview). These revisions entailed the exclusion of all short-term overseas arrivals and departures back to 1925. (It was not possible to go back to 1921 because data for short-term movements were not available for years prior to 1925).

A1.15 Although it would have been possible to maintain the old series as well as the revised one, it was decided that only the revised series would be maintained and updated for future use.

NATIONAL DEMOGRAPHIC DATABANK *continued*

A1.16 For analysing 2006 Census undercount, an age range of 0 to 80 years could be derived for the population estimate from the Databank without using the 1921 Census as the base (since all such persons would have been born after 1921). This age range was considered sufficient for the purposes of comparison with the interim population estimates, while the PES alone was available for the higher age groups. The problem of not having short-term migration data before 1925 is thus not applicable for these ages.

APPENDIX 2 EMPIRICAL BAYES ESTIMATION OF INDIGENOUS UNDERCOUNT

BACKGROUND

A2.1 Estimates of Indigenous undercount from the Census Post Enumeration Survey (PES) are required to adjust Census Indigenous figures as a key input to Indigenous estimated resident population (ERP). These estimates of Indigenous undercount adjustment should be stable (small standard errors) whilst minimising bias.

A2.2 Empirical Bayes (EB) estimation has been used by the ABS to estimate Indigenous undercount adjustments at state/territory by capital city/balance of state level – these are used to produce Indigenous ERP at state/territory level. These estimates and standard errors, prorated to ensure consistency with the Australian PES estimate, were directly produced from the EB estimator using Morris' algorithm (Morris 1983).

WHY THE EMPIRICAL BAYES APPROACH?

A2.3 High standard errors on the preliminary state/territory indigenous undercount rates lead to high sampling error for preliminary state/territory Indigenous ERP. The use of EB estimation in final rebasing in effect smoothed those parts of states with a high standard error, resulting in a more reliable undercount adjustment factor and final state/territory Indigenous ERP.

A MODEL FOR VARIATION OF UNDERCOUNT

A2.4 In estimating Indigenous numbers, the key item to be estimated from the PES is the "undercount adjustment", defined as the percentage increase to be applied to the Census count of Indigenous (after imputing for "not stated" Indigenous) to obtain a final Indigenous count. Suppose that the PES survey provides estimates P_r with variance V_r of undercount adjustment for each region r, where r indexes the 15 state/territory by capital city/balance of state regions. This provides information about the distribution of the true undercount adjustments T_r as follows.

A2.1

$$P_r \sim N(T_r, V_r)$$

where this is read: "P_r is distributed as a normal random variable with mean T_r and variance V_r".

A2.5 This information is to be weighed up against a model for the likely actual variation between the true values. The information provided by this model is summarised as follows.

A2.2

$$T_r \sim N(T, A)$$

A2.6 This model says that, in the absence of survey information about individual regions, we would assume that the regions had similar values. The constant A determines how different regions are likely to be in their undercount adjustments.

A2.7 A model like equation A2.2 was in fact the basis for the practice in 2001 of assuming that a single undercount adjustment should be applied to all regions. This was done in the light of the large survey error associated with PES estimates of Indigenous at state/territory level in 2001.

A MODEL FOR VARIATION OF UNDERCOUNT *continued*

A2.8 Assuming first that the values A and V_r are known constants, and P_r are provided from the PES survey. The best estimate of T given equations A2.1 and A2.2 is given by:

A2.3

$$M = \sum_r P_r \left[\frac{(A+V)^{-1}}{\sum_r (A+V_r)^{-1}} \right]$$

and the estimate of T_r is:

A2.4

$$M_r = \frac{MV_r}{A+V_r} + \frac{P_r A}{A+V_r}$$

A2.9 This gives a very logical outcome: where variance V_r is high, the value M_r is very like the overall value M, while for a region with variance V_r low the value M_r is close to the region's PES estimate P_r.

EMPIRICAL BAYES AND THE MORRIS ALGORITHM

A2.10 In the Empirical Bayes approach the survey estimates themselves are used to estimate the variability between the underlying true values i.e. to estimate the constant A. The Morris algorithm gives a simple approach to this which should give a nearly optimal choice of A.

A2.11 First, note that under the model, with A known,

A2.5

$$P_r - M \sim N(0, A+V_r)$$

A2.12 Given this, set up the random variable

A2.6

$$X = \sum_r \frac{(P_r - M)^2}{A+V_r}$$

A2.13 This will have a chi-squared distribution with 14 degrees of freedom (there are 15 regions, but one degree of freedom is lost by substituting the estimator M for the true value T). The expected value of X for this correct value of A is then 14.

A2.14 The Morris algorithm proceeds to find the value A^{EB} which when substituted for A gives $X = 14$. A simple iterative algorithm achieves this. This value is then used in producing estimates from equations A2.3 and A2.4.

STABLE VARIANCE PARAMETERS

A2.15 A first issue in applying the EB methodology is that the PES survey estimates of the variance V_r are quite unstable, being based on the same small sample of the Indigenous population as the PES estimates themselves. Rather than use these directly, the sample sizes in each region were used in apportioning each region a share of the overall variance.

A2.16 Suppose that the PES provided a simple random sample of size n_r from the population (Indigenous and non-Indigenous), with n_r^I turning out to be Indigenous, of whom n_r^{IU} were undercounted. Writing C_r^I for the Indigenous Census count, C_r for the whole Census count and n_r for the sample size, we have expected Indigenous sample size of $\mathrm{E}(n_r^I) = n_r C_r^I / C_r$. Let the expected proportion undercounted be a constant $\mathrm{E}(n_r^{IU}/n_r^I) = p^{IU}$.

A2.17 The PES estimate U_r^{SRS} of undercounted Indigenous persons in region r would then be:

STABLE VARIANCE PARAMETERS *continued*

A2.7

$$U_r^{SRS} = \frac{C_r n_r^{IU}}{n_r^I - n_r^{IU}}$$

A2.18 Assuming that p^{IU} is small, we have:

A2.8

$$\mathrm{E}(U_r^{SRS}) \approx \frac{C_r p^{IU}}{1 - p^{IU}}$$

and:

A2.9

$$\mathrm{var}(U_r^{SRS}) \approx \frac{C_r^2 \left(\frac{p^{IU}}{n_r^I} \right)}{1 - p^{IU}} \approx \left(\frac{C_r N_r}{n_r} \right) \frac{p^{IU}}{1 - p^{IU}}$$

A2.19 In practice PES is not a simple random sample, nor is its estimator U_r^{PES} as simple as that above. The above development is used to justify distributing the overall PES variance across Australia in proportion to $C_r N_r / n_r$. Thus:

A2.10

$$\mathrm{var}(U_r^{PES}) \approx \mathrm{var}(\textstyle\sum_r U_r^{PES}) \dfrac{\left(\frac{C_r N_r}{n_r} \right)}{\sum_r \frac{C_r N_r}{n_r}}$$

A2.20 Writing

$V^{PES} = \frac{\mathrm{var}(\Sigma_r U_r^{PES})}{(\Sigma_r C_r)^2}$

for the variance of the undercount adjustment at the Australia level, as estimated directly from the PES. Noting that $P_r = U_r^{PES} / C_r$, the value V_r used in EB estimation is:

A2.11

$$V_r = V^{PES} (\textstyle\sum_r C_r)^2 \dfrac{\left(\left(\frac{N_r}{n_r} \right) / C_r \right)}{\sum_r \left(\frac{C_r N_r}{n_r} \right)}$$

A2.21 Note that the resulting parameters V_r do not depend on the observed sample of the Indigenous population in PES except via the overall variance estimate $\mathrm{var}(\sum_r U_r^{PES})$.

