GEODEMOGRAPHIC AND LIFE COURSE PERSPECTIVES OF POPULATION AGEING IN AUSTRALIA

Informing the policy response to population ageing

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Declaration

This thesis is the original work of the author carried out during a PhD candidature in the Australian School of Demography, College of Arts and Social Science, at the Australian National University.

Nerida Hunter

For my mum.

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Lastly, I want to acknowledge an event that has shaped me during this thesis. When I started my doctoral program I studied ageing in regional and remote Australia. I wanted to research an area sufficiently removed from my life. Yet five months into the project, my mother—a tree changer from a cosmopolitan city to a picturesque regional area—was diagnosed with cancer. So, without warning, my urban student life was replaced with caring for a frail parent in a regional community. She died at age 65. In this thesis I argue that 65 is a poor indicator of the aged. While I believe the population level data supports this, my own experience is not forgotten: life can still be short.

Abstract

This study examines the geodemographic and life course perspectives of population ageing in Australia. The ageing of populations around the globe is one of the most significant demographic changes underway, with far reaching implications for the design of policy settings. In Australia, population ageing is intensifying as the large baby boomer cohort born between 1946 and 1966 enters their aged years. At the same time the policy response to population ageing is incomplete, with concerns continuing about the adequacy of the supply of services, retirement incomes and the economic and fiscal consequences of a growing aged cohort. Many studies focus on specific policy questions, regions of interest or birth cohorts and therefore give an incomplete understanding of the aged population.

The aim of this study is to better understand the aged and ageing processes in Australia so that the policy response is better informed. I organise my contributions around three areas. Firstly, I propose four principles to guide future directions in the policy response to population ageing in Australia. Secondly, I develop a multidimensional approach to examine the aged and ageing processes in Australia. Thirdly, I undertake the foundation analysis of the Australian aged population using this multidimensional approach.

The geodemographic and life course analysis is structured around analysis of the size; age structure; characteristics; age-transitions to better understand the threshold age demarcating the commencement of the aged years; mortality conditions such as the length of life and inequality in the length of life; and life course markers of ageing such as working life and disability-free life expectancies. Far from being a homogenous group, the Australian aged population is diverse. The aged population is growing in all regions, but growth is uneven. There are differences too in the characteristics of the aged. Using life course perspectives, I challenge the use of age 65 to signal the commencement of the aged years as it is both disconnected from demographic conditions including working-life expectancy and disability-free life expectancy.

To assist the policy response, I outline four directions to guide the future response to population ageing: increased policy differentiation between the early-aged and late-aged years; a comprehensive approach to longevity risk; increased responsiveness to variation within the aged population and ageing processes; and, a better distribution of the benefits of increased life span across the life course.

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Glossary of key concepts

Concept	**Definition**
Australian Government	The national government of the Commonwealth of Australia.
Age	Years since birth measured as age at last birthday.
Baby boomer	The Australian birth cohort of 1946 to 1966.
Capital City	As defined by the Australian Statistical Geography Standard.
Complete Life Expectancy	The expected number of life years remaining to a randomly selected person between his/her current age and the upper age limit of the human life (Hickman and Estell 1969).
Early-aged	The population aged 65 to 84 years.
Emigrant	As defined by the Australian Bureau of Statistics, a person who has been usual resident in Australia and has been (or are expected to be) residing outside of Australia for a period of 12 months or more over a 16-month period.
Greater Capital City	As defined by the Australian Statistical Geography Standard.
Internal migrant	Person(s) who moves across a defined boundary (in this study the boundary is the Statistical Area 3 boundary as defined by the Australian Statistical Geography Standard).
Immigrant	As defined by the Australian Bureau of Statistics, a person who has been (or are expected to be) residing in Australia for a period of 12 months or more over a 16-month period who had been residing outside of Australia.
Late-aged years	The population aged 85 and over.
Outer regional	As defined by the Accessibility/Remoteness Index of Australia.

Concept	Definition
Partial Life Expectancy	The expected number of life years remaining to a randomly selected person between his/her current age and a fixed terminal age (Hickman and Estell 1969).
Rest of State	Regions not included in the Greater Capital City Area but within State and Territory Boundaries (see the Australian Statistical Geography Standard).
Subnational	Refers to a spatial unit of analysis that is below the national level. It could encompass substate geography.
Substate	Refers to a spatial unit of analysis that is below the state or territory level.
Usual Resident	A person who has (or is expected to be) residing in Australia for a period of 12 months or more over a 16-month period.
Working-age population	The population aged 20 to 64 years.
Youth population	The population aged 0 to 19 years.

Abbreviations

Acronym	Full title
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
ARIA	Accessibility/Remoteness Index of Australia
ASGC	Australian Standard Geographical Classification
ASGS	Australian Statistical Geography Standard
Census	Australian Census of Population and Housing
DFLE	Disability-free life expectancy
ERP	Estimated Resident Population
ESR	Economic Support Ratio
F	Female
NT	Northern Territory
NSW	New South Wales
M	Male
OECD	Organisation for Economic Co-operation and Development
OADR	Old Age Dependency Ratio
Qld.	Queensland
SA1	Statistical Area 1
SA2	Statistical Area 2
SA3	Statistical Area 3
SA4	Statistical Area 4
SA	South Australia
SDR	Standardised Disability Ratio
SMR	Standardised Mortality Ratio
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia
WLE	Working-life expectancy

Chapter 1

Introduction

Without evidence, policy makers must fall back on intuition, ideology, or conventional wisdom – or, at best, theory alone.

(Banks 2009, 5)

Ageing of populations around the world is one of the most significant demographic changes underway, with far reaching implications for the design of policy settings. In Australia, population ageing is expected to intensify over the next twenty years, with the national old age dependency ratio expected to rise more sharply over this period than any equivalent period in its history or 100-year future forecast (Australian Bureau of Statistics (ABS) 2013g; ABS 2014c).[1] Given the current demographic conditions of low fertility and increasing longevity, population ageing will continue for the foreseeable future. Combined with a growing aged population, governments are planning for an increase in the supply of aged services and examining the merits of more fundamental changes in economic and social policy settings.

In this study, I examine the geodemographic and life course perspectives of population ageing in Australia to inform the policy response to population ageing using an expanded demographic evidence-base developed for this study. In 1901 only 4 per cent of the Australian population was aged 65 and over; by 2011 this share had increased to 14 per cent; and, by 2031 a further increase to 19 per cent is expected (ABS 2013g; ABS 2014c).[2] In this study I analyse the period 1901 to 2011 and a projection horizon of 2011 to 2031. The timeframe broadly equates to the life of the population alive today and the early-aged years of the "baby boomer" birth cohort born between 1946 and 1966.

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[1] Defined as the ratio of the population aged 65 and over to the population aged 20 to 64 (see Chapter 9.1).
[2] Based on the Series B projections (ABS 2013g).

In this introduction, I provide an overview of this study—its aim, research questions and approach. I also overview the research context in which I have situated this study and the research problem I address.

The aim of this study is to better understand the aged and ageing processes in Australia. A growing aged population and population ageing is a complex policy challenge involving national and local policy settings. Policy makers are continuing to grapple with this issue, and despite reforms across the areas of work and training, health and care, and retirement income, the policy response in Australia is incomplete.

I begin my analysis by proposing four directions for the future policy response to population ageing, so that these insights guide the collection of the demographic data for the study and design of the analysis. Next, I argue the demographic evidence-base to inform these policy directions should be based on a multidimensional approach incorporating a range of metrics providing distinct perspectives of the aged and ageing processes. The multidimensional approach includes two key perspectives: the geodemographic perspective using conventional demographic methods to examine the size, age structure and characteristics of the aged population; and a life course perspective to incorporate emerging research directions to examine the aged years in the context of the life course. Applying these two perspectives means the analysis looks beyond size and age structure to examine health, work and frailty associated with the aged to reveal more about the characteristics of the aged and assist in defining who is aged, to uncover inequality and understand longevity risks.

Through the inclusion of analysis of the spatial and temporal variation in the aged population I can better understand the aged at the subnational level and the dynamics of a growing aged population. This delivers the improved granularity of analysis that policy makers often look for, but don't find in the existing research. Far from being a homogenous group, the aged are a diverse group and ageing is occurring unevenly around Australia. Too often, however, the aged and ageing population are described in terms of summary national demographic measures, such as life expectancy or the old age dependency ratio.

The geodemographic and life course analysis in this study is structured around analysis of the size; age structure; characteristics; age-transitions to better understand the threshold age demarcating the commencement of the aged years; mortality conditions such as the length of life and inequality in the length of life; and life course markers of ageing such as working life and disability-free life expectancies. I make two key methodological contributions through the development of a subnational projection model of the aged and an area typology for the aged.

This study comprises ten chapters in addition to this introduction. I set the scene in Chapters 2 and 3: in Chapter 2, I outline the key contextual information about Australian society, demography and policy concerns relevant to population ageing; and, in Chapter 3, I outline the existing research context focusing on key themes and Australian studies. I propose four policy directions to guide the response to population ageing in the future in Chapter 4: increased policy differentiation between the early-aged and late-aged years; a comprehensive approach to longevity risk; increased responsiveness to variation within the aged population and ageing processes; and, a better distribution of the benefits of the increased life span to improve wellbeing across the life course.

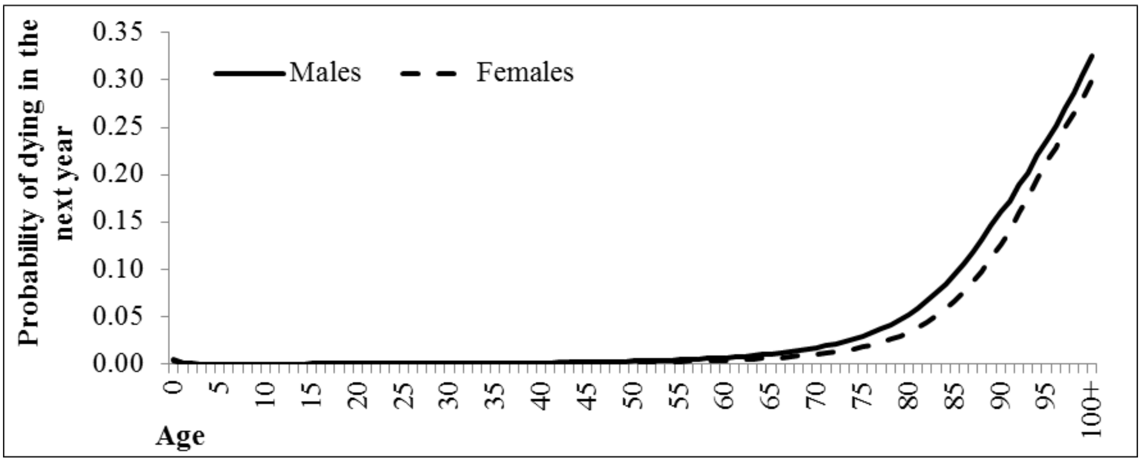
Chapters 5, 6 and 7 are dedicated to the design and development of the multidimensional approach to better understand the aged and ageing processes in Australia and inform the policy directions proposed in Chapter 4. Specifically, in Chapter 5, I introduce the multidimensional approach for examining the aged and ageing process in Australia. In Chapter 6, I introduce the data selected for the analysis and, in Chapter 7, I outline the methods to calculate key demographic variables to perform the analysis included in the multidimensional approach. This includes the static variables calculated from the available data and the methods of indirect estimation to extend the publicly available data and reveal new insights into the aged and ageing processes. The analysis in these chapters forms the basis of an expanded demographic evidence-base revealing of geodemographic and life course insights into the Australian aged population and ageing processes. I report on these findings in Chapters 8, 9 and 10. I focus on the size and aged structure of the aged population in Chapter 8, the characteristics of the aged population in Chapter 9 and the life course characteristics of the aged population in Chapter 10.

Across the literature, different terminology is used to refer to older people. In this study, I use the term aged and differentiate within the aged population using the terms early-aged and late-aged. The early-aged years are defined as the population age 65 to 84 and the late-aged years are defined as the population aged 85 and over. Australia’s national government is referred to as the Australian Government.

1.1 RESEARCH CONTEXT

1.1.1 Individual versus population ageing

Individual and population ageing are distinct but related concepts. Individuals are always ageing, with their age typically measured as years lived since birth. An individual's chronological age is a reasonable indicator of the changes in the body's physiological, biological and cognitive processes (Rose 1991). Initially these changes are characterised by growth and maturation, but in later years the body's systems senesce and the probability of death increases. The onset and pace of senescence can vary between individuals, but at the population level, as shown in Figure 1, it intensifies from the seventh decade of life.



Source: ABS 2014c.
Note: This estimate is from the 2010-2012 life table.

Figure 1 Probability of dying within the next year by age: Australia, 2011

At the population level, measures of ageing focus on the chronological age of the total population. Multiple analysis are acceptable indicators of population age, including summary measures such as the mean or median age or head count ratios such as the old age dependency ratio measuring the relative size of the aged population to the working-age population (Chu 1997; Hobbs 2004). Broadly, population ageing occurs when the indicators of population age (median age, mean age and/or dependency ratio) increase. However, populations can vary in how they grow older: for example: they can age without absolute or relative growth in the aged population; they can age with absolute growth in the aged population and no growth relative to the working-age population; and, they can age with the aged population growing absolutely and relatively to the working-age population. The characteristics of population ageing – whether it be structural ageing, numeric ageing or a combination of both – matters for policy response. Structural ageing can require policies to rebalance the dependent and working populations (such as increasing labour force participation), while numeric ageing can require adjustments to service provision (such as an increase in residential aged care places).

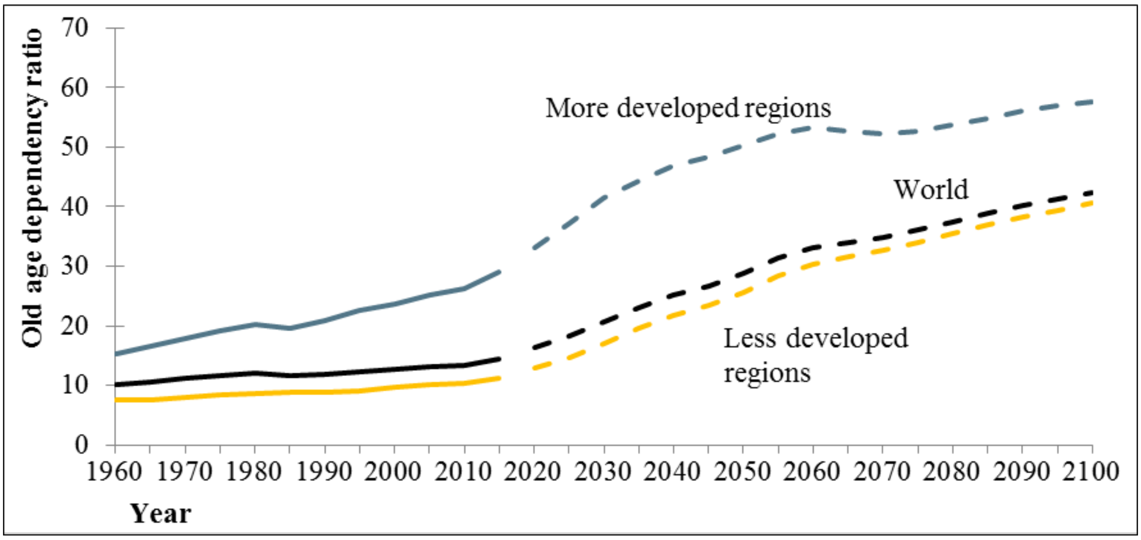
1.1.2 Population ageing: a global phenomenon

The United Nations argues that population ageing is unprecedented, pervasive, profound and enduring (United Nations Population Division 2010). In its 2012 study, the demographic conditions that produce population ageing—falling mortality and falling fertility—were identified in nearly all countries in the world (United Nations Population Division 2013). Thus, population ageing has emerged as an unavoidable global demographic phenomenon of the 21st Century.

Between 1960 and 2010, the size of the global population aged 65 and over more than tripled from 153 million people to 531 million (United Nations Population Division 2013). In the same study, the United Nations projected a further acceleration of population ageing resulting in 995 million people aged 65 and over by 2030 and continuing to increase throughout the century. By 2100, the United Nations projects, globally, there could be 2.5 billion people aged 65 and over.[3] Furthermore, most of the world's aged population will live in developing countries (Kinsella and Phillips 2005).

There is significant variation in the timing and pace of ageing by development status, region and country. Differences in population ageing, measured by the old age dependency ratio, by development status are shown in Figure 2. The developed regions are already significantly older and are projected to remain so throughout the 21st Century. In contrast, the demographic conditions that produce ageing (falling fertility and mortality) are the least entrenched in Africa, particularly in Sub-Saharan Africa, and consequently, these regions are expected to age more slowly (Goldstein 2009).

[3] Based on the medium variant of the UN projections.



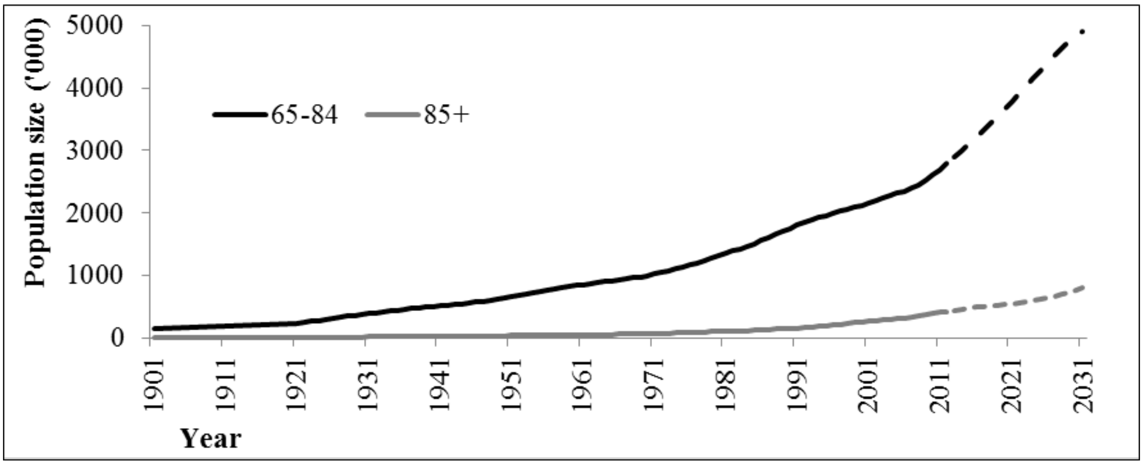
Source: United Nations Population Division 2015.
Note: This estimate is from the medium variant projection; see the report for the projection methodology.

Figure 2 Actual and projected old age dependency ratio: world development regions, 1960 to 2100

1.1.3 Population ageing in Australia, 1901 to 2031

Australia's population aged significantly between 1901 and 2011 (ABS 2014c). During this period, Australia experienced both structural and numeric ageing. In 1901, there were 150,000 people aged 65 and over residing in Australia (4 per cent of the population). In 1961 Australia's total population was approximately 10.5 million people and approximately 900,000 people were aged 65 and over (9 per cent of the population). Over the next fifty years, the population more than doubled to 22.3 million and the aged population grew to 3.1 million people (14 per cent of the population). In addition, the age structure of the aged population changed, with the proportion of the aged population aged 85 and over increasing from 5 to 13 per cent. Population ageing in Australia is the long-term consequence of falling fertility, the ageing of a large birth cohort born after the Second World War (the baby boomers) and increases in the average life span. While Australia has also attracted large numbers of immigrants during this period (see Section 2.2.3), the number and relative youth of these immigrants have not been enough to reverse the momentum of ageing.