ADJUSTING TO ADD TO THE AUSTRALIAN PES ESTIMATE

A2.22 The standard EB estimates are not guaranteed to add to the PES Indigenous estimate at Australia level. To enforce additivity to this PES estimate, a constant c was added to the undercount adjustment rates in all regions. This gave the final estimates

A2.12

$$B_r = c + M_r$$

A2.23 Setting the constraint:

ADJUSTING TO ADD TO THE AUSTRALIAN PES ESTIMATE *continued*

A2.13

$$\sum_r C_r B_r = \sum_r C_r P_r$$

and writing
$C^{AUS} = \Sigma_r C_r$

and
$P^{AUS} = \frac{\Sigma_r C_r P_r}{C^{AUS}}$

gives the value of c as:

A2.14

$$c = P^{AUS} - \sum_r \left(\frac{C_r}{C^{AUS}} \right) M_r$$

THE EB ESTIMATE AS A WEIGHTED AVERAGE OF PES REGION ESTIMATES

A2.24 Using an additive adjustment as given above to ensure additivity allows the EB estimates to be written as a simple weighted sum of the region PES estimates.

A2.15

$$B_r = \sum_q f_{r,q} P_q$$

where:

A2.16

$$f_{r,q} = b_q W_q + \left(b_r - \sum_q W_q b_q \right) w_q + (1 - b_r) I(q = r)$$

$$\text{for } b_r = \frac{V_r}{A + V_r}$$

$$w_r = \frac{(A + V_r)^{-1}}{\sum_r (A + V_r)^{-1}}$$

$$W_r = \frac{C_r}{\sum_r C_r}$$

$$\text{and } I(q = r) = 1 \text{ if } q = r$$
$$= 0 \text{ otherwise.}$$

VARIANCE OF EB ESTIMATE CONDITIONAL ON *A*

A2.25 This and the next two sections give information about the reliability of the estimates conditional on a known value of *A*. The effect of using the EB estimate of *A* is discussed in a later section.

A2.26 Since the PES estimates for each region are almost independent, the variance of the empirical Bayes estimates follows from the linear form equation A2.15 as follows:

A2.17

$$\text{var}(B_r) = \sum_q f_{r,q}^2 \, \text{var}(P_q)$$

A2.27 The variance estimates var(P_q) are provided by the PES estimation system based upon the observed data. They do not depend on the variance model that gave the values V_r and are unbiased estimates of variance of the estimator (conditional on *A*) whether or not the model given by equations A2.1 and A2.2 holds.

VARIANCE OF EB ESTIMATE CONDITIONAL ON *A continued*

A2.28 Note also that state estimates can be written as a weighted sum of the component region estimates, and hence as a weighted sum similar to equation A2.15. The variance of a state estimate can thus be written in a form similar to equation A2.17.

EXPECTED BIAS UNDER THE MODEL

A2.29 Since the PES estimates are design-unbiased we have $\mathrm{E}(P_r) = T_r$, and hence:

A2.18

$$\mathrm{E}[B_r] = \sum_q f_{r,q} T_q$$

A2.30 Clearly if the true values T_r are treated as fixed unknown values with no underlying model, then the estimate B_r is biased to the extent that the particular region r is different to other regions. So for a region with a high value of T_r the estimate B_r will tend to be biased downwards. However, for any actual region we do not know the value of T_r; we only observe the PES estimate P_r. A high value of P_r could be because T_r is high, or because the sampling error was positive, or a combination of these. The estimate B_r tries to balance these possibilities based on the model.

A2.31 The estimator B_r is unbiased for T_r in the sense of expectation across repeated drawings from the model. Thus if we were able to repeatedly draw sets of 15 regions from the model (equation A2.2) and then get PES estimates from them with variance structure given by equation A2.1, and use them to produce estimates B_r, then on average the bias would be zero. This is not very helpful, as even the overall mean estimate M given by equation A2.3 is unbiased in this sense.

A2.32 More useful is to measure the mean squared bias (MSB) of the estimator (or its square root, the root mean squared bias or RMSB). The MSB is zero for the PES estimate, and A for the mean estimate M. Writing $\mathrm{E_M}$ for expectation across the model, the MSB of B_r is obtained as follows:

A2.19

$$\begin{aligned}
\mathrm{MSB}(B_r) &= \mathrm{E_M}\left[(\mathrm{E}[B_r] - T_r)^2\right] \text{ (this defines the MSB)} \\
&= \mathrm{E_M}\left[\left(\sum_q f_{r,q}(T_q - T) - (T_r - T)\right)^2\right] \text{ (since } \sum_q f_{r,q} = 1) \\
&= \mathrm{E_M}\left[\left(\sum_q \left(f_{r,q} - I(q = r)\right) - (T_q - T)\right)^2\right] \\
&= \sum_q \left(f_{r,q} - I(q = r)\right)^2 \mathrm{E_M}\left[(T_q - T)^2\right] \\
&= A\sum_q \left(f_{r,q} - I(q = r)\right)^2
\end{aligned}$$

ESTIMATES OF MEAN SQUARED ERROR

A2.33 Adding the MSB (equation A2.19) to the variance (equation A2.17) gives the expected mean squared error (MSE) of an EB estimate B_r. The MSE serves as a summary of the likely size of errors from using the EB estimator B_r. Estimates of the root MSB (RMSB) and root MSE (RMSE) are presented in the following table, alongside SE of the PES and EB estimators.

ESTIMATES OF MEAN SQUARED ERROR *continued*

A2.20 ESTIMATES OF SE, RMSB AND RMSE FOR PES AND EB ESTIMATES OF UNDERCOUNT ADJUSTMENT RATE , States and territories

	PES			EB		
	SE	*RMSB*	*RMSE*	*SE*(a)	*RMSB*	*RMSE*
New South Wales	6.3	—	6.3	3.9	2.3	4.5
Victoria	9.9	—	9.9	3.1	4.1	5.1
Queensland	4.5	—	4.5	3.2	2.2	3.8
South Australia	10.0	—	10.0	3.3	3.9	5.1
Western Australia	8.8	—	8.8	4.2	2.9	5.1
Tasmania	7.8	—	7.8	2.9	3.9	4.9
Northern Territory	4.2	—	4.2	3.1	1.9	3.7
Australian Capital Territory	12.3	—	12.3	2.9	6.1	6.7
Australia	**2.8**	—	**2.8**	**2.8**	—	**2.8**

— nil or rounded to zero (including null cells)

(a) The SE conditional on the EB value of *A*.

A2.34 For a hypothetical region with no PES information at all, the RMSB would be sqrt(*A*) = 6.6% and the RMSE would be 7.2% (larger because it still gets variance from the PES Australian estimate).

EFFECT OF ESTIMATING THE SMOOTHING CONSTANT A

A2.35 The estimator B_r can be defined for any specified value of the ratio (A / V^{PES}), and the resulting SEs can be predicted. These SEs do not depend on the model being correct at all (though the model is required for analysis of the bias). Thus (A / V^{PES}) could have been chosen to give estimates with a specified size of predicted SEs. The Morris algorithm could still be used to estimate A^{EB} for presentation of RMSB etc.

A2.36 In 2006, the ABS has chosen to use the estimated value A^{EB} in defining the estimator B_r. Different estimates A^{EB} could have arisen, giving different estimates. Thus estimating A^{EB} induces additional variability in the estimates.

A2.37 An example can make this clear. Suppose that a very unusual estimate arises by chance. This will increase the estimated value A^{EB}, which in turn will lead to the estimates being smoothed less than they should be. Thus using the estimated A^{EB} makes the estimates more subject to influence of unusual estimates i.e. more variable.

A2.38 In practice, the ABS is committed to presenting stable Indigenous ERP. In the future this may lead to not using the estimated value A^{EB} if it would lead to unstable estimates, or conversely an unnecessarily extreme smoothing.

A2.39 In the light of this, the ABS is content to present the SEs conditional on the chosen value A^{EB}. Experimental estimates show that the unconditional SE of a "pure" EB estimate which always uses the estimated A^{EB} is somewhat increased over the SEs presented above. Even accounting for this, the unconditional RMSE will still be markedly lower than the SE of the PES estimates.

ALTERNATIVE MODELS AND ESTIMATORS

A2.40 It should be acknowledged that there are many alternative models that could have been used as the basis of an estimator, and alternative methods of producing the estimate. In the process of deciding to use Empirical Bayes techniques, a number of alternatives were investigated. These included modelling different classes of region (e.g. capital cities) separately, and looking for explanatory variables that could explain region differences. Different components of the undercount (e.g. the effect of misclassification as to whether a person is Indigenous) were also examined to see if predicting them separately could improve the estimator. The fit of these more sophisticated models was not sufficiently improved to justify choosing them over the simpler model (equation A2.2) that was used.

APPENDIX 3 ESTIMATING MIGRATION FOR SLAS

INTRODUCTION

A3.1 Post-censal estimates of the age and sex distributions of statistical local area (SLA) populations are made by updating the estimated resident population (ERP) by age and sex for the Census year using annual births, deaths and derived age and sex profiles of migration (both overseas and internal migration). While annual data on births (by sex) and deaths (by age and sex) are available for each SLA, data on migration into and out of SLAs (internal migration) for post-censal years are not available and are derived indirectly.

METHOD

Step 1 – Estimate net migration totals during year t to t+1 for each SLA

A3.2 First, net migration (i.e. the sum of overseas and internal migration) in an SLA during the year from *t* to *t+1* is estimated based on the population at each endpoint and the number of births and deaths occurring during the year.

A3.1

$$N = P_{t+1} - P_t - B_{t,t+1} + D_{t,t+1}$$

where:

N is the net migration within the SLA between t and $t+1$

P_{t+1} is the the ERP for the SLA at time $t+1$

P_t is the the ERP for the SLA at time t

$B_{t,t+1}$ is the births occurring in the SLA between t and $t+1$

$D_{t,t+1}$ is the deaths occurring in the SLA between t and $t+1$.

Step 2 – Derive components of net migration

A3.3 Next, net migration between *t* and *t+1* is split into four components representing internal and overseas arrivals and departures. The following equation shows how these components contribute to net migration while the later equations illustrate how each component is estimated.

A3.2

$$N_{t,t+1} = IA_{t,t+1} - ID_{t,t+1} + OA_{t,t+1} - OD_{t,t+1}$$

where:

$IA_{t,t+1}$ is the internal arrivals within the SLA between t and $t+1$

$ID_{t,t+1}$ is the internal departures within the SLA between t and $t+1$

$OA_{t,t+1}$ is the overseas arrivals within the SLA between t and $t+1$

$OD_{t,t+1}$ is the overseas departures within the SLA between t and $t+1$.

A3.4 Initial estimates of each component of net migration are calculated by multiplying the total population at time *t+1* by a 'movement rate' specific for each component and calculated from one year ago SLA-level movement data from the most recent Census. For example, the internal arrival component would be estimated as:

A3.3

$$IA_{t,t+1} = P_{t+1} \times IA'$$

where IA' is the 'movement rate' for internal arrivals and is in turn estimated as:

Step 2 – Derive components of net migration continued

A3.4

$$IA' = \frac{IA_{c-1,c}}{P_c}$$

where:

$IA_{c-1,c}$ is the internal arrivals to the SLA between $c-1$ and c (i.e. the year prior to the Census), this is sourced directly from the address 1 year ago question in the Census

P_c is the the ERP for the SLA at time c (the Census year).

A3.5 Internal departures (ID) and overseas arrivals and departures (OA and OD respectively) are calculated in the same way.

A3.6 Once an initial estimate for each of the four components of migration has been obtained (equation A3.3), a plus-minus iterative proportional fitting (IPF) procedure is used to satisfy both equation A3.2 and to ensure that when all SLAs in a state/territory are added, the four components equal the state/territory levels. Specifically, the difference between overseas arrivals and overseas departures, summed for all SLAs in a state/territory, must equal the net overseas migration estimate for the state/territory. Similarly, net internal migration summed across all SLAs in a state/territory must equal the net interstate migration estimate for the state/territory. The plus-minus IPF procedure is explained in Appendix 6 – The plus-minus proportional adjustment technique.

Step 3 – Determine age-sex profile for each component of migration

A3.7 The Census-based SLA age-sex profiles for overseas arrivals and departures and internal arrivals are prorated to the SLA OA, OD and IA totals for the year t to $t+1$ calculated in step 2 above.

A3.8 However SLA departures are a function of existing SLA population, and so Census-based age-sex specific departure rates are employed. As Census data excludes residents who have left Australia, the requisite data on usual address one year ago is only available for internal (i.e. inter-SLA) departures, not overseas departures.

A3.9 SLA age-sex internal departures for the year t to $t+1$ are obtained by multiplying the population for each single year of age and sex, who survived to the year being estimated, by the age-sex specific departure rate. Thus for each age and sex,

A3.5

$$ID_{t,t+1} = (P_t - D_{t,t+1}) \times ID'$$

where:

ID' is the internal departure rate and is obtained from the latest Census.

A3.10 ID' was initially calculated using data from the most recent Census (so c = the Census year) as follows:

A3.6

$$ID' = \frac{ID_{c-1,c}}{P_c - IA_{c-1,c} + ID_{c-1,c} - OA_{c-1,c} + OD_{c-1,c}}$$

A3.11 The departure rate in equation A3.6 is internal departures for the financial year prior to the Census as a rate of survived population at time c-1 (i.e. in the case of the 2006 Census, the 30 June 2006 population with migration removed). This can then be used in equation A3.5 to create, say, 2006–07 internal departures by applying it to the survived 2006 population.

Step 3 – Determine age-sex profile for each component of migration continued

A3.12 Once an initial age-sex estimate of IA, ID, OA and OD has been obtained for the year $t+1$, an IPF procedure is used to satisfy both the SLA migration component totals (equation A3.3) and to ensure that when all SLAs in a state/territory are added, the four components equal the state/territory age-sex levels. Specifically, for each age and sex, SLA OA and OD levels must total respective state/territory overseas migration levels, while net SLA internal migration (IA minus ID) must sum to each state/territory's net interstate migration.