The Australian demographic conditions are consistent with developed countries, with acceleration in population ageing expected to occur over the next twenty years. The expected trajectory of population ageing for Australia is growth in absolute and relative size of the aged population – structural and numeric ageing. The projected growth of the early-aged and late-aged group is shown in Figure 3. The ageing of the baby boomer birth cohort, the eldest of which turned 65 years in 2011, is projected to drive the increase in the population aged 65 and over to 5.7 million people by 2031 (19 per cent of the population).[4] The number of people in the late-aged years is expected to double over the twenty years to 2031 but, given the growth expected in the early-aged years, the late-aged group is only projected to increase from one per cent to 14 per cent of the aged population.[5]



Source: ABS 2013g and ABS 2014c.
Note: The estimate is from the ABS Series B projection; see the publication for projection methodology.

Figure 3 Actual and projected population count by age: Australia, 1901 to 2031

While it is near certain that ageing in Australia will intensify over the next twenty years, the subnational characteristics and population dynamics are less certain and have not yet been examined within a national framework. The existing studies of the Australian aged population, outlined in Section 3.2, suggests a high degree of spatial variation in the size and age structure of the aged population. Understanding these variations in structural and numeric ageing will be important for policy makers designing the response to population ageing. Therefore, how these dynamics will develop over time and the characteristics of these aged populations requires detailed examination.

1.1.4 Changes in the measurement of ageing

Demographic research into population ageing is distinct from the biological, physiological, psychological, sociological studies of ageing. These latter disciplines focus on measuring ageing at the individual level or the influence of social and institutional arrangements on the lives of the aged. In contrast, conventional demographic research

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[4] The estimate is based on the ABS Series B projection (ABS 2013g).
[5] Over this projection horizon the relatively large baby boomer cohort age up to 85 years and, therefore, do not contribute to the population count 85 and over.

focuses on the size and age structure of the population and how this observed structural and numeric ageing is shaped by population processes of fertility, mortality and migration. An aged person is typically identified using a retrospective measure of years lived since birth. In Australia, age 65 is the typical threshold for the aged, which is older than the United Nations threshold of age 60 (Australian Government 2015; Goldstein 2009; United Nations Population Division 2013).

In recent decades, there has been criticism of relying solely on chronological age to segment the aged and examine their characteristics (Sanderson and Scherbov 2010). There is more interest in examining variation within the aged population and their other individual, social and economic characteristics. The different streams of this research are outlined in Chapter 3 and include measuring age prospectively as years to death, examining the quality of life of the aged population using measures of health and activity and examining social and economic differences in the characteristics of the aged population across space and time.

1.1.5 The relevance for public policy in Australia

The public policy implications of ageing are wide ranging because economic and social systems are integrally linked to the population age structure. In simple terms, societies comprise of working-age populations, typically the youth and middle-aged in a population, and dependent populations, typically children and the aged. When the dependent population grows relative to the working-age population, pressures on the working-age population increase and could lead to increasing tax burden, falling living standards and intergenerational conflict (Guest 2008).

The growth of the aged population has significant implications for the Australian Government. The Australian Government has responsibility for aged care programs and the income safety-net, as well as being a funder of education, training and employment programs to assist the aged and near-aged to sustain a connection to the labour market. Reforms are underway to meet the growing demands of the aged and lessen the fiscal impact of an aged population growing in size – thus, addressing both structural and numeric ageing. These reforms focus on increasing labour force participation, retirement savings and greater means testing of care and income support arrangements. The policy response, however, continues to evolve and the latest projections bringing together economic, fiscal and demographic scenarios show a fiscal deficit emerging and government debt rising unless there is further reform (Australian Government 2015).

1.2 THE CURRENT STUDY

In the following subsections I introduce key features of the current study: the research problem and design. This should be read in conjunction with Chapter 11 where I conclude the study and outline the contribution of the study to knowledge, notable limitations and suggestions for future research.

1.2.1 Research problem

This study examines the geodemographic and life course perspectives of population ageing to better understand the aged in Australia. A comprehensive demographic analysis is needed to inform policy makers progress the policy response to population ageing in Australia. As mentioned, the current policy response is incomplete and, given the large baby boomer cohort is entering the aged years, progressing the policy response to one that can respond effectively to the economic and social implications of this is an imperative.

Currently, for Australia, evidence about growth in the aged population at a subnational level does not use a consistent methodology and is undertaken on an ad hoc basis so that there is limited continuity of information for policy makers. This means at a time when demand for local level services are increasing, there is inadequate information available about the aged population. One reason for the limited subnational analysis is that building a better understanding of the aged from small area analysis is complex, time consuming and resource intensive undertaking. It involves a trade-off between depth of analysis and breadth and, as I show, considerable indirect estimation.

Demographic theory is clearly developing in new directions. The insights about demographic conditions producing population ageing, which were developed more than fifty years ago, remain unchallenged (see, for example, Coale 1956; Keyfitz 1968; Lorimer 1951; and, Stolnitz 1956). Yet new analytical dimensions are developing to focus on differences within the aged population—by sex, characteristics and differences between the early-aged and late-aged years (see Section 3.1.3). These research insights, when incorporated into applied research, can support improved understanding of the aged and ageing processes and contribute to more effective and efficient design and delivery of services to the aged population.

Currently, in Australia, there is a strong reliance on conventional measures of the aged focusing on the size and age structure of the aged population and ageing processes. The aged are, however, a more complex population, where the characteristics of the population can be important determinants of independence or dependence, social support or work activity. Therefore, drawing from the new directions contained in the international literature, it is possible to introduce into the Australian context a broader set of analyses to better understand the aged population.

1.2.2 Research questions and approach

To better understand the aged and ageing process in Australia, this study is guided by two research questions:

1. How can the demographic evidence-base for Australia be expanded to better inform the policy response to population ageing in Australia?
2. What does a demographic evidence-base incorporating geodemographic and life course perspectives reveal about the aged and ageing processes in Australia?

To design a demographic evidence-base capable of informing the policy response to population ageing in Australia, I need to consider the policy response itself. I argue the policy response is incomplete (see Chapter 2.3) and, subsequently, suggest policy directions which should inform the policy response to population ageing in the Australia in the future (see Chapter 4). It is clear the demographic evidence-base needs to deliver increased granularity through better understanding of spatial and temporal variation in the aged and ageing processes. However, the demographic evidence-base also needs to support an evolution in the policy response. If the focus is solely on informing policies responding to an increase in the number of the aged or the age structure changes (such as planning for service delivery), policy makers will miss the adaptive challenge of population ageing.

To expand the demographic evidence-base I focus on two elements: providing increased granularity through a comprehensive geodemographic analysis and, incorporating life course perspectives of the aged to inform the adaptive policy response. Consistent with conventional demographic studies, the study of the size, age structure and characteristics of the aged population is central to this analysis. The life course perspective, in contrast, incorporates insights from recent research demonstrating the importance of examining the characteristics of the aged using a life course perspective (see Section 3.1.3). Using the life course perspective I focus on age-transitions to better understand the threshold age demarcating the commencement of the aged years, mortality conditions such as the length of life and inequality in the length of life, and life course markers of ageing such as working-life and disability-free life expectancies.

For the expanded demographic evidence-base, I select data from Census, vital records and administrative migration data released by the ABS. The regular release of this data for means this study can be replicated in the future. Specifically, the Australian historical population estimates, population projections, mortality and migration estimates. The population characteristics examined are from the Census and include individual, economic and social characteristics. By applying indirect estimation techniques to the available data, I am able to develop a comprehensive set of key demographic variables including static estimates of population counts and characteristics and dynamic demographic processes of mortality, international migration and internal migration estimates.

Using these variables, I then examine what a demographic evidence-base incorporating geodemographic and life course perspective reveals about the aged and ageing processes in Australia. Consistent with a multidimensional approach, I include a range of analytical methods in this study. There are two key analyses in the geodemographic perspective of the aged: a subnational projection model of the aged population using a cohort component methodology and a subnational geodemographic classification model for the Australian aged population using a k-means cluster methodology. The life course analysis is diverse and includes an analysis of the threshold of the aged using the Sanderson and Scherbov (2013) characteristic-based measure of age, a decomposition of life span change using the Arriaga (1984) method, analysis of life span disparity using a life table index ($e^{\dagger}$) measuring the average years of life lost in a population due to death (van Raalte and Caswell 2013) and, additionally, an analysis of the life course markers of ageing using working-life expectancies and disability-free life expectancies using the Sullivan (1971) method.

Chapter 2

Australian society, demography and current policy concerns relating to population ageing

The lucky country.

(Donald Horn)

In this Chapter, I provide the contextual background for this study to set the scene for readers not familiar with the Australian context. The Chapter covers three areas: Australian society, Australian demography and current policy settings. In the section on Australian society and demographic, I outline relevant information about Australia's society and economics and the background information about historical and current social and economic conditions. In the section on demography I cover ethnic composition, marriage and households; fertility and mortality; international migration; internal mobility of the Australian population; growth and ageing of the Australian population from 1901 to 2011; and, the settlement pattern of Australia. Where possible I focus on 2011 as this is a key reference point in this study, differentiating between historical analyses and the future projections. In the section on current policy settings and concerns, I focus on work and training, health and care, and retirement income.

Interest in population ageing as a policy issue has intensified since the publication of the Australian Government's first *Intergenerational Report* in 2002 (Australian Government 2015). However, the public policy response in Australia is incomplete and current policy concerns continue to focus on the ability to provide (and fund) services to a growing aged population and to maintain improvements in economic growth, productivity and living standards despite an increase in the dependent population.

2.1 AUSTRALIAN SOCIETY

Since British colonial settlement in 1788, Australia has developed into a prosperous and multicultural nation. The Commonwealth of Australia is a constitutional monarchy established in 1901 with the federation of the states of New South Wales, Victoria, Queensland, Western Australia, South Australia and Tasmania. The Australian Government subsequently used its powers under the Australian Constitution to establish an additional thirteen territories. Two of these territories, the Australian Capital Territory and the Northern Territory, have elected governments and powers similar to the states. Consequently, in this study, these two territories are considered alongside the six states.[6] The Australian Constitution makes no provision for local governments, but their presence is entrenched in Australian society and more than 500 local governments are operating in Australia.[7]

Australia's civil and government institutions have their origin in British institutions, including adhering to the rule of law. The Australian Constitution separates power between a bicameral legislature, independent judiciary and executive government. There are two major political forces— a Labor Party representing progressives and a coalition of Liberal and National Parties representing the conservatives. Government is formed in the House of Representatives. Government power, however, is typically checked by the opposition, minor parties and/or independents in the Australian Senate. Thus, new policy, particularly that requiring legislation, is regularly the result of negotiation.

Policy responsibilities can be the sole responsibility of one level of government or shared between governments. The Australian Government's powers are limited, coming from the Australian Constitution or referred power from the states. State governments possess the residual "everything else" powers. State governments also determine the powers of the local governments within their jurisdictions. At the time of writing, a White Paper on the Reform of the Federation is underway and could result in further shifts in policy responsibilities between levels of government in Australia (Abbott 2014).

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6 In June 2011, the population of the Northern Territory and the Australian Capital Territory was 231,000 and 368,000 respectively (ABS 2014b). The combined population enumerated in the other territories in the 2011 Census was 5,000 people (ABS 2011a).

7 The number of local governments changes as State Governments, who control their boundaries, amalgamate or break-up local governments depending on political philosophy and/or the changing population geography.

The Australian Government has significant revenue raising powers and with this comes substantial influence over society, the economy and the activities of state and territory governments. In the 2011-12 financial year, Australian Government revenue—in Australian dollars—was $338.1 billion and expenditure was $377.7 billion, of which there was $97.0 billion in payments to the states and territories (Australian Government 2012a). The Australian Government also has responsibility for Defence, international trade, residential and community care, retirement incomes and the income safety-net arrangement, disability insurance, employment services, higher education and workplace relations. The state and territory governments are responsible for health, education, transport, public housing, workers compensation and vocational education. Local governments administer community services such as parks and libraries. All levels of governments deliver community-based support programs.

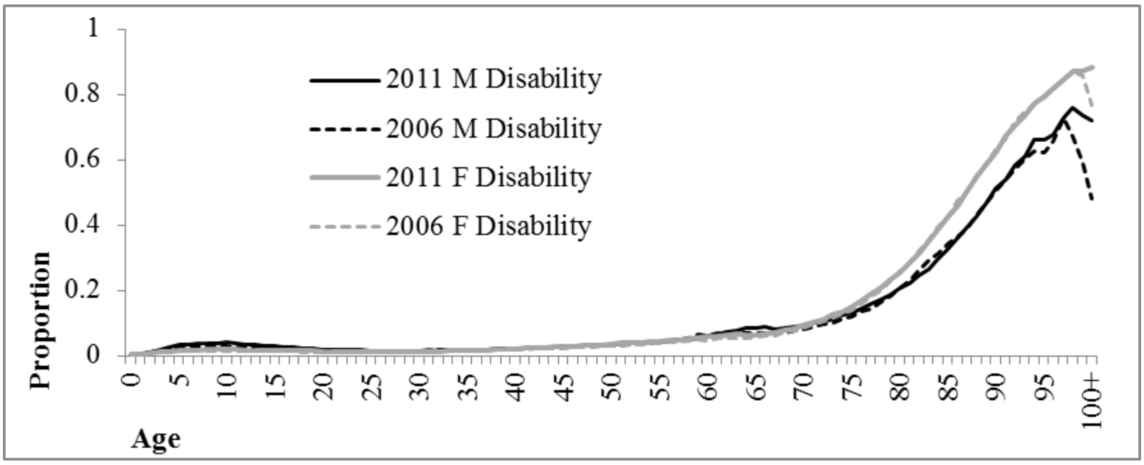
In the 2011-2012 year, national Gross Domestic Product was nearly $AUS1.5 trillion (ABS 2014d). The Australian economy is robust as a result of considerable mineral and resource wealth and an ability to adapt to changing conditions. Australia has enjoyed continuous economic growth since 1991 and navigated the 2007 global financial crisis without recession (ABS 2014d). Industry restructuring, however, has been significant. During the 20th Century the engine of the Australian economy has shifted from primary industry, to manufacturing and then to resources and services (Connolly and Lewis 2010). In 2015, there are increasing signs that the resources boom of the 2000s has reached its peak and mining revenues are falling significantly (Nicholls and Rosewall 2015).

Australia is a liberal welfare state and the strength of the Australian economy has made possible the expansion of welfare, health and education programs. In 2014-15 around 55 per cent of Australian Government spending was directed to health, disability, aged care, pensions, payments to individuals (such as income safety-nets, family payments) and education. Relative to other Organisation for Economic Co-operation and Development (OECD) countries, social expenditure, as a proportion of Gross Domestic Product investment, is below average; but in some areas—such as health and education—per capita expenditure exceeds the OECD average (OECD 2014a; OECD 2014c).[8] While social expenditure remains a priority, neoliberal ideas have been on the rise since the

[8] Note also that Australian pension expenditure is lower than average, but this is due to a higher reliance on private income during retirement compared with other OECD countries.

1980s resulting in social expenditure being increasingly targeted, conditional and means-tested (Stebbing and Spies-Butcher 2010).

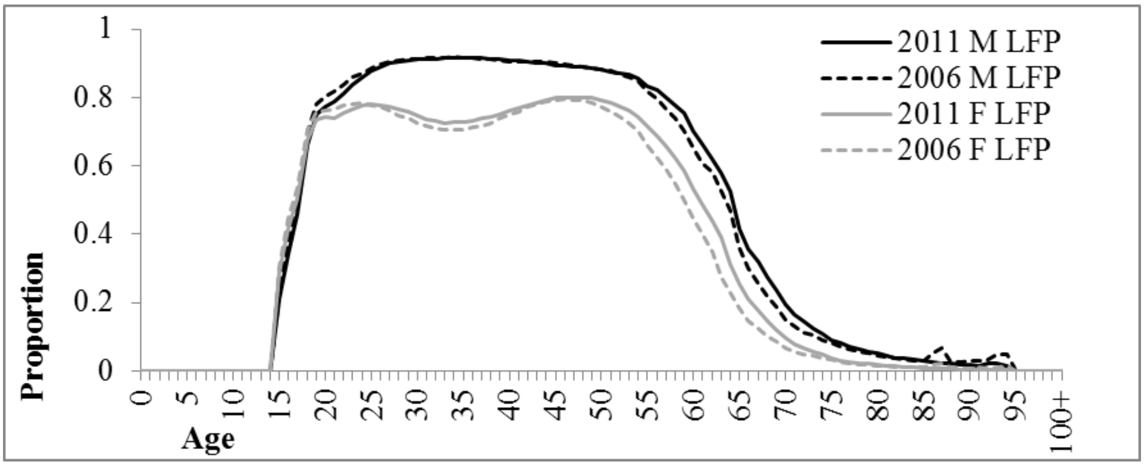
The typical life course in Australia is a period of childhood, followed by education and training in the late teenage years or early twenties, work through to mid-sixties and then retirement. Frailty, if measured as severe and profound disability, is concentrated in older ages (see Figure 4). The majority of Australians are expected to complete secondary education, at an average age of 17 (OECD 2014a). Access to publicly funded, at least in part, post-secondary education is universal (OECD 2014a). As shown in Figure 5, labour force participation increases rapidly through the twenties as young people finish school and enter the labour market. Male and female labour force participation diverge at this point, with females withdrawing from the labour market or reducing their hours as their child-rearing and elder-care responsibilities increase. The average age of retirement is increasing and is currently is 62.9 for females and 64.9 for males (OECD 2014c).



Source: Author's calculations using the ABS 2006 and ABS 2011d.
Notes: These estimates are the disability prevalence estimates used to calculate disability-free life expectancy for Australia. Estimates over the age of 100 are highly unstable. Disability prevalence is the proportion of the population with a severe disability. See Section 7.2.1.1 for the calculations and Section 10.3.2 for the results of the disability-free life expectancy analysis.

Figure 4 Disability prevalence by age: Australia, 2006 to 2011

Overall, living standards, household wealth and disposable income in Australia are high compared with other OECD countries (OECD 2015). With the exception of the lowest and highest wealth households, the majority of wealth is in housing assets (ABS 2013e). Nearly seventy per cent of people own their home (41 per cent outright) (ABS 2011d). Unemployment has maintained a long-term average of around five per cent between the Second World War and the 1970s, but has been higher in more recent decades at around 6 to 7 per cent (Australian Government 2004), and is persistently higher among youth, older people and people with disabilities (ABS 2011b). Approximately 25 per cent of the population access an income payment of some kind (ABS 2013d).



Source: Author's calculations using ABS 2006 and ABS 2011d.
Notes: These estimates are the working-life estimates used to calculate working-life expectancy for Australia. LFP (labour force participation) is the proportion of the population participating in the labour force. See Section 7.2.2.1 for the calculations and Section 10.3.1 for the results of the working-life expectancy analysis.

Figure 5 Labour force participation by age: Australia, 2006 to 2011

Australians are also relatively healthy by international standards. Life expectancy in Australia ranks seventh highest of 36 countries compared by the OECD (OECD 2015). In recent years (between 1998 and 2012), most of the increase in life expectancy is years lived free of disability and severe or profound core activity limitation (AIHW 2014a) (see Section 3.2 for more detailed discussion). The epidemiological transition has occurred, with a shift from infectious diseases to degenerative disease (Olshansky and Ault 1986). Currently, in Australia, the top five underlying causes of death are ischaemic heart disease, dementia and alzheimers disease, cerebrovascular disease, malignant neoplasm of trachea, bronchus and lung and chronic lower respiratory disease (ABS 2015a).

While living standards are expected to increase in Australia there are challenges (Australian Government 2015). Demographic change through population ageing is just one factor. There are additional pressures on social service expenditure from increasing technology in the health sector, increasing demand for disability pension and government funded education and training (Australian Government 2015). The costs of home ownership have increased leading to higher levels of debt and lower rates of outright home outright ownership (Winter 2015). Australian industry continues to restructure, and there are diminishing opportunities for low skilled males and females in the Australian labour market. There is evidence of entrenched poverty, disability and inequality

(Fancisco and Bodsworth 2015), particularly among Australia's Indigenous population which is highly disadvantaged relative to the non-Indigenous population (Biddle 2015).

Meeting these challenges will be difficult. Over the long-term, economic growth is expected to be slower (Parkinson 2014b). The government budget deficit as a proportion of Gross Domestic Product was 3 per cent in 2011, which is low compared with other OECD countries, but the long-term projections are for increasing levels of debt and deficit unless there is fiscal reform (Australian Government 2012a Final Budget Outcome; Australian Government 2015). Total tax revenue has been falling as a proportion of Gross Domestic Product and is currently around 25 per cent, lower than the OECD average (Australian Government 2014a; OECD 2014b).

While Australia should be well positioned to respond to these challenges, the response will not be a simple matter of policy design or raising tax to fund reforms. The current Australian Senate is fragmented and without parliamentary reform is likely to remain so. Any legislation not supported by the government and the opposition, must be negotiated through a broad church of minor parties and independents. Achieving consensus in the current political environment is hard.

2.2 AUSTRALIAN DEMOGRAPHY

Prior to the British settlement of Australia in 1788, the continent was home to an Indigenous population between 315,000 and 1 million people with 700 language groups (ABS 1994). As a result of conflict and disease, the Indigenous population declined sharply and was estimated to be 84,000 in 1961 (ABS 1994). More recently, the Indigenous population has expanded (beyond what can be explained by rates of fertility and mortality) and is estimated to be 669,000 in 2011 (ABS 1994 Year Book; ABS 2014a). The Indigenous population warrants treatment as a distinct group in analysis of the Australian population because their demographic characteristics vary substantial from the non-Indigenous population in Australia (see for example, the Closing the Gap report (Australian Government 2016).

Between 1901, the year of Australia's federation, and 1961 Australia's population grew from 3.8 million to 10.5 million, and continued growing to 22.3 million by 2011 (ABS 2014b; ABS 2014c). While the Australian Government does not have an official population policy, at times population issues have been prominent in public debate. Population growth was initially critical for the survival of the colony and has later been linked to both national security (the "populate or perish" mantra following the Second

World War) and economic security (the "have one for mum, one for dad and one for the country" mantra of the conservative government in the early 2000s). Between the Second World War and the 1970s there was a growth target of two per cent (Australian Population and Immigration Council 1997). More recently, in the context of strong demand for migration to Australia and increasing concern about the environmental impact of growth, concern about the pace of population growth has increased. In 2010, Government established a sustainable population division in the Department of Environment (Australian Government Department of Sustainability 2011). While this group was dismantled by the incoming conservative government in 2013, the conservative's policy platform at the election was for population growth to be closer to the long run average of 1.4 per cent per year (Liberal Party of Australia 2010).

In the following sections I cover key issues in Australian demography, including: ethnic composition, marriage and households; fertility and mortality; international migration; internal mobility of the Australian population; growth and ageing of the Australian population from 1901 to 2011; and, the settlement pattern of Australia.

2.2.1 Ethnic composition, marriage and households

The Australian population is ethnically and culturally diverse, ranking third highest among OECD countries for the percentage of the population foreign born (OECD 2014c). In the 2011 Census, 26 per cent of the enumerated population were foreign born and by 2014 the ABS reported this per cent increased to 28 per cent (ABS 2011d; ABS 2015c). English is the dominant language of the population, and less than 3 per cent of the population characterise their English language abilities as very poor or poor (ABS 2011d). The aged population is also increasingly ethnically diverse (Gibson et al 2001).[9]

Marriage, and to a lesser extent de-facto heterosexual relationships, are the social norm. Most males and females will marry in their lifetimes. The median age of marriage has increased; it was 29.7 years for males and 28.0 years for females in 2011 (ABS 2010b). Divorce rates have fallen to around 2.2 divorces per 1000 people in 2011 after a peak of 4.6 divorces per 1000 people in 1976 following the introduction of "no fault divorce" in the *Family Law Act 1975* (Cth) (ABS 2010b; Hayes et al 2010).

Household composition is changing. Household size has fallen from 3.5 members in 1966 to 2.6 in 2011 (Hayes et al 2010; Qu and Weston 2013). The most common household

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[9] Comparing the population from 1996 to 2011.

type is a couple with children but the proportion of lone households is rising (Qu and Weston 2013). Multi-generational households comprising adult children and their parents are not a norm; Kendig and Lucas (2013)[10] observe "co-residence between the generations is rare except when precipitated by financial necessity, widowhood, disability or cultural distance from the Australia norm." This is not likely to change.

2.2.2 Fertility and mortality

Demographic conditions in Australia changed significantly between the 1860s and 1930s, reflective of a demographic transition. The Crude Birth Rate fell from 42.6 births per 1000 females in 1860 to 16.4 births per 1000 females in 1934 (ABS 2014c; Ruzicka and Caldwell 1977). The Crude Death Rate more than halved over this period from 20.9 deaths per 1000 people in 1860 to 8.6 deaths per 1000 people in 1930.

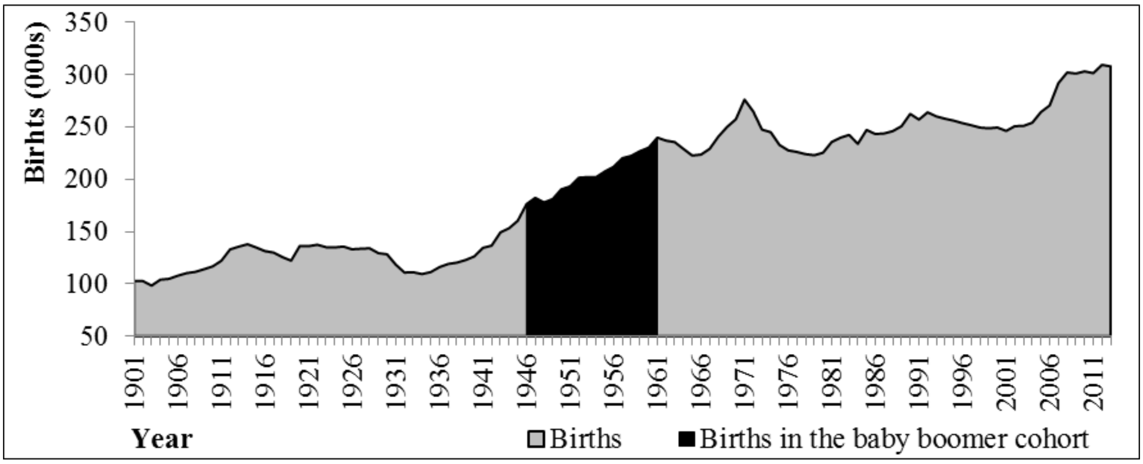
The birth of the baby boomer cohort between 1946 and 1966 has a larger impact on the current population age structure.[11] Over this period the Crude Birth Rate increased to an average of 22.9 births per 1000 females (ABS 2014c). The Total Fertility Rate fertility also increased from an expected 3 births per woman in 1946 to 3.5 births per woman in 1961. Consequently, the birth cohorts during this period were larger than the adjacent birth cohorts (see Figure 6).

Initially, the larger baby boomer cohorts were considered to be catch-up fertility compensating for deferred fertility during the Second World War. With hindsight, however, Ruzicka and Caldwell (1977, 214) determined that changes in marriage were the key driver of the baby boom:

> "The high number of births after World War Two and, particularly, the continuation of high birth rates through the 1950s to the beginning of the 1960s was, in Australia, the consequence of the marriage boom and of changes in the timing and spacing of births within marriage. It did not, and this point must be emphasized, result from any increase in the fertility of marriages".

The effect of the marriage boom, however, was not sustained, and births and the expected number of births per woman fell after 1961.

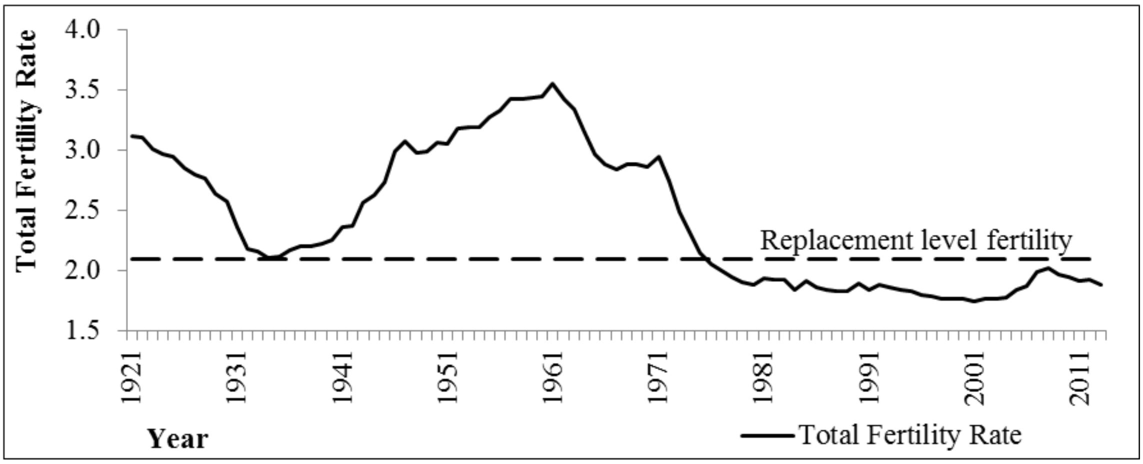
[10] No page numbers are available for this publication.
[11] This is the definition used by the ABS and may vary from the birth years and characteristics of the baby boomer cohort used for other countries.



Source: ABS 2014c.
Note: The 1970s peak is an echo effect of increased births following the baby boomer cohorts.

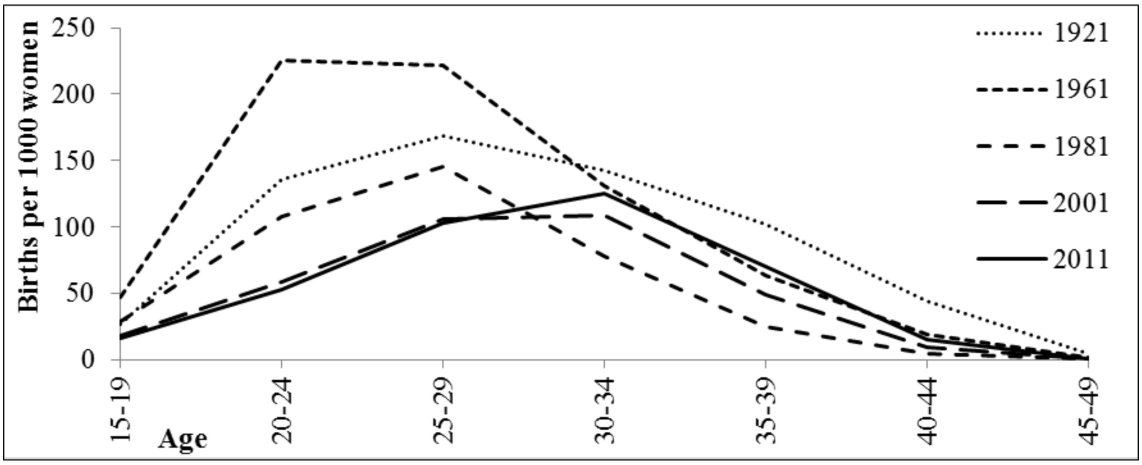
Figure 6 Size of birth cohorts: Australia, 1901 to 2011

The Total Fertility Rate and age-specific fertility rates are shown since 1961 in Figure 7 and Figure 8. After its peak in 1961, the fertility rate fell, initially slowly and then more rapidly from 1971 to 1975. Since 1976 the Total Fertility Rate has been below replacement level of 2.1 births per woman. In addition to declining, the age-specific fertility rates show a shift in child bearing to older ages, with the peak increasing from 20 to 24 years in 1961 to 30 to 34 years in 2011. The increase observed in the mid-2000s is attributed to good economic conditions and the effect of a shift in age-specific fertility rates to older ages (Drago et al 2009).



Source: ABS 2014c and ABS 2014e.
Note: The Australian Historical Population Statistics do not include a Total Fertility Rate prior to 1921.

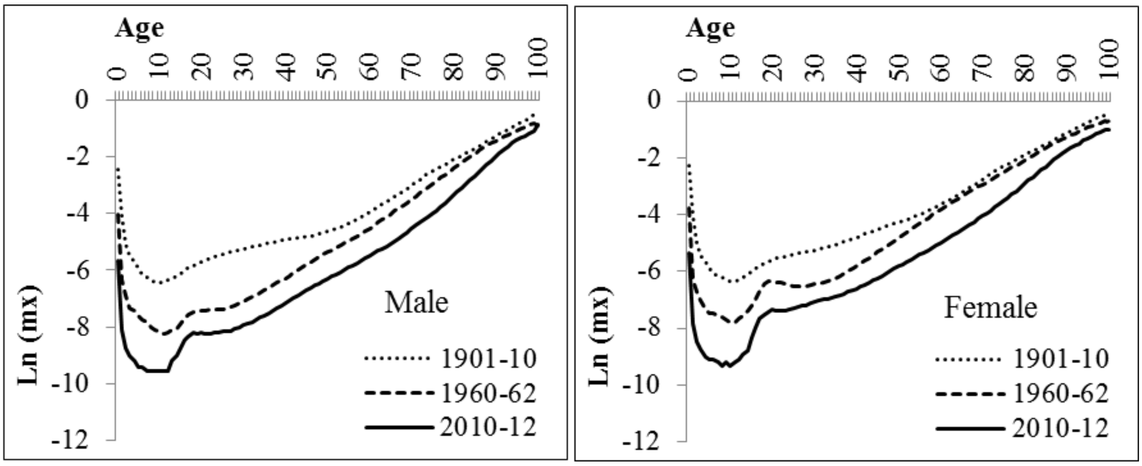
Figure 7 Total Fertility Rate: Australia, 1921 to 2011



Source: ABS 2014c.

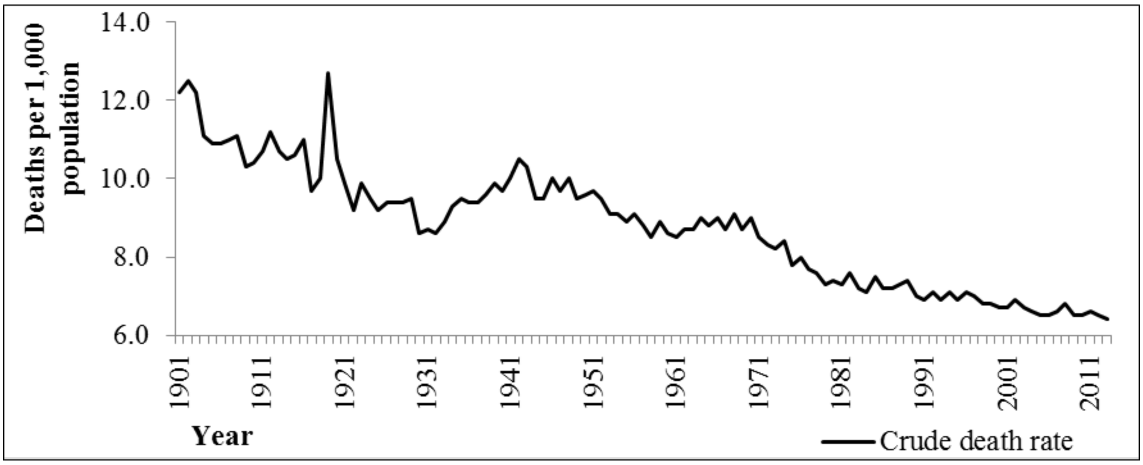
Figure 8 Age-specific fertility rate: Australia, 1921 to 2011

There is variation in fertility at the subnational level and by population subgroups. Fertility is higher in remote areas compared with major cities (ABS 2010a). This is partly due to the concentration of Indigenous populations in remote areas and fertility among Indigenous females is higher than the national average (ABS 2014e). Fertility also tends to be higher in socioeconomically disadvantaged areas and lowest in the highest socioeconomically advantaged areas (ABS 2010a). This is also a trend towards higher proportion of females without children (ABS 2010a).



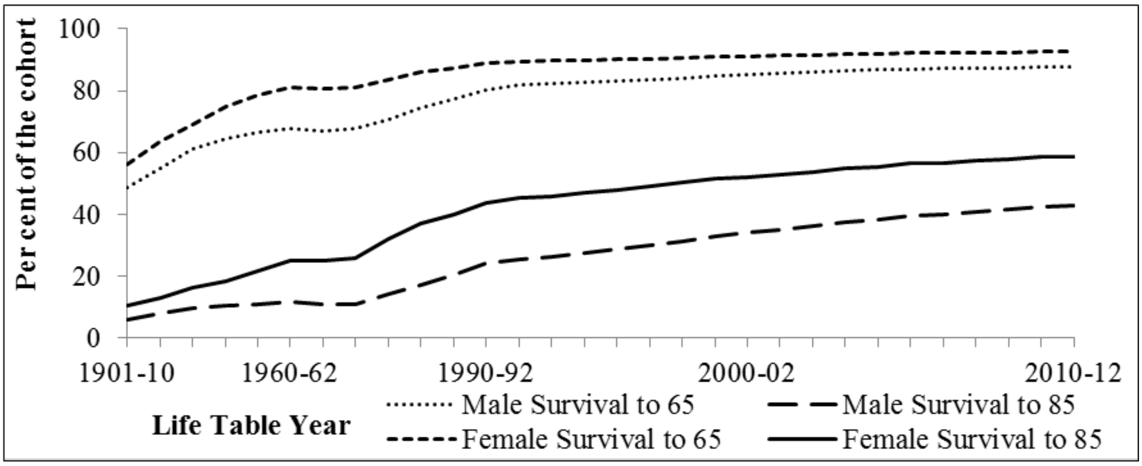
Source: Author's calculations using ABS 2014c.
Note: See Section 6.3 for the calculations.

Figure 9 Age-specific mortality rate by sex: Australia, selected years 1901 to 2011



Source: ABS 2014c and ABS 2013c.
Note: The crude death rate excludes deaths of defence personnel from September 1939 to June 1947.

Figure 10 Crude Death Rate: Australia, 1901 to 2011



Source: ABS 2014c.
Note: Calculated from the (l_x) values in the 2010-2012 life tables.

Figure 11 Survival to age 65 and 85 years: Australia, 1901 to 2011

Mortality reductions occurred at all ages over the period 1901 to 2011 (as shown in Figure 9). As shown in Figure 10, the Crude Death Rate of the population nearly halved from 1901 to 2011. Two main trends have led to this improvement: a fall in infant mortality from 103.6 deaths per 1000 live births to less than ten deaths per 1000 live births by 1983; and, a substantial reduction in mortality in the early-aged years (see Section 10.2.1 for the decomposition analysis of the age structure of mortality change) (ABS 2013c; ABS 2014c).[12]

[12] Infant deaths has continued to fall in Australia and was 6.5 deaths per 1000 live births in 2012 (ABS 2013c).

As a consequence of mortality reductions, a higher proportion of successive birth cohorts survive through each age and the expectation of the length of life has increased (ABS 2014c). Figure 10 shows the per cent of the population surviving to age 65 and age 85 years using period life tables since 1901. By 2011, 88 per cent of male children and 93 per cent of female children were expected to survive to age 65 years. While mortality between age 65 and 84 years remains non-trivial, 42 per cent of male children and 58 per cent of female children are expected to survive to age 85 years.