A3.13 At the conclusion of each annual iteration of the SLA age-sex estimation process, the SLA-specific OA, OD, IA and ID age-sex migration profiles are refined to correct unsustainable migration patterns (small numbers in the denominator of *IA*', etc. can create improbable migration profiles).

APPENDIX 4 ESTIMATING OVERSEAS ARRIVAL AND DEPARTURE MOVEMENTS

INTRODUCTION

A4.1 Overseas Arrivals and Departures (OAD) data provides information on all recorded movements across Australia's borders, both in-bound and out-bound, by category of movement and numerous other variables. These variables are listed in each issue of *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0). The three main categories of movement are:

- permanent movements
- long-term movements (one year or more)
- short-term movements (less than on year).

A4.2 This information is used as inputs into international tourism, net overseas migration (NOM) and through NOM into the estimated resident population (ERP) of Australia and its states and territories.

A4.3 Geographically, OAD data is available at the Australia and state and territory levels. For all arrivals, state and territory data is based on the state or territory of intended address.

A4.4 The OAD statistics relate to the number of movements of travellers rather than the number of persons travelling. Therefore, the multiple movements of individual persons during a given reference period are all counted. While all overseas movements into and out of Australia are documented as part of Department of Immigration and Citizenship's (DIAC's) border control purposes, OAD statistics exclude:

- movements of operational air crew and ships' crew
- transit passengers who pass through Australia but are not cleared for entry
- passengers on pleasure cruises commencing and finishing in Australia aboard ships
- persons attempting to enter Australia, whether by air or sea, without going through official immigration procedures (i.e. unauthorised arrivals).

ESTIMATION

A4.5 The OAD statistics are derived from a combination of full enumeration and sampling. All permanent movements and all movements with a duration of stay of one year or more are fully enumerated. The number of movements where the duration of stay is less than one year are also fully enumerated, however the characteristics are sampled. Statistics relating to these movements are therefore estimates which may differ from statistics which would have been obtained if details of all other movements had been processed. Sample standard errors are provided in each issue of *Overseas Arrivals and Departures, Australia* (cat. no. 3401.0).

A4.6 In January 1997, variable sample skips were introduced in the selection of OAD records to be sampled. Over a year about 3.5% of all short-term movements were selected for sampling. However, for operational reasons variable skips across months were ceased from August 2000. From January 2005, 4.9% of all short-term movements have been sampled. The skip values correspond to the lowest skip value (i.e. highest sample selected) for each country from a sample design including individual months and direction of travel as sub-categories.

APPENDIX 5 THE ITERATIVE PROPORTIONAL FITTING PROCEDURE

INTRODUCTION

A5.1 The iterative proportional fitting (IPF) procedure is used when reliable estimates for a desired cross-classification cannot be obtained directly, but estimates of the variables of interest, and possibly some related variables, are available at a higher level of aggregation. An additional requirement for the use of the IPF procedure is that information on the relationship between the variables is available at the desired level of cross-classification.

A5.2 For example, estimated resident population (ERP) for Census collection districts (CDs) by age and sex cannot be calculated directly, as births, deaths and migration data are not available at the CD level by age and sex. However, we do have information on CD ERP totals (not by age and sex) and statistical local area (SLA) ERP by age and sex. This information may be used in an IPF to calculate CD ERP by age and sex.

DATA REQUIREMENTS

A5.3 In the IPF procedure, these two sources of information appear as two distinct classes of inputs known as the association structure and the allocation structure. The association structure, representing the relationship between available estimates, is typically a two-dimensional table of estimates, and the allocation structure consists of estimates of various 'marginals' of the table. (A 'marginal' of a table is the set of quantities obtained by adding across all categories of any one or more of the cross-classifying variables in the table).

A5.4 In addition, the grand total may be a sum of one of the marginals, or it may be a separate figure. This is the figure to which all table cells (excluding marginals) will sum after the IPF procedure has been performed.

PROCESS

Method

A5.5 The IPF procedure produces new estimates for each cell in the table by adjusting the initial estimates (the association structure) to agree with the marginal constraints provided by the allocation structure, in an iterative fashion.

A5.6 For illustration, take the case where the association structure is a two-dimensional table, with two one-dimensional marginals.

STEP 1

A5.7 The column and row marginals are prorated and rounded so they sum to the grand total.

STEP 2

A5.8 The elements of each row of the table are prorated so their total equals the corresponding marginal estimate.

STEP 3

A5.9 The elements of each column are prorated so their total equals the corresponding estimate in the other marginal.

STEP 4

A5.10 As the estimates in the table no longer sum to the first marginal, steps 2 and 3 are repeated until the procedure converges to the unique solution which sums to the marginals while preserving the relationships as specified by the association structure.

Method continued

STEP 5

A5.11 Population estimates and components of population change deal with whole numbers of persons, therefore after convergence, a rounding process that maintains the marginal totals is employed.

Example

A5.12 The technique is illustrated in table A5.1 where the CD ERP by age and sex is calculated using a two-dimensional IPF.

A5.13 For Census year ERP, the initial estimates (matrix body) are CD of usual residence Census population counts by age and sex (with demographic adjustments applied), the column marginal (A) is the sum of these CD of usual residence population counts and the row marginal (B) is SLA ERP by age and sex from *Population by Age and Sex, Regions of Australia* (cat. no. 3235.0).

A5.1 CALCULATION OF CD ERP USING ITERATIVE PROPORTIONAL FITTING

	Males				Females				**CD Total (A)**
	0 years	1 year	etc...	85+ years	0 years	1 year	etc...	85+ years	
CD 1	*CD of usual residence Census counts by age and sex*								*CD of usual residence Census counts* (a)
CD 2									
etc...									
CD n									
SLA age and sex totals (B)	*SLA ERP by age and sex*								*SLA ERP*

(a) Adjusted for over-imputation and demographic adjustments

A5.14 In this case, only the column marginal is prorated to sum to the grand total as it was calculated by summing the row marginal.

FURTHER INFORMATION

A5.15 When an IPF procedure needs to be applied to a distribution with positive and negative values in either the association structure or the allocation structure, plus-minus pro ration (see Appendix 6 – The plus-minus proportional adjustment technique) is substituted for the standard method of pro ration.

A5.16 For a more detailed description of the IPF procedure, see Siegel & Swanson (2004), pg 712.

APPENDIX 6 THE PLUS-MINUS PROPORTIONAL ADJUSTMENT TECHNIQUE

INTRODUCTION

A6.1 The plus-minus proportional adjustment technique is a procedure for pro rating a distribution with positive and negative frequencies. For example, this technique is used to estimate net migration in an SLA. The plus-minus proportional adjustment technique ensures that the components (arrivals and departures) sum to net migration and that the sum of each component across SLAs sums to the state/territory level components. See Appendix 3 – Estimating migration for SLAs for more information.

A6.2 The procedure minimises the adjustments to the original distribution. It requires the use of two factors, one for the positive frequencies and one for the negative frequencies. The formulae are as follows:

Adjustment Factor for positive items:

$$\frac{\sum_i |n_i| + (N - n)}{\sum_i |n_i|}$$

Adjustment factor for negative items

$$\frac{\sum_i |n_i| - (N - n)}{\sum_i |n_i|}$$

where:

$\sum_i |n_i|$ = the sum of absolute frequencies

n = the algebraic sum of frequencies

N = the assigned total that the distribution must sum to

A6.3 Having calculated the adjustment factors for positive and negative items, the adjusted values of these items are obtained by multiplying the positive items by the positive factor and the negative items by the negative factor.

EXAMPLE

A6.4 The technique is illustrated in the following table where the algebraic sum of the frequencies is adjusted from 10 to 15.

A6.1 PRO-RATA ADJUSTMENT OF PLUS/MINUS FREQUENCY DISTRIBUTION

i	n_i	*Adjustment factor (a)*	*Adjusted* n_i
1	30	1.045	31
2	-50	0.955	-47
3	30	1.045	31
Total	10	. .	15

. . not applicable

(a) The positive adjustment factor is calculated as $\frac{100+5}{110} = 1.045$, while the negative adjustment factor is calculated as $\frac{110-5}{110} = 0.9555$,

EXAMPLE *continued*

where:

$n = 10$

$N = 15$

$N\text{-}n = 5$

$\sum_i |n_i| = 110$

APPENDIX 7 THE DIFFERENCE CORRELATION METHOD FOR UPDATING REGIONAL POPULATION ESTIMATES ...

INTRODUCTION

A7.1 The difference correlation method is based on determining the relationship between population growth and growth in one or more 'symptomatic indicator(s)' using regression techniques. Symptomatic indicators refer to data which is related to population size. Examples include dwelling counts, Medicare enrolments and numbers of people on the electoral roll.

A7.2 Once the relationship between population growth and growth in the symptomatic indicator(s) has been determined, on the assumption that this relationship is stable over time, it is possible to obtain population estimates for future time periods provided the data on the symptomatic indicator(s) are available for that future date.

A7.3 The assumption that the relationship between population growth and growth in the symptomatic indicator(s) is stable over time leads us to use linear regression techniques.

METHOD

A7.4 To understand the difference correlation method let us define the following:

P^t_{SLA}, P^t_{State} = SLA and State populations respectively at time t

S^t_{SLA}, S^t_{State} = symptomatic indicator for SLA and State respectively at time t

$P^{t,t+n}_{SLA}$ = measure of population growth in an SLA over t to $t+n$

$S^{t,t+n}_{SLA}$ = measure of growth in the symptomatic indicator in an SLA over t to $t+n$

A7.5 In the difference correlation method, growth is measured in terms of differences between proportions of the state/territory total in the region (for example SLA). Thus population growth between time t and $t+n$ is expressed as:

A7.1

$$P^{t,t+n}_{SLA} = \frac{P^{t+n}_{SLA}}{P^{t+n}_{State}} - \frac{P^{t}_{SLA}}{P^{t}_{State}}$$

A7.6 Similarly, growth in the symptomatic indicator is given by:

A7.2

$$S^{t,t+n}_{SLA} = \frac{S^{t+n}_{SLA}}{S^{t+n}_{State}} - \frac{S^{t}_{SLA}}{S^{t}_{State}}$$

A7.7 The following relationship is assumed to exist:

A7.3

$$P^{t,t+n}_{SLA} = a + bS^{t,t+n}_{SLA} + e_{SLA}$$

where:

a and b are regression coefficients from data on all SLAs

e_{SLA} is an error term

t and $t+n$ refer to two successive Census dates.

METHOD *continued*

A7.8 With this information, growth in SLA population estimates from time $t+n$ to time T can be obtained from equations A7.1, A7.2 and A7.3 as follows:

A7.4

$$P_{SLA}^{t+n,T} = a + bS_{SLA}^{t+n,T}$$

substituting for $P_{SLA}^{t+n,T}$ from equation A7.1,

A7.5

$$\frac{P_{SLA}^{T}}{P_{State}^{T}} - \frac{P_{SLA}^{t+n}}{P_{State}^{t+n}} = a + bS_{SLA}^{t+n,T}$$

or

A7.6

$$P_{SLA}^{T} = P_{State}^{T} \times \left[\frac{P_{SLA}^{t+n}}{P_{State}^{t+n}} + (a + bS_{SLA}^{t+n,T}) \right]$$

where:

T is the time at which the estimate is required

$S_{SLA}^{t+n,T}$ is the growth in the symptomatic indicator between time $t+n$ and T and is known

a and b are regression coefficients estimated from equation A7.3.

A7.9 The difference correlation method can accommodate more than one symptomatic indicator. In this case, the simple linear regression equation, equation A7.3, is replaced by a multi-variable linear equation of the form:

A7.7

$$P_{SLA}^{t+n,T} = a + b_1 S_{1_{SLA}}^{t+n,T} + b_2 S_{2_{SLA}}^{t+n,T} + \ldots + b_k S_{k_{SLA}}^{t+n,T} + e_{SLA}$$

where:

$S_{i_{SLA}}^{t+n,T}$ refers to the ith symptomatic indicator of growth in the SLA

$a, b_1, b_2, \ldots, b_k$ are regression coefficients

e_{SLA} is an error term.

GLOSSARY

12/12 month rule

A method for measuring an overseas traveller's duration of stay or absence in which the 12 month usual residence criterion in population estimates is measured across a 12 month period. Under a 12/12 month rule, overseas travellers must be resident in Australia for a continuous 12 month period or more to be included in the estimated resident population. Similarly, Australian residents travelling overseas must be absent from Australia for a continuous 12 month period or more to be removed from the estimated resident population.

For NOM, this rule has been superseded by the 12/16 month rule.

12/16 month rule

A method for measuring an overseas traveller's duration of stay or absence which takes an approach to measure usual residence that does not have to be continuous, as opposed to the continuous approach used under a 12/12 month rule. Under a 12/16 month rule, overseas travellers must have been resident in Australia for a total period of 12 months or more, during the 16 month follow-up period to be included in he estimated resident population.

The 12/16 month rule therefore takes account of those persons who may have left Australia briefly and returned, while still being resident for 12 months out of 16. Similarly, it takes account of Australians who live most of the time overseas but periodically return to Australia for short periods.

Aboriginal and Torres Strait Islander origin

The 2006 Census of Population and Housing (Household Form) asked the following question of each person:

Is the person of Aboriginal or Torres Strait Islander origin?

- For persons of both Aboriginal and Torres Strait Island origins, mark both 'yes' boxes.

No
Yes, Aboriginal
*Yes, Torres Strait Islande*r

Demographic statistics are based on this definition.

Age specific

An age specific rate is a measure relating to the experience of each age group. For example, age-specific fertility rates are usually expressed in terms of the experience of females within each of the five-year age groups (15–19 years, 20–24 years, 25–29 years, etc.), or they can also be expressed in terms of single age rates.

Age-specific death rates

Age-specific death rates are the number of deaths (occurred or registered) during the calendar year at a specified age per 1,000 of the estimated resident population of the same age at the mid-point of that year (30 June). Pro rata adjustment is made in respect of deaths for which the age of the deceased is not given.

Age-specific fertility rates

Age-specific fertility rates are the number of live births (occurred or registered) during the calendar year, according to the age of the mother, per 1,000 of the female estimated resident population of the same age at 30 June. For calculating these rates, births to mothers under 15 years are included in the 15–19 age group, and births to mothers aged 50 years and over are included in the 45–49 age group. Pro rata adjustment is made for births for which the age of the mother is not given.