Improved survivorship to older ages means that, on average, remaining life expectancy has also increased. The expected years of remaining life at birth, age 65 and age 85 are shown in Table 1. While the pace of change has been uneven, over more than a century, the gains in the expected years of life have been significant at each of these ages. By 2011, males could expect to live 79.9 years and females could expect to live 84.3 years.

Table 1 Remaining life expectancy at birth, age 65 and age 85: Australia, selected years from 1901 to 2011.

Life Table Year(s)	Birth		Age 65		Age 85	
	Male	Female	Male	Female	Male	Female
1901-10	55.2	58.8	11.3	12.9	3.7	4.2
1960-62	67.9	74.2	12.5	15.7	4.1	4.8
1970-72	67.9	74.6	12.2	15.9	4.1	5.1
1980-82	71.2	78.3	13.8	18.0	4.7	5.8
1990-92	74.3	80.4	15.4	19.3	5.2	6.4
2000-02	77.4	82.6	17.4	20.8	5.6	6.8
2010-12	79.9	84.3	19.2	22.0	6.1	7.2
Per cent change	+44	+43	+70	+70	+65	+71

Source: ABS 2014c.

Note: Remaining life expectancy is measured by years.

Since 1901, there has been a significant reduction in variation in length of life for the Australia. The interquartile range for the length of life for Australian males and females for selected years between 1901 and 2012 is shown in Figure 12. The decrease for females from 1901 to 1961 was 17.2 years and for males over the same period was 15.5 years. From 1961 to 2011, the interquartile range continued to reduce, by a further 3.2 years for females and 3.4 years for males.

Source: ABS 2014c.
Note: IQR is the interquartile range based on the (d_x) values in the life tables.

Figure 12 Life span variation based on the interquartile range: Australia, males and females, 1901 to 2011

2.2.3 International migration

Australia is a nation built on migration. In the post-war era, migration has added more than 8 million people to the Australian population, with most settlement in capital cities (particularly Sydney and Melbourne) (Hugo 2008). The level of migration since 1972 is shown in Figure 13. The concept of "populate or perish" was the driver of Australia's early migration programs (Hughes 2014). More recently, the migration program has focused on the skills needs of industry. Currently, the migration program has three components: the annually capped permanent migration program including the skilled, family and humanitarian visa groups; temporary entrants through largely uncapped programs including students, business long stay, working holiday makers and long-term visitors; and other entrants including Australian and New Zealand citizens[13] (Australian Government Department of Immigration and Citizenship 2011).

[13] Note that special conditions are in place allowing New Zealand citizens to enter, reside and work in Australia.

The characteristics of Australia's migrants are changing. A 'White Australia' policy in place between federation and 1973 ensured strong migration routes from Britain, its colonies, and other European nations (Hughes 2014). Following the dismantling of this policy, the foreign born population has become more diverse and, in particularly, the migration flows from Asia have increased (Khoo 2003). Arrivals to Australia are now more diverse and more skilled. Since 1997, the size of the skilled migration program has exceeded the family, working and holiday visa programs (Hughes 2014). Similarly, as the international education sector has expanded, the proportion of arrivals who are students has increased (Australian Government Department of Immigration and Citizenship 2011).

Demographically, there are differences between the international migrant population and the Australian born population. In 2011 (and subsequently), the median age of the migrant population is older than the Australian born population—45.1 years compared with 33.5 years (ABS 2015c).[14] Overall, the fertility rate of Australia's foreign born population is currently lower than the Australian born population, but does vary by the country of origin of each migrant (ABS 2014e). Historically, the foreign born population, particularly the population with poor English skills, has experienced relative socio-economic disadvantage in Australia. Massey and Parr (2012), however, find signs of socio-economic equalization, particularly in the foreign born population in regional and remote locations, possibly associated with the shift towards a skilled migration program.

2.2.4 Internal mobility of the Australian Population

The Australian population is free to move. The majority of these moves, however, are classified as residential mobility, meaning moves within a region. Internal migration is defined by the ABS as "the movement of people from one defined area to another within a country: as moves across geographic boundaries such as a state and territory boundary" (ABS 2011d). The incidence of internal migration, therefore, will be less than residential mobility, which includes all moves, and will depend on the geographic boundary used to define internal migration.

Bell (1995) identifies for Australia four major spatial trends in internal migration since the Second World War. These are: movements away from the south-east towards north and west (for example, to Queensland and Western Australia); movements away from the

[14] Although this does vary based on country of birth.

interior of Australia; movements from cities to adjacent rural areas in a process referred to as counter-urbanisation; and movement of people from inner and middle suburbs to the metropolitan fringe in a process referred to as suburbanisation.

Estimates based on the 2011 Census provide a crude indication of recent spatial trends and the degree to which moves are classified as residential mobility or internal migration. At the state and territory level, more than 2.9 million people reported moving in the year prior to the Census. At the state and territory level, this ranges from 12.3 to 17 per cent of the population moving. The majority of the moves do not cross state and territory boundaries (see Figure 32).

Internal migration does vary with age, individual and household characteristics and location. Life course theories are often used to explain these differences, with moves in youth and working-age associated with life course events of leaving the family home and relocating for education and work opportunities, to form domestic partnerships and begin families (Bill and Mitchell 2006). In the aged years, Litwak and Longino (1987) argue there are three stages of migration: moves for amenity reasons after retirement; moves when widowed or development of a chronic illness; and, moves when institutional care is required.

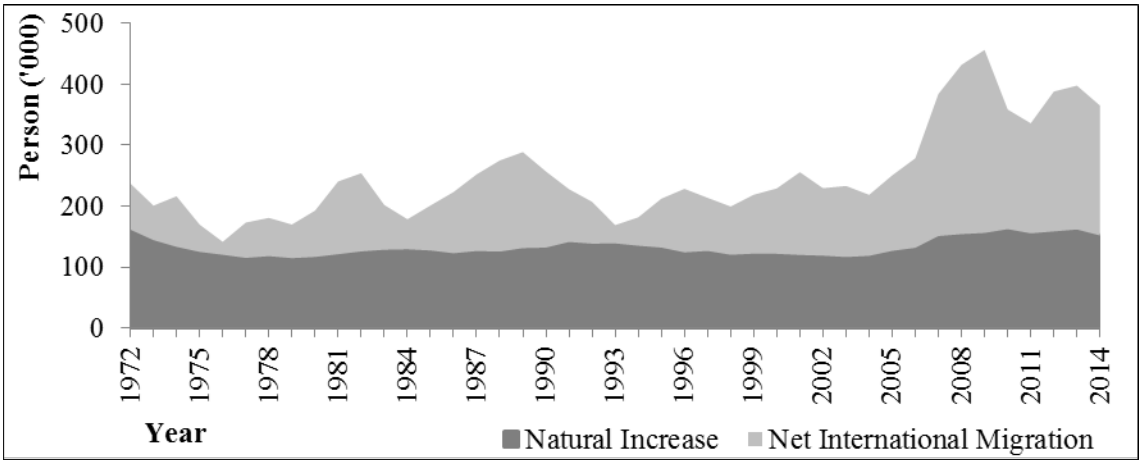
The incidence of internal migration also varies with individual and household characteristics. Studies show mobility is highest among the separated and divorced, the unemployed, people from English-speaking backgrounds and recent overseas arrivals (Bell 1995). Mobility is lowest among the married, immigrants from non-English speaking backgrounds and people outside of the labour market (Bell 1995). For some characteristics, such as income, the relationship can be unclear. For example, high income appears to enable mobility but low income can also prompt moves to reduce living costs (Maher and Whitelaw 1995). At the household level, mobility is lowest among home owners and couples living with dependent children. In contrast, mobility is highest among renters and group households (Maher and Whitelaw 1995).

The characteristics of an area can influence how attractive the region is to new migrants. Several locational features are influential, including economic development, natural resources and amenity, industry and structural change in the industry, geography, climate, environmental amenity, and social-cultural factors such as social networks, social cohesion and the availability of affordable housing (Argent et al 2011; Holmes, Charles-Edwards and Bell 2005; Maher and Stimson 1994). Australia is like other developed countries: the highest propensity to move is to cities, which receives internal migrants, and the more remote regions of inland Australia, which typically regions associated with emigration (Bell 1995).

A number of theories have been put forward to explain the interactions between migration and individual, household and locational characteristics. Two theories are relevant to this study. The amenity-led migration theory identifies moves to locations with high accessibility and physical amenity (Argent et al 2011; Bell 1995). This explains, in particular, some of the migration to coastal areas and accessible inland regions particularly by the healthy and active aged (Hugo 2003). The second theory is the welfare-led theory where people with fewer resources (such as pension recipients) relocate to regions where the cost of living is less (Morrow 2000). This explains some of the relocations from urban areas to city-fringe locations (Morrow 2000).

2.2.5 Growth and ageing of the Australian population from 1901 to 2011

At the time of federation in 1901, the population of Australia was 3.8 million people. In the 60 years to 1961, Australia's population more than tripled to 10.5 million people, and in the subsequent 50 years to 2011, Australia's population more than doubled to 22.3 million people. Historically, natural increase (the growth in population when births exceed deaths) has been the primary contributor to Australia's population growth (Maher and Stimson 1994). Since 2006, however, as shown in Figure 13, net overseas migration has contributed more to Australia's population growth than natural increase.



Source: ABS 2014b and ABS 2014c.
Note: Counts are stacked.

Figure 13 Contributions to growth in the population: Australia, 1972 to 2014[15]

[15] The Australian Historical Population Statistics 2014 include estimates for natural increase and overseas migration from 1972. While these are the official statistics, the ABS has noted that these are an imperfect

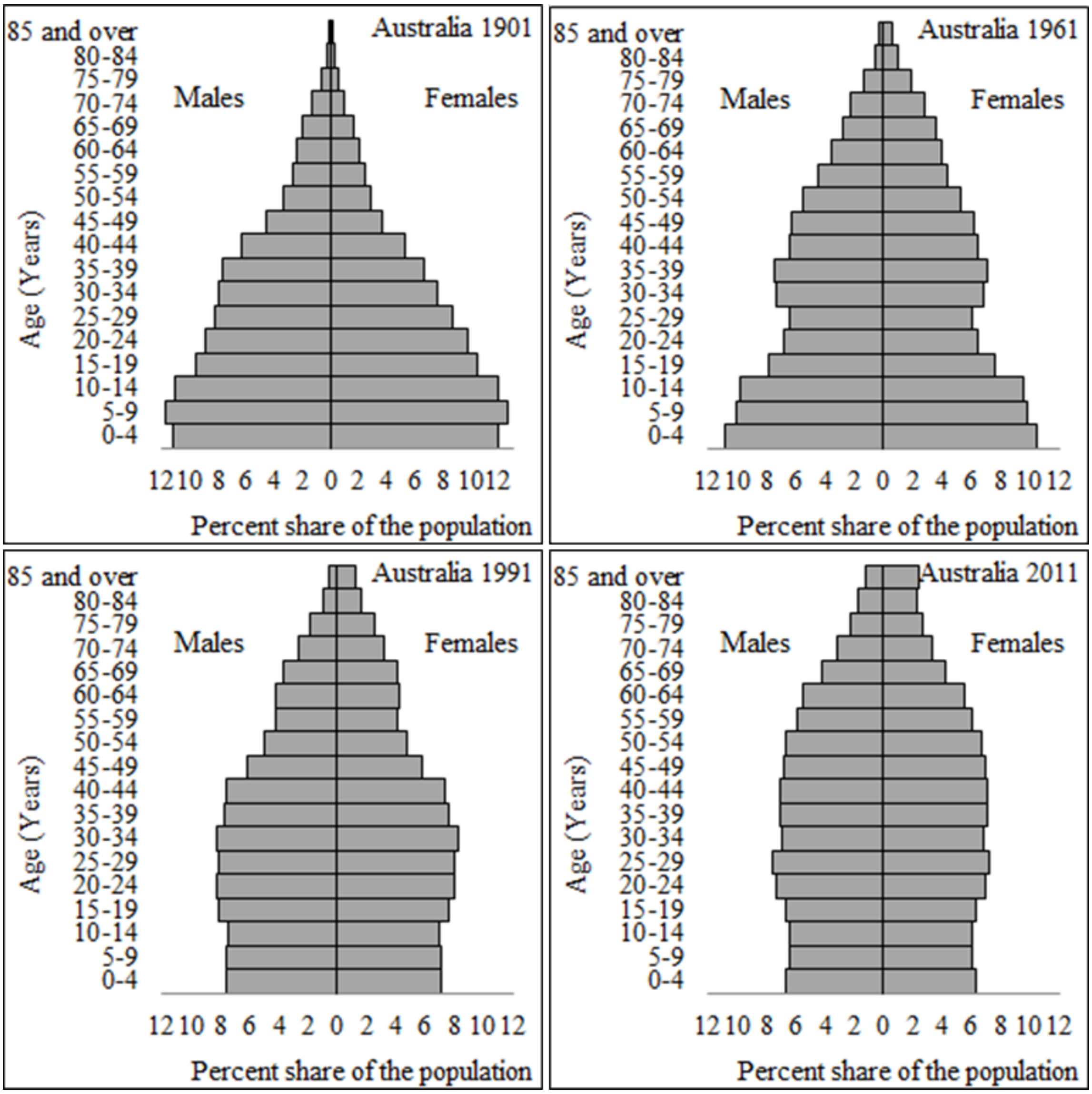
Accompanying growth in Australia's population has been a change in its age structure. As Preston, Himes and Eggers (1989, 184) observed, population ageing occurs "when age-specific growth rates are positively correlated with age". The mean annualised growth rates by age and sex for the period 1901 to 2011 are shown in Table 2. Over the period 1901 to 2011, the youth, working-age and aged population all increased, but at different rates. Between 1961 and 2011, for example, the size of the youth population (age 0 to 19 years) increased 1.4 times, the working-age (age 0 to 19 years) increased 2.4 times, and the aged (age 65 and over) increased by 3.5 times (ABS 2014c). If the aged group is further divided into an early-aged (age 65 to 84) and late-aged group (age 85 and over), the differential growth rates are more pronounced—with the late-aged group being the fastest growing age group. The late-aged (aged 85 and over) increased by more than 10 times between 1901 and 1961 and more than 9 times between 1961 and 2011.

Table 2 Actual mean annual per cent growth of the population by age: Australia, 1901 to 2011

	0-19	20-64	65-84	85+	Total
1901-1961	1.7	2.2	3.5	4.7	2.1
1961-1971	2.0	2.3	1.9	4.3	2.2
1971-1981	0.28	1.8	2.8	4.3	1.3
1981-1991	0.25	1.9	2.8	4.1	1.5
1991-2001	0.29	1.3	1.8	5.4	1.1
2001-2011	0.70	1.6	2.2	4.3	1.5
1961-2011	0.71	1.8	2.3	4.5	1.5

Source: ABS 2014c.

time series due to methodological changes in estimating natural increase and net overseas migration and further information can be obtained in the explanatory notes accompanying the Australian Historical Population Statistics.



Source: ABS 2014c.

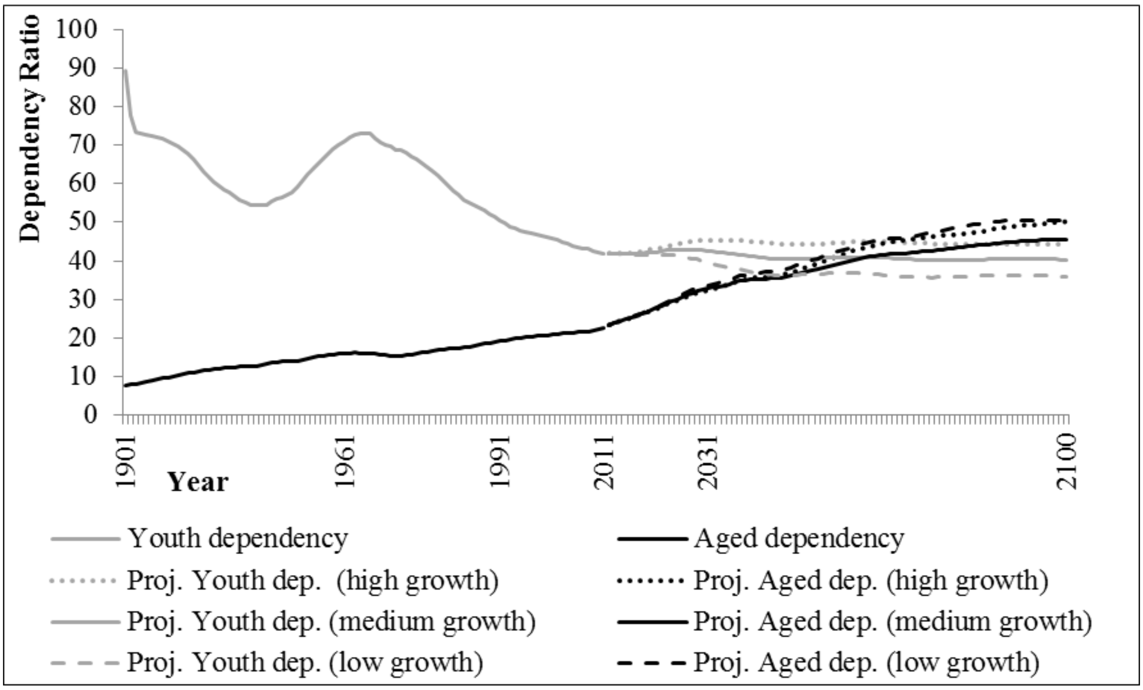
Figure 14 Composition of the population by age and sex: Australia, selected years 1901 to 2011

The Australian population has already aged significantly. In 1901, 50 per cent of the population was aged less than 22.5 years. By 1961, this increased to 29.3 years, and increased further by 2011 to 37.2 years (ABS 2014c).[16] However, such summary measures can mask the extent of change that has occurred. The population pyramids for selected years shown in Figure 14 indicate a more significant transformation in the age structure of the population. The reduction of the youth and growth of the aged population are the most striking changes in the age structure. The birth and ageing of the baby boomer cohort between 1946 and 1966 is also apparent. Over the period 1901 to 2011, the

[16] In 1961 the median age for males was 28.7 and 30 for females. In 2011 the median age for males was 36.4 for males and 38.1 for females (ABS 2014c).

proportion of the population age 65 and over increased from 4.0 per cent of the population to 13.8 per cent.

The Australian dependent population has typically comprised of more youth dependents than aged dependents. While the age structure of the Australian population has changed significantly since 1901, the youth dependent population still remains larger than the aged dependent population. However, the projected dynamics of dependency, as shown in Figure 15, forecasts that aged dependency will eventually exceed youth dependency. Depending on the projection scenario, the old age dependency ratio increases between 9.1 and 10.3 percentage points between 2012 and 2031. The youth dependency ratio is less certain to 2031, increasing in the high growth scenario and decreasing in the medium and low scenario.

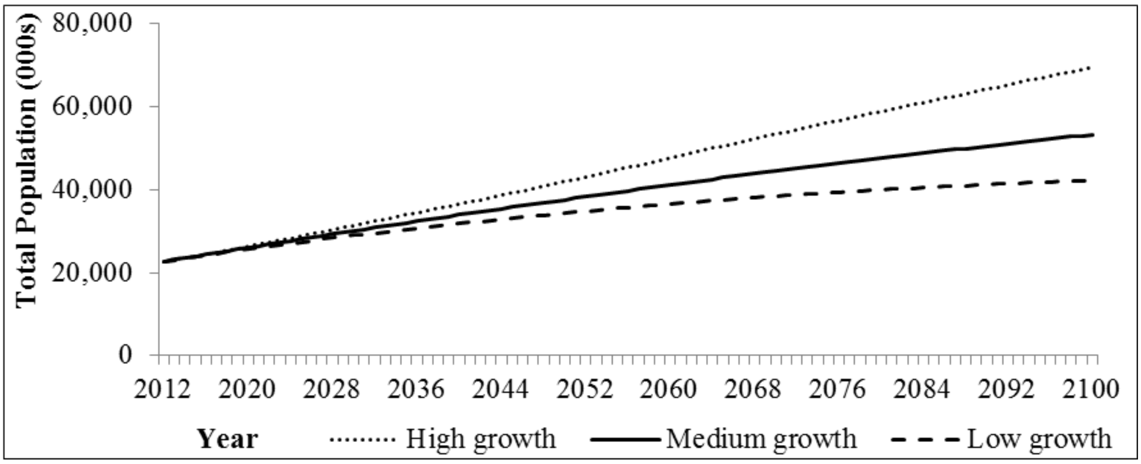


Source: ABS 2013g and ABS 2014c.
Note: See the publication for projection methodology and Section 6.1 for an overview of the projection scenarios.

Figure 15 Actual and projected youth and old age dependency ratios: Australia, 1901 to 2100

2.2.5.1 National projections of the population: 2012 to 2101

Official population projections are produced by the ABS (see Section 6.1). The latest projections launch from 2012 and include three main growth scenarios, referred to in this study as high, medium and low growth.[17] Under the medium scenario, the population is projected to increase to 30.5 million people by 2031 and to 53.2 million by 2100. The upper and lower range, derived from the high and low scenarios, project the Australian population to be between 31.9 million and 29.3 million in 2031 and 69.5 million and 42.3 million people in 2100. Of this total population, between 5.7 million and 5.8 million are expected to be aged 65 and over by 2031 and between 11.5 and 17.9 million by 2100. These population trajectories are shown in Figure 16.



Source: ABS 2013g.
Note: See the publication for projection methodology and Section 6.1 for an overview of the projection scenarios.

Figure 16 Population projection scenarios: Australia, 2012 to 2100

The projections show a continuation of the differential growth rates by age. The projected growth rates by age groups for the high, medium and low scenario are shown in

Table 3. In each scenario, growth is highest in the aged categories. There is little variation in growth in the early-aged years across the high, medium and low scenarios over the next twenty years. This is as expected, given that the key driver of growth over this period will, initially, be the ageing of the baby boomer birth cohort into the aged years. Over the medium term, from 2031, the baby boomer cohort will drive increases in the growth rate of the late-aged population.

[17] The ABS refers to high growth scenario as the Series A, the medium growth scenario as Series B and the low growth scenario as Series C (ABS 2013g)

Table 3 Projected mean annual per cent growth of the population by age: Australia, 2012 to 2100.

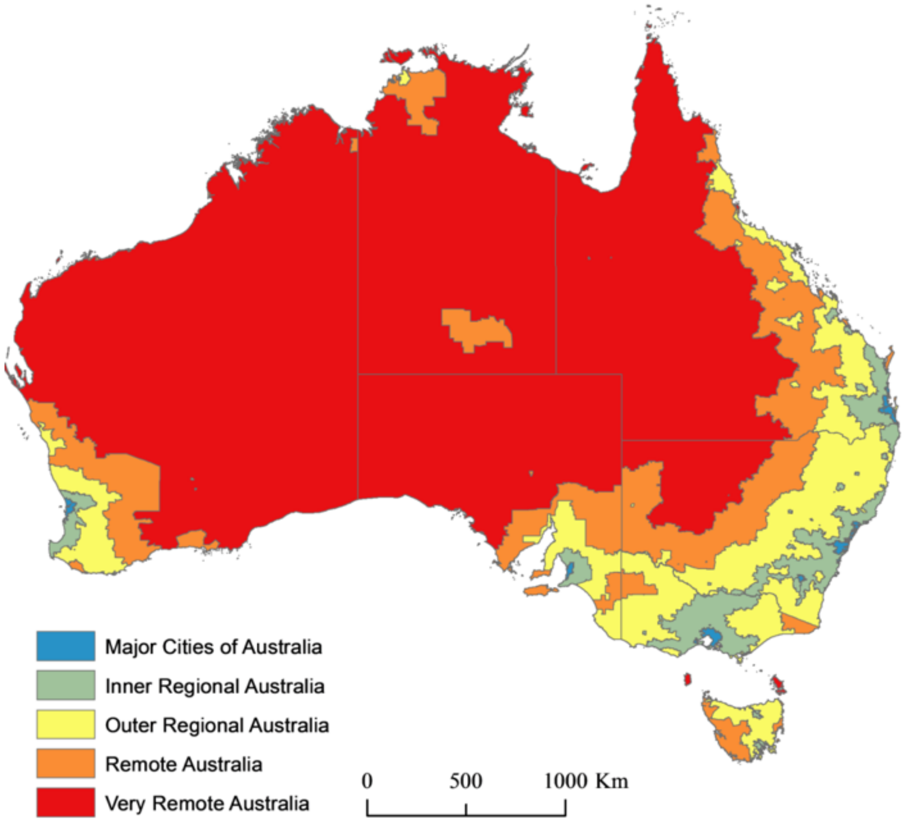
	Projection Scenario					
	High		Medium		Low	
Age Group	2012-2031	2031-2101	2012-2031	2031-2101	2012-2031	2031-2101
0-19	1.8	0.97	1.3	0.6	0.8	0.3
20-64	1.4	1.0	1.2	0.7	1.1	0.4
65-84	3.0	1.3	2.9	1.0	2.9	0.8
85+	3.7	2.7	3.4	1.9	3.4	1.8
Total	1.8	1.1	1.5	0.8	1.3	0.5

Source: ABS 2013g.

2.2.6 The settlement pattern of Australia

Australia's 22.3 million people are settled across the 7.5 million square kilometre land mass. The settlement pattern of Australia is highly variable, with the majority of the population residing in capital cities and the south-east corner of the mainland. As shown in Figure 17, Australia's capital cities are located in coastal regions and the majority of the landmass is classified as remote or very remote where population densities are low.

At the administrative level, the distribution of the population is heavily skewed to the states of New South Wales and Victoria (see Figure 19 for a map of Australia with state and territory and their capital city labelled). The proportion of the population residing in these states has fallen over the period 1961 to 2011. The proportion of the population residing in New South Wales and Victoria has fallen from 65.2 per cent in 1961 to 57.0 per cent in 2011. The proportion of the population living in Queensland and Western Australia has grown over the same period from 14.5 per cent to 20.1 per cent in Queensland and from 7.0 per cent to 10.4 per cent in Western Australia. Small declines in the proportion of the population residing in South Australia and Tasmania have occurred, from 9.2 per cent to 7.4 per cent in South Australia and from 3.3 per cent to 2.3 per cent in Tasmania. In 2011, 1.0 per cent and 1.7 per cent of the population, respectively, resided in the two territories: Northern Territory and the Australian Capital Territory. This is an increase from 0.3 per cent and 0.6 per cent respectively in 1961.



Source: ABS 2013b.

Figure 17 Map of the Accessibility/Remoteness Index of Australia, 2011

The Australian population is highly urbanised, with close to 85 per cent of the population residing in around one hundred significant urban areas in mainland Australia 2011 (ABS 2015d).[18] In Australia, urbanisation has been the result of the settlement pattern of international migration (in excess of 80 per cent of international migrants settle in major capital cities), structural change in the economy favouring job growth in urban areas and consolidation of services in cities and larger regional towns (Hugo 2008; Maher and Stimson 1994).

While population growth is the highest in the capital cities, regional and remote Australia is growing (ABS 2015d).[19] Urbanisation has also occurred within regional and remote locations with more than 5 million Australians living in urban areas outside of capital cities (ABS 2015d). The aggregate figure, however, masks the sizeable variation in growth at the regional and remote level. Argent et al (2011, 29) argue that "...rural Australia is bifurcating;" inland areas are experiencing demographic and economic

[18] In comparison, only 3 per cent of the population Australia reside in the near 68 per cent of the Australian land mass that is the desert (Brown, Taylor and Bell 2008).
[19] However, note that the most recent estimates of regional population growth found a decline in the population size of the very remotes regions between 2013 and 2014.

decline and the high amenity regions are growing. Smaller towns have tended to stagnate or decline (Hugo 2005).

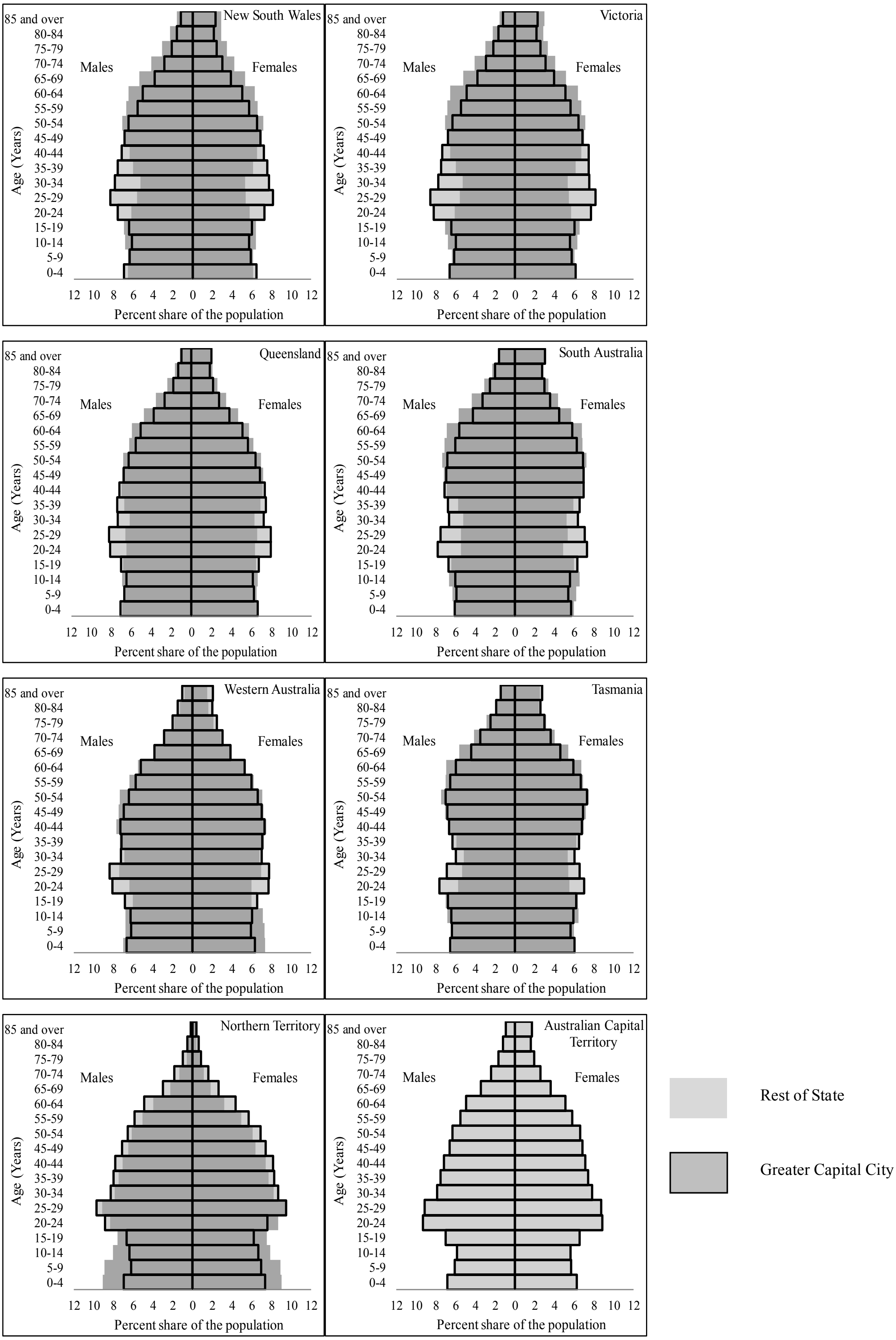
Some population subgroups can have unique settlement patterns. There are unique settlement patterns by country of birth, income and age. Of most significance is the settlement pattern of the Indigenous population. The majority of the Indigenous population reside in urban areas, one-third in capital cities (Taylor 2011). Yet, Indigenous Australians constitute nearly half the very remote population in Australia in nearly 1300 discrete Indigenous communities in remote Australia (Taylor 2011).[20]

2.2.6.1 Differences in the age structure of the population across Australia

The age structure of the Australian population varies between the states and territories and by remoteness. The population pyramids for capital city and rest of state regions are shown Figure 18.[21] The age structure of the capital city regions are typically younger, with a larger proportion of the population aged in their 20s. In contrast, the rest of state regions are typically older, particularly in the early-aged and near-aged years around age 50 to 64. The differences between the rest of state regions and the capital cities are the most pronounced in New South Wales and Victoria. There are, however, some exceptions to the overall pattern. In Western Australia, a youth bulge in the greater Perth region is observed, but there are only minor differences in the age structure at older ages. In the Northern Territory, the capital city population has an older age structure than the rest of the Northern Territory. This is a result of the Indigenous population settlements in the rest of the Northern Territory region where fertility and mortality rates are higher (Northern Territory Department of Treasury of Finance 2014).

[20] See Taylor (2011) for a map of these communities

[21] This also includes the territories.



Source: ABS 2014g.
Note: Great capital city and rest of state geography is not available for the ACT.

Figure 18 Composition of the population by age and sex: Australian capital city regions and rest of state regions, 2011

These differences in the age structure produce differences in the old age dependency ratio between regions.[22] The old age dependency ratios for Australia and the states and territories are shown in Table 4. While the national average is 22.8, it can vary between 7.4 and 31.5 (the Rest of Northern Territory and Rest of New South Wales respectively).

Table 4 Old age dependency ratio: Australian states and territories by greater capital city and rest of state, 2011

Region	NSW	Vic.	Qld.	SA	WA	Tas.	NT	ACT
State average	24.2	22.9	21.5	26.7	19.6	27.5	8.6	16.4
Capital City	20.4	20.7	18.7	25.2	19.9	25.3	9.4	NA
Rest of State	31.5	30.5	24.1	31.9	18.4	29.2	7.4	NA

Source: ABS 2014g.

2.2.6.2 Distribution of the aged population across Australia

In terms of size, as shown in Figure 19, the largest aged population is in the state of New South Wales, which exceeds one million people. Seventy-five per cent of the Australian aged population reside in the states of New South Wales, Victoria and Queensland. As expected, the territories have the smallest populations of aged Australians and just 12,800 people are estimated to be age 65 and over in the Northern Territory.

The distribution of the aged population within the states and territories is similar to the total population. While 66 per cent of the total population resides in capital cities, approximately 60 per cent of the aged population are residing in capital cities. In the majority of states and territories, the majority of the aged population resides in the capital cities. In Western Australia, the highest proportion of the aged resides within the capital city area with nearly 80 per cent of the aged population. The two states with the exceptional settlement pattern are Queensland and Tasmania, where the majority of the aged population reside outside of the capital city areas. In these states, 57.1 per cent and 60.2 per cent of the aged population respectively, reside outside the capital cities.

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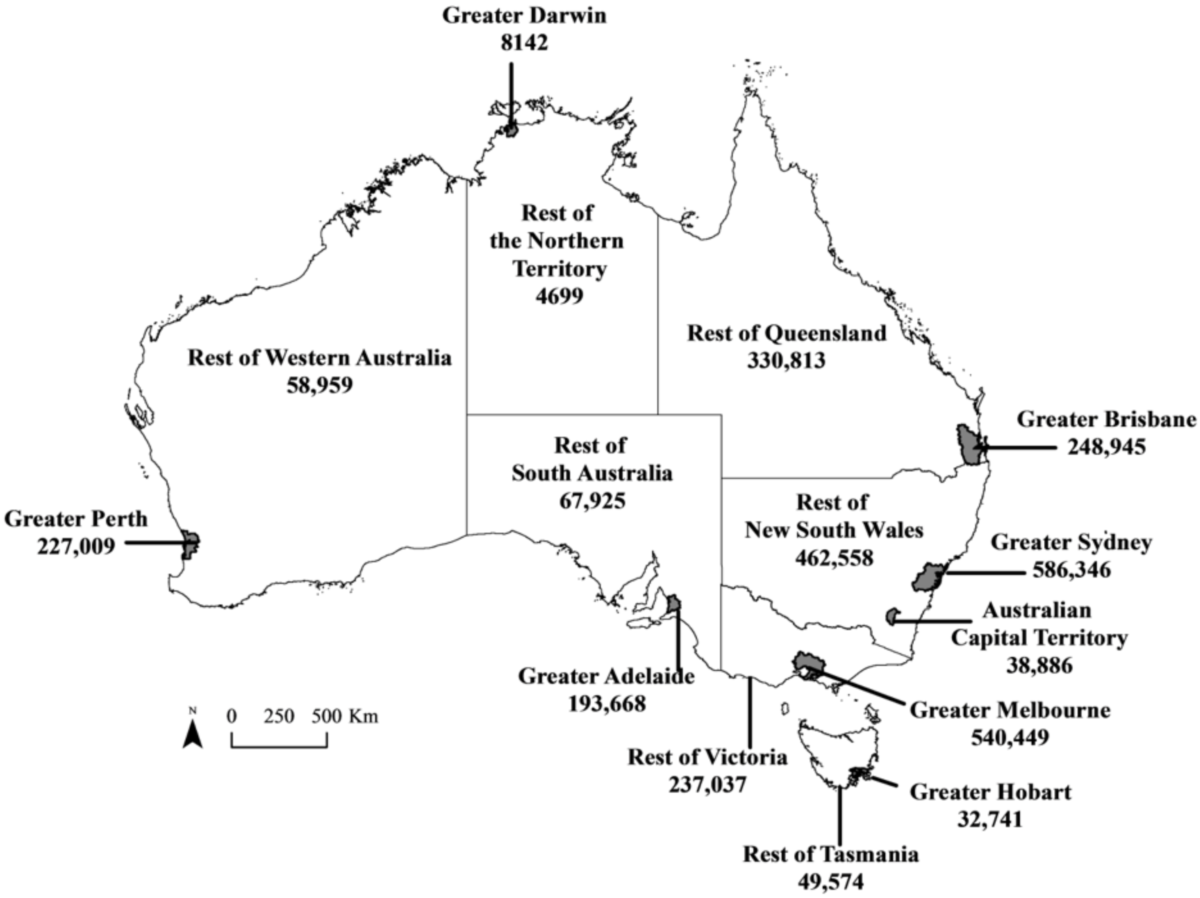
[22] See also Chapter 9.1 for the old age dependency ratios for a further 327 regions examined.



Source: ABS 2014g.
Notes: Due to the small size of the Australian Capital Territory it is not differentiated between the capital city and the rest of state geography.

Figure 19 Population count of the population 65 years and over: Australian states and territories by greater capital city and rest of state, 2011

2.3 CURRENT POLICY CONCERNS RELEVANT TO POPULATION AGEING

Australia has adjusted to ageing well, so far (Choi 1998). Aged-related programs have increased in size and scope since federation in 1901, but it took until the 1980s for the long-term economic consequences of population ageing to emerge as a key policy concern. In this section I discuss how ageing emerged as a policy issue, the current policy response and current policy concerns. I focus on three policy areas: work and training; health and care; and retirement income.

The first Office for an Ageing Australia was established in 1986 (United Nations Economic and Social Commission for Asia and the Pacific 2011). However, it was not until the mid-1990s when the economic consequences of population ageing were fully explored through two government reports examining the long-term economic and social consequences of ageing (see Economic Planning Advisory Council 1996). Subsequently, the Parliament agreed to the *Charter of Budget Honesty Act 1998* (Cth) requiring the Australian Government to produce an intergenerational report every five-years focusing on the implications of demographic change for economic growth and assessing the financial implications of current policy and trends over four decades.