At risk population

The population at risk of experiencing a particular event. For example, the at risk population for calculating divorce rates is the married population.

Australian resident

For estimated resident population statistics, the Census year population estimates classify a person as an Australian resident if the person has (in the most recent Census) reported a usual address in Australia where the person has lived or intends to live for six months or more in the Census year. The post-censal estimates, while based on the Census data, are updated with international migration data that have a criterion of one year or more of intended stay in or departure from Australia.

For overseas arrivals and departures statistics, Australian residency is self-reported by travellers when completing an Incoming or Outgoing Passenger Card.

Average annual growth rate

The average annual growth rate, r, is calculated as a percentage using the formula:

$$r = \left[\left(\frac{P_n}{P_0} \right)^{\frac{1}{n}} - 1 \right] \times 100$$

where:

P_n is the population at the end of the period
P_0 is the population at the start of the period
n is the length of the period between P_n and P_0 in years.

Balance of state or territory

The aggregation of all statistical divisions (SDs) within a state or territory other than its capital city SD. See major statistical region in *Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Birth

The delivery of a child, irrespective of the duration of pregnancy, who, after being born, breathes or shows any evidence of life such as heartbeat.

Capital city

Refers to the capital city statistical divisions (SDs) of states and territories as defined in *Statistical Geography: Volume 1 – Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Category jumping

Category jumping was the term used to describe changes between stated intention and actual duration of stay of travellers to/from Australia, such that their classification as short-term or as long-term/permanent movers is different at arrival/departure from that after twelve months. For more information, see *Migration, Australia, 2002* (cat. no. 3412.0), chapter 6, 'Special article: Adjustments to overseas migration estimates'.

The Australian resident component of category jumping for a reference quarter was estimated by comparing the number of residents departing short-term in that quarter with all residents who left in that quarter and return in the following 12 months, to obtain the net number of Australian residents who 'jumped category'.

Similarly, the number of overseas visitors arriving short-term in a quarter was compared with all overseas visitors who arrived in that quarter and depart in the following 12 months, to obtain the net number of overseas visitors 'who jumped category'.

Estimates of category jumping were derived by subtracting the Australian resident component from the overseas visitor component.

Category jumping is no longer used following the implementation of the NOM 12/16 month rule.

Category of movement

Overseas arrivals and departures are classified according to length of stay (in Australia or overseas), recorded in months and days by travellers on passenger cards. There are three main categories of movement:

- permanent movements
- long-term movements (one year or more)
- short-term movements (less than one year).

Category of movement *continued*
A significant number of travellers (i.e. overseas visitors to Australia on arrival and Australian residents going abroad) state exactly 12 months or one year as their intended period of stay. Many of them stay for less than that period and on their departure from, or return to, Australia are therefore classified as short-term. Accordingly, in an attempt to maintain consistency between arrivals and departures, movements of travellers who report their actual or intended period of stay as being one year exactly are randomly allocated to long-term or short-term in proportion to the number of movements of travellers who report their actual length of stay as up to one month more, or one month less, than one year.

Census
The complete enumeration of a population or groups at a point in time with respect to well-defined characteristics (e.g. Population, Manufacturing, etc.). When the word is capitalised, "Census" usually refers to the national Census of Population and Housing.

Census collection district (CD)
The smallest geographic area for which population estimates are calculated. For more information see the *Statistical Geography: Volume 1 – Australian Standard Geographical Classification (ASGC)* (cat.no.1216.0).

Census count
The Census of Population and Housing enumerates persons on the basis of where they were located on Census Night. The Census also compiles information on people according to their place of usual residence. This information is coded to Census collection districts (CDs). This means that Census counts of people can be produced according to their location on Census Night as well as their place of usual residence. Characteristics of households are based on persons usually resident in a dwelling.

Census Post Enumeration Survey (PES)
The Census Post Enumeration Survey (PES) is a household survey conducted shortly after the Census. The PES allows the ABS to estimate the number of people missed in the Census and the number counted more than once. Usually more people are missed than counted more than once in Australia, resulting in a net undercount. Results from the PES contribute to a more accurate calculation of the estimated resident population (ERP) for Australia and the states and territories which is then backdated to 30 June of the Census year.

Confinement
A pregnancy which results in at least one live birth.

Country of birth
The classification of countries is the Standard Australian Classification of Countries (SACC). For more detailed information refer to *Standard Australian Classification of Countries* (SACC) (cat. no. 1269.0) and *Migration, Australia* (cat. no. 3412.0).

Country of residence
Country of residence refers to the country in which travellers regard themselves as living or as last having lived.

Death
Death is the permanent disappearance of all evidence of life after birth has taken place. The definition excludes deaths prior to live birth. For the purposes of the Deaths and Causes of Deaths collections conducted by the ABS, a death refers to any death which occurs in, or en route to Australia and is registered with a state or territory Registry of Births, Deaths and Marriages.

Divorce
Dissolution of marriage through a decree absolute from the Family Court.

Dwelling
A dwelling is a building or structure in which people live. This can be a house, a block of flats, a caravan or tent, humpy or park bench. For the purposes of Census of Population and Housing, dwellings are classified into private and non-private dwellings. Each of these dwelling types is further divided into occupied and unoccupied dwelling categories.

Estimated resident population (ERP)
The official measure of the population of Australia is based on the concept of residence. It refers to all people, regardless of nationality or citizenship, who usually live in Australia, with the exception of foreign diplomatic personnel and their families. It includes usual residents who are overseas for less than 12 out of 16 months. It excludes overseas visitors who are in Australia for less than 12 out of 16 months.

Exnuptial birth An exnuptial birth is the birth of a child whose parents are not legally married to each other at the time of the child's birth.

Family A family is defined by the ABS as: two or more persons, one of whom is at least 15 years of age, who are related by blood, marriage (registered or de facto), adoption, step or fostering, and who are usually resident in the same household. The basis of a family is formed by identifying the presence of either a couple relationship, lone parent-child relationship or other blood relationship. Some households will, therefore, contain more than one family.

Group household A group household is a household consisting of two or more unrelated people where all persons are aged 15 years or over. There are no reported couple relationships, parent-child relationships or other blood relationships in these households.

Household A household is a group of two or more related or unrelated people who usually reside in the same dwelling, who regard themselves as a household and who make common provision for food or other essentials for living; or a person living in a dwelling who makes provision for his or her own food and other essentials for living, without combining with any other person. Households include group households of unrelated persons, same-sex couple households, single-parent households as well as one-person households. A household may consist of:

- one person
- one family
- one family and unrelated individual(s)
- related families with or without unrelated individual(s)
- unrelated families with or without unrelated individual(s)
- unrelated individuals.

A household usually resides in a private dwelling (including caravans etc. in caravan parks). Persons usually resident in non-private dwellings, such as hotels, motels, boarding houses, jails and hospitals, are not included in household estimates.

Household estimate Household estimate is a measure of the number of households of the usually resident population. It is based on the Census count of households which is adjusted for missed households, households of overseas visitors, households of Australian residents where all members were temporarily overseas at the time of the Census and households of Australian residents where all members were not home on Census Night and spent Census Night in a non-private dwelling in Australia.

Indigenous birth The birth of a live-born child where either the mother or the father was identified as being of Aboriginal or Torres Strait Islander origin on the birth registration form. Indigenous births in Indigenous population estimates/projections are those which result by applying assumed age-specific fertility rates to Aboriginal and Torres Strait Islander mothers in reproductive ages.

Indigenous death The death of a person who is identified as being of Aboriginal or Torres Strait Islander origin on the death information form.

Indigenous origin Persons who identify as being of Aboriginal or Torres Strait Islander origin.

Indigenous status See Indigenous origin.

Intended length of stay On arrival in Australia, all overseas visitors are asked to state their 'Intended length of stay in Australia'. On departure from Australia, all Australian residents are asked to state their 'Intended length of stay overseas'.

Intercensal discrepancy Intercensal discrepancy is the difference between two estimates at 30 June of a Census year population, the first based on the latest Census and the second arrived at by updating the 30 June estimate of the previous Census year with intercensal components of population change which take account of information available from the latest Census. It is caused by errors in the start and/or finish population estimates and/or in estimates

Intercensal discrepancy *continued*

of births, deaths or migration in the intervening period which cannot be attributed to a particular source.

Intercensal error

Intercensal error is the difference between two estimates at 30 June of a Census year population, the first based on the latest Census and the second arrived at by updating the 30 June estimate of the previous Census year with intercensal components of population change which do not take account of information available from the latest Census.

Internal migration

The difference between the number of persons who have changed their place of usual residence by moving into a defined geographical area within Australia and the number who have changed their place of usual residence by moving out of that defined geographical area during a specified time period. This difference may be either positive or negative.

Interstate migration

See net interstate migration.

Life table

A life table is a statistical model used to represent mortality of a population. In its simplest form, a life table is generated from age-specific death rates and the resulting values are used to measure mortality, survivorship and life expectancy.

Local government area (LGA)

Local government areas (LGAs) are the spatial units which represent the geographical areas of incorporated local government councils and incorporated Community Government Councils (CGCs) where the CGC is of sufficient size and statistical significance. The various types of LGAs are cities (C), areas (A), rural cities (RC), towns (T), shires (S), district councils (DC) and municipalities (M). Further information concerning LGAs is contained in *Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Long-term arrivals

Long-term arrivals comprise:

- overseas visitors who state that they intend to stay in Australia for 12 months or more (but not permanently)
- Australian residents returning after an absence of 12 months or more overseas.

Long-term departures

Long-term departures comprise:

- Australian residents who state that they intend to stay abroad for 12 months or more (but not permanently)
- overseas visitors departing who stayed 12 months or more in Australia.

Main destination

Australian residents travelling overseas are asked on departure for the name of the country in which they intend to spend most time.

Main state/territory of stay

Overseas visitors are asked on departure for the name of the state or territory in which they spent the most time.

Marital status

Two separate concepts are measured by the Australian Bureau of Statistics. These are registered marital status and social marital status.

Registered marital status refers to formally registered marriages and divorces. Registered marital status is a person's relationship status in terms of whether he or she has, or has had, a registered marriage with another person. Accordingly, people are classified as either 'never married', 'married', widowed' or 'divorced.

Social marital status is the relationship status of an individual with reference to another person who is usually resident in the household. A marriage exists when two people live together as husband and wife, or partners, regardless of whether the marriage is formalised through registration. Individuals are, therefore, regarded as married if they are in a de facto marriage, or if they are living with the person to whom they are registered as married. Under social marital status, a person is classified as either 'married' or 'not married' with further disaggregation of 'married' to distinguish 'registered married' from 'de facto married' person.

All references to marital status in this publication refer to registered marital status.

Marriage Refers to registered marriages only. Under the Australian Marriage Act 1961 (Cwlth), a marriage may be celebrated by a minister of religion registered as an authorised celebrant, by a district registrar or by other persons authorised by the Attorney-General. Notice of the intended marriage must be given to the celebrant at least one calendar month but within six calendar months before the marriage. A celebrant must transmit an official certificate of the marriage for registration in the state or territory in which the marriage took place.

Migration adjustment The ABS applies a number of adjustments to overseas arrivals and departures data in order to produce estimates of net overseas migration (NOM). These mainly comprise adjustments designed to reflect differences between stated travel intentions and actual travel behaviour, but (in the case of revised NOM estimates) also include adjustments to transform numbers of overseas movements into numbers of travellers. Migration adjustments replaced the 'category jumping' adjustments previously applied to NOM estimates.

Mortality Experience of death in a population and its measurement.

Moving average Average value of a series of data over a fixed period of time such that, as new data become available, the earliest dated observation is removed from the calculation of the average and the most recent observation added in its place. For example, a 3 term moving average is used to smooth input components to calculate expansion factors for interstate migration.

Natural increase Excess of births over deaths.

Net interstate migration (NIM) The difference between the number of persons who have changed their place of usual residence by moving into a given state or territory and the number who have changed their place of usual residence by moving out of that state or territory. This difference can be either positive or negative.

Net overseas migration (NOM) Net overseas migration is the net gain or loss of population through immigration to Australia and emigration from Australia. It is:

- based on an international travellers' duration of stay being in or out of Australia for 12 months or more
- the difference between the number of incoming travellers who stay in Australia for 12 months or more and are added to the population (NOM arrivals) and the number of outgoing travellers who leave Australia for 12 months or more and are subtracted from the population (NOM departures).

When using the current method for estimating final net overseas migration this term is then based on a travellers' actual duration of stay or absence using the 12/16 rule. Preliminary NOM estimates are modelled on patterns of traveller behaviours observed in final NOM estimates for the same period two years earlier.

Net permanent and long-term movement The difference between the number of permanent (settler) and long-term arrivals and the number of permanent and long-term departures. Short-term movements are excluded.

Net population growth For Australia, net population growth is the sum of natural increase and net overseas migration. For the states and territories, net population growth also includes net interstate migration.

Net undercount The difference between the actual Census count (including imputations) and an estimate of the number of people who should have been counted in the Census. This estimate is based on the PES conducted after each Census. For a category of person (e.g. based on age, sex and state of usual residence), net undercount is the resultant of Census undercount, overcount, misclassification and imputation error.

NOM arrivals NOM arrivals are all overseas arrivals that contribute to net overseas migration (NOM). It is the number of incoming international travellers who stay in Australia for 12 months or more and are added to the population.

NOM arrivals *continued*

When using the current method for estimating net overseas migration this term is then based on a travellers' actual duration of stay using the 12/16 rule.

NOM departures

NOM departures are all overseas departures that contribute to net overseas migration (NOM). It is the number of outgoing international travellers (Australian residents and long term visitors to Australia) who leave Australia for 12 months or more and are subtracted from the population.

When using the current method for estimating net overseas migration this term is then based on a travellers' actual duration of absence using the 12/16 rule.

Non-private dwelling (NPD)

Non-private dwellings (NPDs) are residential dwellings with accommodation which are not included in the Census of Population and Housing list of private dwelling categories. NPDs are classified according to their function. They include hotels, motels, guest houses, jails, religious and charitable institutions, military establishments, hospitals and other communal dwellings. Where this type of accommodation includes self-contained units (as provided by hotels, motels, homes for the elderly and guest houses), the units are enumerated as part of the NPD. Complexes such as retirement villages, which have a combination of self-contained units, hostel and/or nursing home accommodation, are enumerated as NPDs.

Nuptial birth

A nuptial birth is the birth of a child born of parents who are legally married at the time of the child's birth.