Four of these intergenerational reports, as they are known, have been released and each has focused attention on the long-term implications of population change (Hugo 2003; McDonald 2012). Each report has confirmed population ageing contributes to increasing social expenditure and deficits. The most recent finds: health spending is projected to increase from 4.2 per cent in 2014-15 of Gross Domestic Product to 5.7 per cent by 2054-55; age and service pension expenditure is projected to rise from 2.9 per cent of Gross Domestic Product in 2014-15 to 3.6 per cent in 2054-55; and education and training spending will rise more slowly from 1.7 per cent of Gross Domestic Product in 2014-15 to 2.0 per cent in 2054-55 (Australian Government 2015).

While influential, the intergenerational reports have been criticised on several grounds. Much criticism focuses on the parameters selected for the projections—not just the demographic assumptions, but also the stability of policy settings and economic conditions across the forty-year projection horizon (particularly labour force participation rates (see McDonald 2012). Already, the demographic assumptions have changed significantly. In the first report, the Total Fertility Rate was forecast to fall from 1.75 to 1.6 but in later reports is 1.9. Net migration also changes significantly across the reports, from 90,000 per year to 215,000 per year (Australian Government 2002; Australian Government 2015). Consequently, all things being equal, the impacts of population ageing in successive reports are less than what was previously thought and are projected to occur further in the future.

Direct comparisons of the impact of population ageing are not possible across intergenerational reports. Not only have the demographic assumptions changed, but the underlying economic conditions changed significantly since the first report was published prior to the global financial crisis. Additionally, the reports have become less about understanding and responding to demographic change and more about pursuing political agendas. The third intergenerational report, released in 2010, included a heavy emphasis on responding to climate change. The fourth (and latest) intergenerational report, released in 2015, was released in the context of difficult political negotiations over measures to repair the budget and reads as an argument for the Government's proposals.

As a result, the intergenerational reports have lost some influence in public debate. Instead there are a number of alternative reports which are now more useful in assessing the current policy settings and make recommendations for future reforms. One example is the National Transfer Accounts which have been published for Australia in 2003-04 and 2009-10 (Rice, Temple and McDonald 2014). The accounts provide detailed analysis of age-related patterns of consumption and labour income that are associated with the life cycle of education, work, and retirement. For 2009-10, on average, the population over the age of 57-58 relies on non-income transfers (an increase from age 54-55 in 2003-04). Whether it be based on the finding of the intergenerational reports or the National Transfer Accounts, it is clear that as the aged population grows relative to the working-age population, the demands increase on government and the working-age population to fund transfers to the aged.

Now there are also a number of Government reports examining the impacts of ageing. One of the most recent is the National Commission of Audit which called for greater self-reliance in the aged years and more equitable sharing of the cost of age-related services funded by government (Australian Government 2014c). A summary of other key reports is shown in Table 5. These reports have examined care, labour force participation, discrimination experienced by older people, tax and transfer arrangements, productive ageing and superannuation arrangements.

Reviewing these reports collectively, two key concerns arise relating to population ageing. These are slowing economic growth due to falling labour force participation and increasing costs of transfers to the aged from governments to the aged particularly in the areas of health, care and income support programs. Faced with demographic change, policy makers will need to respond through multiple policy levers to ensure living standards continue to increase. Many adjustments will be needed: adjustments to savings behaviour, labour supply, private and public transfers and human capital investment (Harper 2009). In designing and implementing these adjustments, policy-makers will also need to be sensitive to the issue of intergenerational and intragenerational equity (Harper 2009).

The policy response of successive Australian Governments to a growing aged population and population ageing focus on the principles of ageing-in-place, active ageing and self-reliance underpinned by social protections of universal health care and an income and housing safety-net for those in need. The ageing-in-place strategy was adopted by the Commonwealth Government in 1990s to respond to the desire of older Australians to stay in their homes and to alleviate the growing costs of residential care (Kendig and Lucas 2013). Active (or *productive*) ageing is a policy objective growing in importance. It underpins policies encouraging labour force participation among the aged and recognises the potential of the aged to contribute to society through volunteering, care and philanthropy.

These policy concerns have supported a range of policy initiatives. These include: change in machinery of government arrangements to give the Australian Government responsibility for key aged related programs; the establishment of a sovereign wealth fund as a tax smoothing measure in 2004 to accumulate resources to be invested and used for unfunded Commonwealth superannuation liabilities after 2020 (Future Fund, 2016); passage of legislation to ensure older Australians are protected from discrimination in the *Age Discrimination Act 2004 (Cth)*; and, the appointment of a dedicated Age Discrimination Commissioner in 2011.

Demographic change, however, does not occur in isolation of other economic and social change. Like other developed countries, Australia is still recovering from the global financial crisis. The infrastructure demands of a growing population, industry restructuring, persistently high youth unemployment, pressures to skill the population with more qualifications and to provide the population with the latest medical and pharmaceutical technologies all co-exist with the pressures to respond to demographic change. Changes in migration and fertility may also be triggers of changes to policy settings over the coming decades.

Similarly, the population aged 65 and over is changing over time and how this population changes will moderate the impact of ageing. Some have argued community expectations about the level of support governments must provide are rising (see, for example, Parkinson 2014a). This can make reform difficult, and to achieve success political parties will rule out significant reforms in areas where these reduce transfers to key interest groups (such as families or pensioners).

Clearly, therefore, current policy concerns relating to population ageing are influenced by many factors. In the subsequent subsections I focus in more detail on three policy areas: work and training; health and care; and, retirement income. In reality population ageing will be a catalyst for change across a broader spectrum of policy affecting housing, transport, education, employment, social inclusion and regional policy. However, the three policy areas identified are the key policy areas and among the most important for a successful response to a growing aged population.

Table 5 Recent Reports Commissioned by the Commonwealth Government Relating to the Policy Response to Population Ageing[23,24]

Title	Year	Key recommendation
Caring for Older Australians	2011	The aged system should be person-centred and consumer directed. Remove restrictions on community care and residential bed licences so that supply can meet demands.
Pensions Review Report	2009	Pensioners need more financial security to ensure they keep up with cost of living. Single pensioners who live alone are particularly vulnerable. Incentives to work should be incorporated into pension arrangements to improve workforce participation and the financial security of pensioners.
Access all Ages – Older Workers and Commonwealth Laws	2013	A range of instruments including legislative, codes of practice, guidelines and education and training are needed to remove barriers and promote workforce participation among older Australians.
Super System Review	2010	Superannuation should be for the benefit of members, with a choice architecture model enabling members to select superannuation management options based on their preferred level of choice and individual responsibility. Better governance, transparency and integrity is also needed.
Working past our 60s	2012	Age thresholds that apply to workers compensation, income insurance and to essential professional licences are limiting the access older people have to work.
Australia's Future Tax System	2009	The tax and transfer arrangements should be configured to support productivity, participation and growth. Pensions should be tax free but more taxes should be applied to superannuation and superannuation should be included in the means test for the Age Pension on the same basis as other savings. Greater development of longevity insurance products.
Realising the Economic Potential of Older Australians	2011	Establish an Office of Active Ageing overseen by a Cabinet Minister. Complementary strategies in the areas of housing, participation, volunteering, philanthropy, lifelong learning and age discrimination.
A New System for Better Employment and Social Outcomes	2015	The 20 income support payments should be reduced to five payments: tiered working-age payment; supported living pension; child and youth payment; carer payment; and, age pension.
Superannuation Policy for Post-Retirement	2015	The objectives of the retirement income system are poorly defined and need to be reformed to improve sustainability and efficacy.

[23] For further information see: Australian Government 2012b; Australian Human Rights Commission 2012; Australian Law Reform Commission 2013; Cooper et al 2010; Harmer 2009; Henry et al 2009; McClure, Aird, and Sinclair 2015; Productivity Commission 2011; Productivity Commission 2015.

[24] Note, Parliamentary reports are not summarised here and can be found at www.aph.gov.au, including the *Inquiry into Older People and the Law (2007)* and the *Inquiry into cost of living pressures on older Australians (2008).*

2.3.1 Work and training

The key policy concerns relating to work and training are how long people work and the potential to accumulate wealth through the working-age years. As jobs growth favours higher skilled jobs, access to training is a key component of labour force attachment (Australian Government Department of Employment 2015). The labour force participation rates in the 2011 Census are shown above in Figure 5. The Australian Government is expecting improvements, with participation among the aged population forecast to increase from to 12.9 per cent in 2014-15 to 17.3 per cent in 2054-55 (Australian Government 2015). Through increased labour force participation, the fiscal pressures resulting from a growing aged population could reduce significantly (Chomik and Pigott 2012; Kendig and Lucas 2013). Additionally, higher levels of wealth accumulation during the working-age years will increase potential for self-reliance during the aged years.

The Australian Government has addressed this policy challenge from several directions: providing employment services to match job seekers with employment opportunities, providing incentive payments to employers employing and retaining job seekers aged 50 years and over and protecting aged workers from discrimination. Changes have also been made to retirement income arrangements to make it possible for aged Australians to accumulate retirement income regardless of age (Australian Government 2013). There are also substantial investments in training by offering free or subsidised vocational and/or tertiary education to ensure access to at least a minimum qualification. In addition, within the education and training systems, there are dedicated programs to support near-aged and aged workers.

There are some problems. Sex inequality is a key issue, due to caring responsibilities falling to females affecting labour force attachment during the working-age years. Females also exit the labour force when their (typically) older partner exits which further reduces their capacity to generate adequate retirement income (Australian Human Rights Commission 2016). Additionally, long-term unemployment is highest among people age 55 to 64 (ABS 2015b). Training is highly concentrated among youth, and the aged have lower skills on average (ABS 2011d), adding to the vulnerability of the aged in a labour market increasingly seeking higher skills.

2.3.2 Health and care[25]

There is no one policy concern in health and care. A leading concern, however, is escalating costs in health, particularly in the context of falls in projected government revenue (Australian Government 2015). However, against this backdrop, successive governments are committed to ensuring Australians gain increased years of life and healthy-life years (Prime Minister's Science, Engineering and Innovation Council 2003). In the internet-age, citizens demand the best of medical and pharmaceutical treatments available. Concerns also focus on care, particularly the availability and quality of care. While the Australian Government wants to meet demand for care places in the location where people need them (in the home or residential services), it can struggle to provide services in remote locations and distribute culturally appropriate services to ethnically-diverse communities (Baldwin 2013).

The public perceive the aged to be frail even though this is not statistically true. The majority of older Australians live independently (Kendig and Lucas 2013) and the average age of entering residential aged care is increasing (AIHW 2014c). A home care program is available to provide support within the home and most aged have social support through a spouse.[26] While the life time risk of permanent residential care is one in two for females at age 65 and one in three for males at age 65 (Centre of Excellence in Population Ageing Research 2014).

The care sector has already been subject to significant reforms. The aged care sector expanded rapidly from the early days of Australian Government involvement funding benevolent societies to providing both capital funding and funding care of nursing homes since mid-20th Century (Centre of Excellence in Population Ageing Research 2014). The rapid expansion in demand for aged care in the 1980s resulted in a policy shift to encourage services in the home. This has been a successful policy intervention—in 2010-11 there were approximately 160,000 permanent residents in aged care facilities compared to 750,000 home and community clients (Centre of Excellence in Population Ageing Research 2014). However, between 2002 and 2011 growth in residential aged care clients was higher than population growth (AIHW 2014c). Additionally, the supply

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[25] Note: policy and program settings for Indigenous Australians are different compared with the non-Indigenous population and are not specifically addressed here. Due to higher morbidity and mortality, Indigenous Australians access aged care programs at age 50 years (see Cotter et al 2011 for some discussion about this policy setting).

[26] See details at: https://www.dss.gov.au/our-responsibilities/ageing-and-aged-care/programs-services/home-care-packages (access date 8 March 2016).

of services remains capped and there is concern about moving to demand-driven programs because demand could exceed the government's capacity to pay (Centre of Excellence in Population Ageing Research 2014).

Despite the reform efforts, policy challenges affecting health and care programs remain. There are also calls to revisit the planning ratio currently set at 125 aged care places per 1,000 people aged 70 and over (Australian Government 2015) because this target population is an imprecise indicator of need for aged care programs (residential or home care) (Productivity Commission 2011). In the health area more generally, work is underway looking at efficiency and productivity access to new technologies. There is also discussion about how the primary care sector can better support the aged to reduce hospitalisations and manage chronic disease. Health care costs, per capita, are continuing to rise significantly at older ages (Rice, Temple and McDonald 2014) and as income falls (with age) so do rates of private health insurance. Furthermore, one of the most significant social policy reforms underway in Australia is the National Disability Insurance Scheme and currently, due to concerns about costs, aged Australians are excluded from the scheme if they acquire a disability in their aged years.

2.3.3 Retirement income

The sustainability and effectiveness of the Australian retirement income arrangements is among the most topical of policy concerns relevant to a growing aged population. By international standards, Australia's retirement income settings are good—with the system built on compulsory savings and private savings supplemented by a publicly funded means tested income safety-net. The Age Pension safety-net was introduced in 1909 and grew from humble beginnings as a small supplementary payment to around 70 per cent of the aged receiving the payment (Australian Government 2015; Herscovitch and Stanton 2008; Kendig and Lucas 2013). Reforms are underway to increase the age of access to the Age Pension to age 67 from age 65 over the period 2017 and 2023 (Australian Government Department of Social Services 2014a). The current Government has sought, so far unsuccessfully, to increase the Age Pension to age 70.

The Superannuation Guarantee was introduced in 1992 to ensure greater self-provision for retirement income and increase national savings. Prior to 1992 superannuation schemes were mostly limited to public sector employees and managers in the private sector. The Superannuation Guarantee would direct 9 per cent of income (from 2002-03 year) rising to 12 per cent of income by 2025 towards compulsory superannuation accounts accessible upon permanent withdrawal from the labour force after the age of 65

(Asia and Stanford 2003).[27] While the superannuation system in Australia is large ($1.84 trillion at June 2014), the median balance for a person aged 60 and over who is not receiving a pension from their superannuation is $95,000 (Australian Government 2015).

The financial assets of Australia's aged incorporate more than pension and superannuation wealth. In fact, most of the wealth of Australia's aged is in their home (Bradbury 2010). It is this housing wealth that is often referred to in countering arguments that poverty among older Australians is higher than the OECD standard (Wood et al 2010). There is, undoubtedly, poverty and financial hardship among the aged. Approximatively 30 per cent rely solely on the age pension (Australian Government 2014c). There is also wealthy aged: the wealthiest quarter of the baby boomer cohort has 60 per cent of the total net worth of the baby boomer cohort; the poorest quarter has 4 per cent of the group's total net worth (Australian Mutual Provident Society and National Centre for Social and Economic Modelling 2007).

However, there remain several concerns relating to the retirement income system. There is growing criticism of the superannuation scheme: projections of utilisation of the age pension are not showing reductions (Australian Government 2014c)[28]; there are perverse outcomes in the incentive schemes allowing wealthy individuals to accumulate wealth (Maher, Wood and Coates 2015); high management fees (McGing 2011); and, by applying a tax on employment (Australian Government 2015; Guest 2008).

More fundamentally, there are issues about the design of Australia's retirement incomes system and its sustainability (for individuals and governments) when the life span increases in the context of population growth. However, it is also clear that continuous change makes it hard for individuals to plan ahead for retirement. Significantly, there is no consensus between the major political parties on the reforms to pursue. Also unresolved is the role the Age Pension arrangements have in the accumulation of housing assets and decumulation of retirement incomes. I expect these are issues the Australian Government will tackle in the near future.

2.4 CONCLUSION

In this Chapter I provided the contextual background to the study. I outlined the key features of current Australian society and demography and current policy concerns

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[27] Or earlier in the case of hardship.

[28] Note, however, that the proportion of the aged population receiving a full pension is forecast to decline.

relevant to a growing aged population and population ageing. I focused on three policy areas: work and training; health and care; and, retirement income. I argued the public policy response to the demographic change is incomplete and current policy concerns continue to focus on the ability to provide (and fund) services to a growing aged population and to maintain improvements in economic growth, productivity and living standards despite an increase in the dependent population. There are particular concerns about ensuring adequate supply of services to an aged population unevenly distributed across the country and the adequacy of retirement incomes. Policy settings are being adjusted to encourage and support longer attachments to the labour market. While there is concern about the age of access to the Age Pension and by how much it should increase, there is little evidence of a broader discussion about the threshold in the aged.

The Australian Government is relatively well placed to respond to the challenge of ageing, having both significant policy responsibilities in this area and financial resources to respond. It also has experience to draw from. Ageing is not a new phenomenon; on average, since 1901, growth of the aged population has exceeded growth in the pre-aged population. That being said, growth in the aged population is still expected to be significant over the next twenty years—with the age 65 and over population expected to increase from 3.1 million in 2011 to be between 5.7 million and 5.8 million by 2031 (ABS 2013g).

The existing analysis shows the Australian aged population to be a diverse group and unevenly distributed around the country. To respond to current policy concerns, an analysis will need to be clear on the size of the aged population where the aged-related services are delivered. Policy makers will also need to understand the structure of the aged population as service needs vary within the aged group. They will also need to understand the individual, social and economic characteristics of the aged to identify where there is advantage or disadvantage as these factors may also influence the services provided.

Responding to a growing aged cohort is not just about service provision. The analysis should equip policy makers to step back and evaluate the response to population ageing. In a fiscally constrained world with competing priorities, policy settings will need to be both efficient and effective. There should be careful examination of the threshold of the aged to assist in evaluating retirement income settings. The age of eligibility is just one factor; the length and depth of working lives is a key factor in the accumulation or retirement incomes and the length of life within the aged years is a key factor in designing strategies for the decumulation of retirement assets. Finally, policy makers need to be equipped to understand variation in the aged population. Population averages are important insights, but so too are perspectives on variation. Understanding diversity and inequality is critical to understanding the true lived experience of the aged population and ensuring policy settings are equitable. A demographic analysis cannot contribute all that needs to be known to design and implement a response to population ageing, but as will be seen over the following chapters, demographic analysis can make a substantial contribution.

Lastly, policy makers need to accept they do not have all the levers to enact change available to them. Government can change access to the Age Pension, for example, but individuals with access to personal savings may still choose to exit the labour market. Policy settings are important signals and over time can shift cultural, economic and social conditions. This said, effective responses to ageing will ultimately involve individual decisions made over decades—to study, to work, to be healthy, to be connected and engaged in their communities.

Chapter 3

Key research directions and Australian studies of the aged and ageing process

Very long lives are not the distant privilege of remote future generation—very long lives are the probable destiny of most people alive now in developed countries.

(Christensen et al 2009, 1196)

One of the reasons policy-makers are still grappling with population ageing is that it is a dynamic process. Demographic conditions are changing and new analytical dimensions are being developed to better understand the aged and ageing processes. In this Chapter I identify key research directions in the field of applied demographic study of the aged and ageing processes. In the first section of the Chapter I outline four research themes: defining the threshold of the aged population; the dynamics of a growing aged population and population ageing; new analytical dimensions to examine the aged; and, situating the aged within the life course. In the second section I consider Australian studies and argue that the analysis of the Australian aged population is often outdated and narrowly applied to a population subgroup or location.

3.1 KEY RESEARCH THEMES

This literature review focuses on the demographic research relating to population ageing. The same issue has also been explored from biological, psychological, sociological and cultural perspectives, but such a broad literature is not addressed here. Even the demographic research is too extensive to be covered completely and I narrow this discussion to four key themes: research defining the threshold of the aged population; research examining the dynamics of a growing aged population and population ageing; research using new analytical dimensions to understand the aged; and, research situating the aged population within the life course. These four research areas assist in developing the expanded demographic analysis of population ageing in Australia.