Nuptiality

Nuptiality relates to the registered marital status of persons and the events such as marriages, divorces and widowhood. Confinements and births are identified as being nuptial where the father registered was married to the mother at the time of birth, or where the husband died during pregnancy. Confinements and children of Indigenous mothers considered to be tribally married are classified as nuptial. Other confinements, and the children resulting from them, are classified as ex-nuptial whether or not both parents were living together at the time of birth.

Occupied private dwelling (OPD)

An occupied private dwelling is defined as the premises occupied by a household on Census Night (see Household).

Overseas arrivals and departures (OAD)

Overseas arrivals and departures (OAD) refer to the arrival or departure of persons, through Australian airports (or sea ports), which have been recorded. Statistics on OAD relate to the number of movements of travellers rather than the number of travellers (i.e. the multiple movements of individual persons during a given reference period are all counted).

Overseas migration

See net overseas migration (NOM).

Overseas migration adjustment

See Migration adjustment.

Partner

A person in a couple relationship with another person usually resident in the same household. The couple relationship may be in either a registered or de facto marriage, and includes same-sex couples.

Permanent arrivals

Permanent arrivals (settlers) comprise:

- travellers who hold migrant visas (regardless of stated intended period of stay)
- New Zealand citizens who indicate an intention to settle
- those who are otherwise eligible to settle (e.g. overseas-born children of Australian citizens).

This definition of settlers is used by the Department of Immigration and Citizenship (DIAC). Prior to 1985 the definition of settlers used by the ABS was the stated intention of the traveller only. Numerically the effect of the change in definition is insignificant. The change was made to avoid the confusion caused by minor differences between data on settlers published separately by the ABS and DIAC.

Permanent departures

Permanent departures are Australian residents (including former settlers) who on departure state that they are departing permanently.

Population age-sex pyramid

A population age-sex pyramid is a bar chart graphically representing the age structure of the population, usually in five-year age groups, for males and females separately. The age structure of the population usually approximates the shape of a pyramid because mortality progressively reduces the number in each birth cohort as it ages. The age pyramid is useful to show the existence of unusually large or small cohorts, and in this way, not only conveys a lot about a country's past demographic history, but also a great deal about its demographic future.

Population growth

For Australia, population growth is the sum of natural increase and net overseas migration. For states and territories, population growth also includes net interstate migration. After the Census, intercensal population growth also includes an allowance for intercensal discrepancy.

Private dwelling (PD)

A private dwelling in the Census is defined as a house, flat, part of a house, or even a room; but can also be a house attached to, or rooms above shops or offices; an occupied caravan in a caravan park or boat in a marina, a houseboat, or a tent if it is standing on its own block of land. A caravan situated on a residential allotment is also classed as a PD.

Residents temporarily overseas (RTOs)

Residents temporarily overseas are Australian residents who are overseas on Census Night for a period less than 12 out of 16 months.

Sex ratio

The sex ratio relates to the number of males per 100 females. The sex ratio is defined for total population, at birth, at death and among age groups by selecting the appropriate numerator and denominator of the ratio.

Short-term arrivals

Short-term arrivals comprise:
- overseas visitors who intend to stay in Australia for less than 12 months
- Australian residents returning after a stay of less than 12 months overseas.

Short-term departures

Short-term departures comprise:
- Australian residents who intend to stay abroad for less than 12 months
- overseas visitors departing after a stay of less than 12 months in Australia.

State or territory of clearance

State or territory of clearance refers to the state or territory in which a passenger is cleared by Customs and Immigration authorities. Embarkation or disembarkation and clearance are usually, but not necessarily, in the same state or territory.

State or territory of intended residence

State or territory of intended residence is derived from the intended address given by permanent arrivals (settlers), and by Australian residents returning after a journey abroad. Particularly in the case of the former, this information does not necessarily relate to the state or territory in which a traveller will eventually establish a permanent residence.

State or territory of intended address/where lived

Overseas visitors are asked on arrival in Australia for their state or territory of intended address. On departure from Australia overseas visitors are asked the state or territory where they spent most time.

Australian residents are asked on departure for the state or territory in which they live/lived. Residents returning to Australia are asked for their state or territory of intended address.

State or territory of intended stay

See state or territory of intended addressed/where lived.

State or territory of registration

State or territory of registration refers to the state or territory in which the event was registered.

State or territory and statistical local area (SLA) of usual residence

State or territory and statistical local area (SLA) of usual residence refers to the state or territory and SLA of usual residence of:
- the population (estimated resident population)
- the mother (birth collection)
- the deceased (death collection).

State or territory and statistical local area (SLA) of usual residence *continued*

In the case of overseas movements, state or territory of usual residence refers to the state or territory regarded by the traveller as the one in which he/she lives or has lived. State or territory of intended residence is derived from the intended address given by settlers, and by Australian residents returning after a journey abroad. Particularly in the case of the former, this information does not necessarily relate to the state or territory in which the traveller will eventually establish a permanent residence.

Statistical district (S Dist)

Statistical districts (S Dist) consist of selected, significant, predominantly urban areas in Australia which are not located within a capital city statistical division (SD). S Dists enable comparable statistics to be produced about these selected urban areas. Further information concerning S Dists is contained in *Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Statistical division (SD)

Statistical divisions (SDs) consist of one or more statistical subdivisions (SSDs). The divisions are designed to be relatively homogeneous regions characterised by identifiable social and economic units within the region, under the unifying influence of one or more major towns or cities. Further information concerning SDs is contained in *Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Statistical local area (SLA)

Statistical local areas (SLAs) are, in most cases, identical with, or have been formed from a division of, whole local government areas (LGAs). In other cases, they represent unincorporated areas. In aggregate, SLAs cover the whole of a state or territory without gaps or overlaps. In some cases legal LGAs overlap statistical subdivision boundaries and therefore comprise two or three SLAs (Part A, Part B and, if necessary, Part C). Further information concerning SLAs is contained in *Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Statistical subdivision (SSD)

Statistical subdivisions (SSDs) are of intermediate size, between statistical local area (SLA) and statistical division (SD). In aggregate, they cover the whole of Australia without gaps or overlaps. They are defined as socially and economically homogeneous regions characterised by identifiable links between the inhabitants. In the non-urban areas an SSD is characterised by identifiable links between the economic units within the region, under the unifying influence of one or more major towns or cities. Further information concerning SSDs is contained in *Australian Standard Geographical Classification (ASGC)* (cat. no. 1216.0).

Total fertility rate

The sum of age-specific fertility rates. It represents the number of children a female would bear during her lifetime if she experienced current age-specific fertility rates at each age of her reproductive life.

Underenumeration

See net undercount.

Unoccupied private dwellings

These are structures built specifically for living purposes which are habitable, but unoccupied at the time of the Census of Population and Housing. Vacant houses, holiday homes, huts, cabins (other than seasonal workers' quarters) and houseboats are counted as unoccupied dwellings. Also included are newly completed dwellings not yet occupied, dwellings which are vacant because they are due for demolition or repair, dwellings to let and dwellings where all members of the household were absent on Census Night.

Usual residence

Usual residence within Australia refers to that address at which the person has lived or intends to live for a total of six months or more in a given reference year.

Year of occurrence

Data presented on year of occurrence basis relate to the date the event occurred.

Year of registration

Data presented on year of registration basis relate to the date the event was registered.

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