3.1.1 Defining the age threshold of the aged population

Since ageing emerged on the demographic agenda in the mid-20th Century, it is conventional to use retrospective chronological age, measured as years lived since birth, to define the threshold of the aged population.[29] The threshold demarcating the commencement of the aged years is usually a social construct, rather than linked to a biological maker of some kind (Bowling et al 2005). Two ages are dominate in the literature—age 60 and age 65 (Sanderson and Scherbov 2010; United Nations Population Division 2001). Age 65 is more typical in developed countries such as Australia.[30] There are good reasons for common thresholds to be used: policy makers value consistency and use these ages in aged-based policy settings (such as the eligibility age for the Age Pension); and, for researchers, there is a strong incentive to use a threshold which supports comparisons across studies.

As population dynamics have changed, dissatisfaction has arisen with the common thresholds of the aged years being 60 and 65 and in using retrospective age to define the aged (Sanderson and Scherbov 2010; Settersten and Mayer 1997). Robert Butler, the founder of the International Longevity Centre, coined the now famous term "the façade of chronological age" in his 1968 publication arguing that "social, personality, and health variables would therefore appear to be of considerable importance towards explaining the manifestations of aging" (Butler 1963, 721). Subsequent research confirmed age to be a poor indicator of biological, social and psychological age (Neugarten and Hagestad 1976). It is also becoming clear, as will be discussed below, that social and economic characteristics moderate the relationship between chronological age and key markers of ageing such as retirement, disability, senescence and death.

Given mortality rates increase with age, a threshold for the aged population of 60 or 65 means the early-aged will be dominate analysis of the aged population. If the characteristics of the early-aged group differ from the late-aged years, studies of the aged will be skewed towards the early-aged years. Chu (1997) argues important information about the demographic conditions occurring in the right tail of the population age distribution can be hidden. There are several options to resolve this tension, including to

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[29] However, this is not universally true; there are some cultures where life stages are more important than chronological age (see Howell 1986).
[30] In Australia, for example, the Age Pension was introduced in 1909 using a threshold age of 65 for males and 60 for women (Herscovitch and Stanton 2008).

redefine the threshold of the aged or to distinguish populations within the aged group. Both these options are considered in this study.

Ryder (1975) challenged the idea that the aged should be defined retrospectively and measured in chronological years since birth. In doing so he laid the foundation for prospective age analysis. Ryder (1975, 16) observed:

> To the extent that our concern with age is what it signifies about the degree of deterioration and dependence, it would seem sensible to consider the measurement of age not in terms of years elapsed since birth but rather in terms of the number of years remaining until death.

Prospective age definitions focus on the end of life rather than beginning of life to define the aged. As time to death is not known at the individual level, prospective age measures focus on the average remaining life expectancy of the population (Lutz 2009).

To date, prospective age analysis has not challenged the dominance of retrospective chronological age measures used to define the aged. However, the application of prospective age analysis can be revealing of population dynamics.[31] Additionally, as will be discussed in Section 3.1.4 below, there is a growing body of research focusing on the population in the right-hand tail of the age distribution.

Another approach to defining the aged in the literature is to situate the aged within the total population age distribution. These analyses are endogenous to the population, relying on the selection of age groupings that are optimal according to pre-defined criteria (such as a constant aged proportion). Using the optimal grouping technique developed by Aghevli and Mehran (1981), D'Albis and Collard (2013) identify cut-off ages for the older populations and then adjust the cut-off based on the total population age distribution at any time. The advantage of these approaches is that they recognise whole population age structures is important; the disadvantage is defining the aged relative to the total population can disconnect the age from both senescence and life course makers of ageing (such as average retirement age). For this reason, using these methods to define the aged are poor choices for policy makers.

Unlike retrospective chronological age, a definition of the threshold of the aged years based on prospective age or total population age distribution will be a dynamic definition. If the age structure of the population changes, so could the threshold of the aged. Policy makers are increasingly interested in dynamic approaches to define the aged years (OECD 2009). In the context of increasing longevity, policy makers see these methods as

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[31] For example, using prospective age measures, Seshamani and Gray (2004) showed increased longevity is reducing age-specific costs can mean that postponement in the costs of health care.

important tools in designing fiscally sustainable programs where program parameters (such as eligibility) change when relevant population characteristics change. Programs using a retrospective definition can still adjust dynamically if linked to dynamic criteria such as life expectancy.

Sanderson and Scherbov are at the forefront of research into different methods to define the aged using dynamic models and prospective age analysis. In 2013, they published a characteristics-based approach to form “a new paradigm in conceptualizing population ageing” (Sanderson and Scherbov 2013, 675). Theirs is a more comprehensive approach to studying ageing. They argue:

> Many important characteristics of people vary by age, but age-specific characteristics also vary over time and differ from place to place. Focusing on a single aspect of the changes entailed in population aging but not on all the others provides a limited picture of the process, one that is often not appropriate for either scientific study of policy analysis (Sanderson and Scherbov 2013, 73).

Sanderson and Scherbov (2013) are particularly interested in three groups of age-specific characteristics—elder proportions, elder ratios and elder relationships—and they developed an approach to track change in these characteristics over time. This is particularly useful tool for policy makers interested in dynamic models of the threshold of the aged and I use their method in this study (see Section 10.1).

An expanding area of research is subjective age perspectives where the aged threshold is defined by asking individuals or groups their opinion on the threshold of old age. For example, in a study by Ayalon et al (2014) researchers found that the average beginning of the aged years was age 62. Interestingly, in contrast to the ending of youth, which Ayalon et al (2014, 15) found to be “highly individualized phenomenon that is dependent on individual circumstances rather than on cultural or societal influences”, the beginning of old age was more uniformly aligned with contextual factors such as the official retirement age. Individual differences (as compared with country differences) explained more than 90 per cent of the variance in defining the beginning of old age. Being a woman, higher levels of education, better subjective health, higher life satisfaction and residence with a spouse and national life expectancy were all associated with a higher threshold of the aged years (Ayalon at al 2014). While these are valuable insights, subjective age perspectives are not sufficiently robust to be used in defining the aged in public policy. However, it does reveal an insight—that community views on the threshold of the aged years can be the result of cultural factors and disconnected from longevity, frailty and/or service needs.

This short discussion of recent literature relevant to defining the *aged* reveals several insights. The dominate threshold of the *aged* is the retrospectively defined chronological age, typically set at age 65 in Australia. However, other perspectives should complement the retrospective chronological age approach. Specifically, these are analyses which can be adjusted dynamically and reveal additional detail about the population processes of the right tail of the age distribution. Lastly, alignment with contextual factors, such as the age of eligibility for the Age Pension is important to produce analysis credible with population perceptions of the aged years.

3.1.2 The dynamics of a growing aged population and population ageing

Conventional demographic research is concerned with the size and age structure of the population and the population process of fertility, mortality and migration. These conventional perspectives reveal numeric and structural ageing. Demographic insights can be gained from simulation studies using stable population models and actual population studies. Both types of analysis produce important lessons and contribute to the design of demographic analysis to better understand the aged and ageing processes in Australia.

Previous research has investigated how each population process contributes to the growth of the aged population and population ageing. In theory, because individual ageing is inevitable, the natural momentum of a population is to age (Preston, Himmes and Eggers 1989). In reality, populations are complex and their age structure is affected by the size of successive birth cohorts, the level and age structure of immigration and emigration and survivorship of the birth and migrant cohorts as they age (Preston and Stokes 2012).

Previous research has established populations age when the population growth rate correlates positively with age (Preston, Himmes and Eggers 1989). Additionally, the level of growth is not important, but changes in the level of a demographic rate are (Preston and Stokes 2012). Preston and Stokes (2012, 223) give the growth rate for persons age *x* between time *t* and *t+1* as:

$$r(x,t,t+1) = ln\frac{B(t-x+1)}{B(t-x)} + ln\frac{p(x,t-x+1)}{p(x,t-x)} + ln\frac{j(x,t-x+1)}{j(x,t-x)}$$

"Where $B(t-x)$ is the number of births in the year ending *t-x*, $p(x,t-x)$ is the proportion of the birth cohort surviving to time *t* and $j(x,t-x)$ is the factor by which a birth cohort born in year ending at *t-x* changed in size by time *t* as a result of migration."

Taking a long-term view, demographers such as Nathan Keyfitz and Ansley Coale, identified that the demographic transition would be the genesis of population ageing (Coale 1956; Keyfitz 1968; Lorimer 1951; Stolnitz 1956).[32] The demographic transition was a theory first published by Notestein (1945) to explain the pattern of a world-wide phenomenon of falling morality and fertility.[33] Keyfitz (1968) and Coale (1956) showed the demographic transition would fundamentally and permanently change the age structure of a population—causing a relative fall in the size of the young populations and growth in the aged populations. Furthermore, these researchers established declining fertility as the primary cause of population ageing.

More recent research, however, has focused on why population ageing continues. Several prominent demographers in the 1980s and 1990s argue that the current period of population ageing is primarily caused by declining mortality (Horiuchi 1991; Horiuchi and Preston 1988; Preston, Himes and Eggers 1989; Preston and Stokes 2012). The effect of mortality change on the population age structure is more complex than the effect of fertility (which simply offsets the momentum to age). As Preston, Himes and Eggers (1989, 692) observe "mortality declines concentrated at young ages eventually produce a younger population, and those heavily concentrated at older ages will produce an older population". Mortality change can also interact with other population processes; for example, mortality reductions improving survivorship through the reproductive years can result in more births and thus a younger age structure.

Researchers have also examined the effect of international migration on population ageing. This research is not only motivated by trying to understand the dynamics of population ageing, but also the utility of using international migration to slow or offset population ageing. The results have been conclusive; in Coleman's words: "immigration…can only prevent population ageing at unprecedented, unsustainable and increasing levels of inflow, which would generate rapid population growth and eventually displace the original population from its majority position" (Coleman 2002, 583).

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[32] The primary method used in these studies was to create a stable population. These stable populations are synthetic or hypothetical populations, created by projecting a population with constant rates of fertility and mortality until the age structure becomes constant. Once a population is stable, the effects of a change in a rate can be studied to assess its impact on the age structure. Examples are Hermalin (1966), Preston (1974) and Keyfitz (1975).

[33] While Frank Notestein's publication in 1945 is considered the genesis of this theory, Kirk (1996) discusses in more detail how this theory emerged.

Among the most influential work undertaken in this area is the United Nations' modelling of the level of replacement migration needed to keep the size of the population from falling, the size of the working-age population constant and the size and the potential support ratio constant (Coleman 2002).[34] For example, for the European Union to maintain a constant population over the period 2000 to 2050 it would need 949,000 migrants annually; 1,588,000 per year to maintain the population in the working-age group and 13,480,000 per year to maintain the potential support ratio. A similar study, undertaken by Bermingham (2001) found for the United States to maintain its population to 2050 it would need 116,000 immigrants per year, rising to 319,000 per year to maintain the working-age population and 10.8 million per year to maintain the ratio of the elderly to the working-age. Similar studies have been undertaken for Australia and are discussed in Section 3.2.

The age of international migrants and their demographic rates are also of interest to researchers isolating the impact of international migrants on population age structures. Like mortality, the effect of international migration depends on the age of immigrants. Usually migrants are younger than the median age, and will initially contribute to a younger population (although only if ageing is measured in relative terms) (Goldstein 2009). International migrants age, however, and over the long-term contribute to population ageing (McDonald and Kippen 2004).

Researchers have also been interested in identifying if international migration may have secondary effects on the population age structure, and a particular interest has been on fertility rates of international migrants. One hypothesis is international migrants will have higher fertility, commensurate with the sending rather than receiving countries. Most studies, however, find a convergence between the fertility rates of international migrants and the receiving population (Chiswick and Miller 2015). Additionally, with fertility rates falling around the world it will be increasingly difficult to source immigrants from regions with high fertility.

Based on the current demographic conditions, there is consensus in the literature about the inevitability of population ageing (United Nations Population Division 2010). Even if demographic conditions were to change, the level of change required to reverse

[34] The potential support ratio is the number of persons aged 15 (or 20) to 64 per every person aged 65 or older (United Nations Population Division 2001).

population ageing is substantial. Bermingham (2001) examined the fertility change that would be needed and showed, using France as an example, that an abrupt increase to a higher fertility to 2.36 children per woman (from 1.71 children) would not offset the expected falls in the number of working-age population relative to growth in the aged population. Additionally, there are no signals of an increase of this magnitude being on the horizon or effective pronatalist public policy levers to stimulate an increase in fertility to this level (Coleman 2002; McDonald 2007). Additionally, with the reduction in mortality generally considered to be a significant achievement (as it should be) there is no support within mainstream policy or research for increasing mortality to circumvent population ageing.

While the dynamics of population ageing are largely settled, there is still uncertainty about the exact size of the aged population and the geographic distribution at the subnational level. Growth in the size of the aged population—numeric ageing—is dependent on the size of the cohorts who survive to become aged and survival time as an aged person. History has shown that demographers have tended to underestimate mortality improvements for industrialized countries leading to underestimation of the size of the aged population (Booth and Tickle 2008).

There are several unresolved issues relating to mortality improvement. Fundamental among these issues is whether there is a limit to life expectancy. Supporters of the view that there are no limits to life expectancy highlight multiple factors including no deceleration in reducing mortality (Christensen et al 2009; Vaupel 2009). Oeppen and Vaupel (2002), for example, point out that life expectancy gains have been stable at three months per year for 160 years. This suggests that in the future sociological factors are likely to increase as influential determinants of the length of life.

Researchers have also identified significant variations in mortality rates based on social and economic determinants (van Raalte and Caswell 2013). In theory, this could have significant effects on mortality rates at older ages, including cohort effects as the characteristics of the aged change over time. Engelman, Canudas-Romo and Agree (2010, 512) studied 23 national populations and showed there are growing inequalities in later life, specifically arguing “although overall mortality decreased as life expectancy rose, survivors to older ages have become increasingly heterogeneous in their mortality risk…[which] may be a by-product of successfully delaying death”. However, this is an unsettled area of research with debates continuing among researchers about whether social and economic determinants of mortality persist at older ages (Hoffman 2005; Jatrana and Blakely 2013; Murphy, Grundy and Kalogirou 2007).

Clearly fertility and migration are also sources of uncertainty. Given many decades must pass before a birth cohort enters the aged years, the relationship between fertility and the size of the aged cohort is not often a pressing concern. Similarly, migration is highlighted as a source of uncertainty but not studied as intensely as mortality. Additionally, national migration programs are typically designed to respond to short-term labour market conditions and any implications for the growth of the aged cohort or population ageing are left for subsequent generations of policy-makers.

Variation in the geographic distribution of the aged population at the subnational level can be significant. Maher and Stimson (1994, 37) observed "national population growth rates and local change are only indirectly related". In theory, regional differences can be produced by variation in rates of fertility, mortality, international migration and internal migration. In practice, ageing-in-place and internal migration are the most significant factors (Rogers and Raymer 1999; Rogers and Raymer 2001).

Of particular relevance for this study is the Litwak and Longino (1987) theoretical framework for examining residential mobility among the elderly. They propose there are three types of moves within the aged years: moves into high amenity retirement locations; moves to maximise informal supports from kin; and moves into residential care facilities. This framework is a useful reminder that the life course in the aged years can be influential on the size of aged cohorts and should be considered in forecasting the aged population at the subnational level.

Additionally, moves within the aged years can shape the characteristics of aged populations. Rogers and Raymer (2001), drawing on the work of Rogers (1992), Biggar (1980) and Rogers and Woodward (1988) argue:

> Because much of the elderly migration is selective of individuals and is undertaken near the age of retirement, the relatively young elderly migrants are, on average, more likely to be married, better educated, wealthier and healthier than the nonmigrant elderly population that they join. Consequently, regional elderly population that grow mostly from net aging-in-place...are more likely to need more health services and exert a larger per capita demand on government funds than regions that grow mostly from net migration.

As far as I am aware, this is untested in the Australian context. However, research such as this highlights the complexities of studying population dynamics affecting the aged and the importance in looking beyond simple analysis of the size and age structure of the aged population.

Lastly, the theoretical explanations of current population dynamics is still subject to debate. One influential theory is the "second demographic transition" proposed by Lesthaeghe and van de Kaa in 1986 (Lesthaeghe and van de Kaa 1986). They argue that the demographic transition, reframed as the "first demographic transition", does not result in a stationary population with mortality and fertility in balance, but by below-replacement fertility. Their theory points to social revolutions leading to increased focused on higher order needs, particularly individual autonomy leading to individualistic and nonconformist orientations and falls in fertility (Lesthaeghe 2014). The explanatory and predictive power of this theory will be tested over time. It does highlight, however, the complex forces influencing demographic conditions and the potentially intractable nature of population ageing.

In summary, the research into the dynamics of a growing aged population and population ageing has not yet resolved all issues relating to population ageing. Previous research has established that once there is momentum towards population ageing it is unlikely that a population will shift from this trajectory. The dynamics of mortality at older ages, the geographic distribution of the aged and the characteristics of the aged are, however, less certain and need ongoing monitoring. Lastly, there are likely to be complex relationships between demographic processes and population characteristics but the relationships are not yet fully understood.

3.1.3 New analytical dimensions to understand the aged

In the previous sections I outlined research on defining the threshold of the aged and the dynamics of a growing aged population. In this section I focus on new lines of inquiry emerging in the literature to examine the growing aged cohort and population ageing. I discuss how researchers are increasingly differentiating subgroups within the aged population and examining the characteristics of the aged.

Increasingly, research of the aged populations disaggregates within the aged population. The growing size of the aged cohort has provided more opportunities to segment the aged population by early-aged years and late-aged years. The early-aged studies, which typically focus on life in the sixties and/or seventies, focus on economic contributions; formally through the labour force participation and informally through areas such as volunteering and caring for family members (Pavlova and Silbereisen 2016; Walker 2015). The late-aged studies typically focus on frailty and care needs of population, particularly from the age of 85 (for example, Christensen et al 2008; Collerton et al 2007).

There is also a lot of interest in the differences between males and females in both their ageing processes and experience being aged. Variation in the length of life is one of the most significant issues examined with females living longer than males on average (Seifarth, McGowan and Milne 2012). Sex differences extend beyond life expectancy. Vaupel (2009) identified that sex differences are more accurately described as a health survival paradox where females enjoy a survival advantage but also a higher burden of disability relative to males. These differences can have significant implications for how a population subgroups experience ageing and the unique challenges they may face. Research has established that females are more likely to have inadequate retirement income and are more likely than males to access aged related services (aged are and income support) (Australian Institute of Health and Welfare (AIHW) 2007a; Productivity Commission 2015).

In addition to sex differences, there is also interest in other social and economic characteristics of the aged and how these characteristics moderate well-being in the aged years and the need for services (Kingston et al 2015; Grundy and Jitlal 2007). There is no limit to the variables of interest, although much of the focus is on education, income, employment, marital status, children and housing, ethnicity and disability. Education, income, home ownership and employment, particularly in professional occupations, are associated with higher well-being in older ages (Jorm et al 1998). Education attainment and homeownership are factors commonly associated with maintenance of functioning, labour force participation, independence and activity (Cosco et al 2014; Jorm et al 1998; Stenberg and Westerlund 2013). Marriage and children can also improve well-being, particularly through access to informal care supports (Vlachantoni 2013).

Ethnicity is an important but a complicated characteristic to assess. Willis, Price and Glaser (2013) challenged the notion that ethnic minority groups provide higher levels of support to the aged within their families. Some studies have examined the service needs of migrant versus non-migrant populations. Because immigrants are positively selected, one theory is that their need for support will be lower relative to the native population. Clearly the relationship is complex and Glasgow (1995) concludes that migrants may have less need for services but a higher propensity to use services. Regardless, it appears that differences between migrant and non-migrant population diminish with age (Glasgow 1995).

Another characteristic of interest is the onset and prevalence of disability and whether additional years of life are lived disability-free. Assuming that human well-being improves if longevity is accompanied by additional years of healthy life, an expansion of life spent with disability could be indicative of declining well-being. From a practical perspective, a healthier aged population could contribute more to their own support and require less service. The reality has been more complicated with the empirical evidence finding considerable differences between countries and different time periods (Christensen et al 2009; Jagger et al 2008).

Underpinning empirical investigations of disability and ageing are three key theories about changing disability rates. There are the pessimists, such as Kramer (1980), who argue morbidity is increasing because the old and frail are being kept alive; the optimists, such as Fries (1980) and Fries and Bonnie and Chakravarty (2011), who argue the onset of disability and progress of chronic illness is being delayed; and those advocating for a dynamic equilibrium, such as Manton, Corder and Stallard (1997), where there is more disability but it is less severe.

One reason the empirical evidence regarding disability trends is unclear may be that these competing forces coexist (AIHW 2014a; Christensen et al 2009; Howse 2006; Jagger et al 2008; Robine and Michel 2004). The increased survivorship of sick people and the growth in the very old frail populations (i.e. those who survive one illness in order to be struck down with senescence) contributes to an expansion of morbidity. Yet, controlling chronic illness and improving the health status of older people can lead to dynamic equilibrium or compression of morbidity (Howse 2006). Social and economic factors also appear to be contributing to inequality in rates of disability. One study by Schoeni et al (2005) found over the period 1982 to 2002 declines in the prevalence of disability were uneven, with declines the smallest for the least-advantaged population.

Less frequent, but also important is the relationship between characteristics and demographic processes of mortality, migration and fertility. The social and economic characteristics of the aged can influence the size, age structure and geographic distribution of the aged population by affecting rates of mortality and migration. Overall, this line of inquiry is showing the heterogeneity of the aged population.

There is inequality in the length of life and social and economic characteristics appear to be important determinants. Vaupel, Zhang and van Raalte (2011) analysed mortality in 40 developed countries over the period 1840 to 2009 and concluded that countries with the highest life expectancy typically have low life span disparity. Part of the disparity discussion is the social and economic determinants of inequality in mortality. That these determinants exist is not in dispute, but their effect into older ages is unresolved. Hoffman

(2005) proposes that the social and economic disparities do not decrease with age but instead diminish in ill-health. A competing view is put forward by Jatrana and Blakely (2013) who argue that a shift from social to biological determinants of selective mortality occurs at older ages (Jatrana and Blakely 2013).

The experience of migration – both in the sense of moving the location of home and from the home into care – varies by social and economic characteristics and by age. Litwak and Longino (1987, 272) observe that "migration is selective" and "not all persons are equally likely to migrate". The social and economic characteristics can vary by age. Empirical studies have confirmed that moves within the aged years are associated with different characteristics. Moves in the early-aged years have been associated with longer distance moves, higher wealth and individuals in better health (Biggar 1980; Sander and Bell 2014), while moves into residential care are associated with characteristics of disadvantage and functional disabilities (Granbom et al 2014). Prince, Prina and Guerchet (2013) examined two systematic reviews of characteristics associated with the transition to care which find strong evidence of higher service needs being associated with age, not owning a home, low self-rated health status, functional impairment, cognitive impairment, prior nursing home placement, number of prescriptions, caregiver age, caregiver stress, caregiver desire to institutionalise and caregiver psychological distress. Moderate evidence was found to support the impact of factors including being employed, low social network, low activity, diabetes, low caregivers social support and duration of dementia. Inconclusive evidence was found for gender variable (male), living alone, income and education (among other variables).

The characteristics of the aged and the relationship with demographic conditions and service needs are likely to change over time. Currently there is a lot of focus on the baby boomers. Overall, the baby boomers are expected to change the characteristics of the Australian aged population. As McDonald and Kippen (1999) and McDonald (2012) highlight, there are rising levels of education, higher employment in growing industries, better health and availability of part-time work, less work in physically demanding jobs, later entry into the labour market and later child rearing. These changes provide natural momentum for greater independence among the aged.

Also changing are perceptions of the aged. A key concept in this work is active ageing. There are different definitions including the OECD approach which emphasises "the capacity of people, as they grow older, to lead productive lives in society and the economy" (OECD 2000, 126), and the World Health Organisation approach emphasising quality of life: "active ageing is the process of optimising opportunities for health, participation and security in order to enhance the quality of life as people age" (World Health Organisation 2002, 12). Regardless of these differences, research in this area has increased the focus on health, autonomy and engagement of the aged (Bowling et al 2009; Walker 2015). It is research not without criticism and I return to this concept in Section 3.1.4 below.

Related to the concept of active ageing is the labour force potential of the aged, or, to use an alternative term the social productivity of the aged (Asquith 2009). This is driven by both an interest in assisting individuals to actively age and in reducing the fiscal impacts of ageing. Several studies show momentum towards increasing labour force participation in older ages, but this is far from universal (Hurd and Susann 2011; Hytti and Nio 2004; McDonald 2012; Prskawetz et al 2005). In Australia, at least, this momentum is not enough to offset the decline in labour force participation expected the changing age structure of the population (Australian Government 2015). While much research is dedicated to the social and economic determinants of the characteristic of the aged and the ageing processes, it appears policy settings could also be important (Bloom et al 2015).

In this section I outlined the evolution of the measurement of population ageing. I have demonstrated that the measurement of ageing has expanded from a focus on core demographic dimensions of population cohort size and age structure to more sophisticated measures focusing on population characteristics and variation in the aged and ageing processes.

3.1.4 Situating the aged within the life course

Demographic researchers have always been interested in the life span and, increasingly, they are interested in the life course. These are distinct but related concepts. Life span analysis focuses on the individual trajectory in relation to the length of life. In contrast, life course analysis focuses on the key roles and transitions through life (Antonucci 2008). In life span analysis, the key transition is between life and death. In life course analysis, the key transitions are between childhood and education, education and work, work and retirement, and retirement and frailty.

Kertzer and Schiaffino (1986, 78) give an overview of ageing in the context of the life course:

> In the life course view, aging is a lifelong process conditioned by biological, psychological, social and cultural factors. Patterns of aging change over time as the society changes, and

> different patterns of aging are found within the same society at the time as a result of social differentiation. Of special importance in operationalizing life course research are "life events", which may be defined as noteworthy occurrences in an individual's life, such as marriage, entering the labour force, and/or having children…,and death. Life events and their temporal relationships are among the primary objects of examination in life course study. The study of life events also has a cultural dimension, for each society has norms regarding age-appropriate transitions and behaviour, which provide social sanctions for those who do not follow the proper cultural life script. Closely tied to this, of course, is the behavioural dimension, involving the actual sequence and timing of events in an individual's life.

Life course and life span analysis can have many similarities. Both can be studied from the individual or aggregate level (Settersten and Mayer 1997). Both use chronological age as a key variable (Nikander 2009; Settersten and Mayer 1997). Additionally, both examine the micro and macro processes shaping life span and the life course. In the life course approach, however, there is greater emphasis on the role of social institutions shaping the life course and the time of life events and transitions. This lens opens researchers to viewing cohorts within their social conditions and to understand the influence of changing social conditions on the life course. As Settersten and Mayer (1997, 235) observe:

> "So while the life course can be viewed as an event history of a single individual, it can also be viewed at aggregate level (e.g. as something shared by a cohort), as a property of cultures themselves, and as something that can be compared across historical periods or between nation-states".

In an era where there is more certainty to the time to death and the length of life is increasing, these life course perspectives can play an increasingly important role in understanding and shaping policy responses to population ageing.

Since studies of the life course began, different theories have emerged (Kertzer and Schiaffino 1986). There are normative life patterns, where age and time play an integral role in a process referred to as chronologisation of the life course. There is role theory where people play sequential roles throughout their life and chronological age can be a key determinant of the role (Kinsella and Phillips 2005, 31). There is also age-stratification theory where standardised life course patterns are constructed and reinforced by social institutions (Riley, Johnson and Foner 1972).

Overall, life course theories tend to segment life as a period of maturation and growth and then decline and regression (Settersten and Mayer 1997). Decline and regression are characteristics of the aged and negative stereotypes persist (Kornadt, Meissner and Rothermund 2016; Nelson 2004). Conventionally, the life event of withdrawal from the labour market is the marker of entry into the aged period of the life course (World Health Organisation 2016). This is regardless of whether the transition is voluntarily, following attainment of compulsory retirement age or upon the onset of permanent disability. There are persistent negative stereotypes associated with being aged.

Lee and Goldstein (2003) consider how the life course may change as the life span increases. They speculate the consequences of ageing "will depend in large part on how the additional expected years of life are distributed across the various social and economic stages of the life cycle" (Lee and Goldstein 2003, 183). There could be *proportional rescaling* where each stage of the life course would be unchanged but increase in length relative to the increase in life expectancy. However, as Lee and Goldstein (2003) conclude, this is highly unlikely in humans given biological constraints of human growth, maturity and menopause. Alternatively, there could be *proportional stretching* of the life course where the additional years in each life stage are gained relative to gains in the expected years of life within each age group. This too, however, would not be straightforward as broader change occurs to transitions that are sociologically defined rather than biologically defined–for example, the length of time in education and training before entering the labour market.

In 1989, the sociologist, Peter Laslett, released a new theoretical framework for the life course. He argues that as life span has increased, the life course has changed. Laslett believes that the aged life course includes two distinct life courses which he calls the third and fourth age. In effect, Laslett argues that the third age is emerging as a result of people exiting the labour force while healthy and enjoying a period of healthy retirement years before the onset of disabling illness and death. The characteristics of the third age may include early retirement, no caring responsibilities for children and the reasonable certainty of remaining life expectancy and healthy life expectancy (Laslett 1989). In contrast, the fourth age is characterised by a loss of independence and ultimate death.

Some researchers have subsequently tried to operationalise Laslett's theory in demographic studies. For example, Baltes and Smith (2003) differentiate between the third and fourth age at the age when either 50 per cent of a birth cohort is deceased or the cohort surviving to age of 60 is deceased; and Heigl (2002) uses active life expectancy to differentiate between the third and fourth age. This is an inherently difficult task because Laslett's theory allows for individual differences in the timing of the third and fourth age. Laslett argues there could be considerable variation in experience of the fourth age; those individuals who suffer a sudden death would have no fourth age, while for others it may be life stage lasting several years. Consequently, population level analysis may not be the best way to differentiate an early-aged and late-aged population within the aged years.

Laslett's theory has been criticised for marginalising the fourth age (Chatzitheochar and Arber 2013; Higgs and Gilleard 2015). Supporters of active ageing argue maximising independence and activity is not just an objective for the early-aged years but also highly relevant to the late-age years when there is more frailty and decline (Kalache and Kickbusch 1997). In other words, the negative categorisation of the fourth age is seen by some to undermine the work underway to break down negative stereotypes of the aged and to encourage policy and program interventions to prevent or delay frailty and decline.

Regardless of these criticisms, Laslett's research is a positive contribution to life course theories. As Rowland (2012, 180) highlights, the concept of a third age "provide[s] a framework for considering influences on individuals' quality of later life". This helps to recognise that, the early-aged years at least, are can be productive and fulfilling. Further, his work is an important conceptual advance in the literature, supporting greater differentiation within the aged years and challenging demographers to think outside the realm of life span analysis which is bound only by birth and death. The lengthening life span can pose a much more fundamental challenge to the way the life course is structured.

3.2 AUSTRALIAN STUDIES OF THE AGED AND POPULATION AGEING

Most of what is known about population dynamics in Australia is derived from official government modelling—at the national and state and territory level—from a small group of domestic researchers and the inclusion of Australia in comparative international studies. However, interest in Australia's aged population and ageing processes is increasing. The establishment of the Centre of Excellence for Population Ageing Research in 2011 has provided funding for policy relevant research.[35] Also, significant research projects are made possible by key longitudinal data collections including the annual Household Income and Labour Dynamics of Australia which commenced in 2001, the 45 and Up Study involving 250,000 Australians which commenced in 2004, and the Dynamic Analyses to Optimise Ageing which commenced in 2007 and draws together data from nine longitudinal studies.[36] The ABS, since its establishment in 1905, has released Census, vital record and survey data to support research (see Chapter 6 for a discussion of the data available).

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[35] See CEPAR – ARC Centre of Excellence in in Population Ageing Research 2016.
[36] See Melbourne Institute of Applied Economic and Social Research (2016), 45 And Up Study – Sax Institute (2016) and ANU - DYNOPTA - Dynamics Analyses to Optimise Ageing (2016).

In this section I outline key Australian studies of the aged and population ageing to identify relevant research directions and key research findings. I structure this analysis around two key research themes beginning with studies analysing the dynamics of a growing aged cohort and population ageing in Australia and then insights from the new analytical dimensions to examine the aged and ageing in Australia. Australian researchers also contribute to general theoretical and methodological research, and applied research into other countries. Their insights into these issues, where relevant, were included in Section 3.1 above. The focus of this section is research findings relevant to Australia.

Like other developed countries, at the national level, the forces contributing to ageing in Australia are well understood. Kippen (2002) provides a summary of these conditions—fertility below replacement level since the mid-1970s, a fall in mortality at older ages (estimated at the time of publication to be 20 and 50 per cent since the early 1970s) and the ageing of the baby boomer cohort born between 1946 and 1966. Additionally, the "ageing of the aged" in Australia, like other advanced economies, is also established (Hugo 2003). More recent studies, including by Davies and James (2012) have incorporated spatial dimensions to examine population age structures at a subnational level. They found a combination of geographic, social and economic conditions contribute to spatial unevenness in Australia, with remoteness/accessibility, size of the population and proportion of the Indigenous people in the population provided good explanatory power of the variability.

Given the important role international migration has played in shaping the Australian population, there has been interest in its contribution to population ageing. Kippen and McDonald (2000) conclude immigration to have had virtually no impact on Australia's age structure because the average age of immigrants and their fertility has been in-line with the Australian population. This is changing. Now that the Australian population is older, ageing can offset growth in the aged population by supporting growth in the working-age population (Kippen 2002; Withers 2002). The Productivity Commission (2005) and Betts (2008) found that net migration has modest and relatively short-lived impact on population ageing. Additionally, consistent with international studies, international migration is expected to increase ageing in the long-run (Kippen and McDonald 2004; Productivity Commission 2005).

Population projections for Australia have been produced by academic demographers and the ABS. Official projections have been available since the 1970s (Bell, Wilson, Charles-Edwards 2011). Academics are freer to experiment with different methodologies and assumptions, but their projections are typically produced on an ad hoc basis and the results are soon redundant. For example, Kippen (2002) uses a Total Fertility Rate assumption of around 1.65 births per woman and net migration assumptions at 90,000 per year—credible assumptions at the time. However, in the subsequent decade fertility rose and stabilised around 1.9 births per female and net migration in 2008-09 alone was 300,000 people and is now forecast to be between 200,000 and 280,000 people per year (ABS 2013g). Similarly, Hugo (2003) based his analysis of the implications on the growth of the population aged 65 and over on and aged population of 5 million in 2031, when the latest assumptions place the size of the aged population closer to 5.7 million based on current demographic conditions (ABS 2013g).

There is Australian research applying frontier projection methodologies. Wilson and Bell (2004a), for example, produced probabilistic projections for Australia; but, again, demographic conditions have changed substantial in the interim. Hyndman and Booth (2008) developed stochastic forecasting for Australian demographic conditions using data from 1921 to 2003. Such methods, however, are yet to be incorporated into mainstream applied demographic research. A National Centre for Social and Economic Modelling (NATSEM) was established in 1993 to lead develop microsimulation models examining Australian demographic conditions (see NATSEM 2016). Their work has been influential, particularly in the areas of understanding policy changes and service planning for locally delivered services such as aged care and child services and in identifying patterns of advantage and disadvantage (Gong et al 2011; Harding, Vidyattama and Tanton 2009).

There are specialised projections available for Australia in areas such as housing demand (McDonald, Kippen and Temple 2006) and elderly living arrangements (Temple 2007). In a working paper relating to the projections of housing demand, McDonald and Temple (undated) argued that demand is increasing for lone households more than any other type as a result of population ageing. Gibson et al (2001), for the AIHW, projected older immigrants from culturally and linguistically diverse backgrounds from 1996 to 2026 at the national, state and territory, and the smallest substate region available at the time. The study was designed to inform aged care planning by estimating the size of the aged population from culturally and linguistically diverse backgrounds. While the specific findings are now outdated, this study demonstrates the presence of spatial and temporal diversity within the aged population and the policy relevance of such results.

Another area of inquiry is to examine the issue of supply of aged-related services. Gibson, Braun and Liu (2002) found spatial inequities in the supply of aged care services in Australia favouring delivery in capital city areas. There are also differences in demand for services. A recent longitudinal study found increasing age, female sex, lower pre-tax household income, not having a partner, not being in work, Indigenous background and living in a regional or remote location were strongly associated with demand for home care in Australia (Jorm et al 2010). Lindeman and Pedler (2008) also examined demand for home care among Indigenous Australians in remote locations, finding evidence of service rationing in Central Australia to manage demand. A more comprehensive demographic evidence-base could better inform these types of studies.

While national population projections are produced on a regular basis, subnational projections tend to be the realm of state governments.[37] State governments have additional data for housing and land supply and are more directly involved in delivering local level services (such as education and health care), so demand for local level projections is high at the state level. Rarely, therefore, is there need for these substate analyses to cover all regions of Australia. In fact, there are few small area projections of Australia which aggregate to a national picture of demographic conditions. One example is the Australian Internal Migration Database which included 69 regions across Australia (Muhidin, Bell and Brown 2008). It, however, has not been kept up to date.

Projections at the state and territory level or substate level are regularly adapted to the local circumstances. For example: the Northern Territory government differentiates between the Indigenous and non-Indigenous population (Northern Territory Department of Treasury and Finance 2014); in Queensland, the projections have estimated service resident populations (Charles-Edwards, Bell and Brown 2006); and in Victoria and New South Wales, both population and household projections are undertaken (New South Wales Department of Planning and Environment 2014; Victorian Department of Environment, Land, Water and Planning 2015; Wilson 2011a; Wilson 2008). While this locally-relevant information can improve the accuracy and relevance of the projections, these are often state-specific and resource-intensive methodologies that cannot be replicated in a small area analysis using a national framework.

[37] Although there are also a small number of fee-for-service consultancies who specialised in local area projections.

Several subnational models have been developed by academic researchers. Wilson and Bell (2003) developed a bi-regional framework projecting Queensland and the rest of Australia using a probabilistic framework. In a more recent study, Wilson (2011b) developed a multi-bi-regional model for up to 75 regions across Australia. Hyndman, Booth and Yasmeen (2013) developed a method of mortality forecasting suitable for subpopulations and tested. These are valuable contributions to understanding demographic conditions but do not provide a projection approach suitable for the detailed understanding of the Australian aged and ageing processes.

These existing subnational perspectives suggest there is regional variation in the aged and ageing processes in Australia. Jackson and Felmingham (2002a) and Jackson and Felmingham (2002b) show the states of South Australia and Tasmania are at the frontier of population ageing. Hugo (2005) highlights population dynamics are different in regional and remote areas compared with cities with ageing in regional and remote locations enhanced by the emigration of youth from these regions moving out while ageing is diminished in cities due to the immigration of youth. Hugo (2003) also identified that within capital cities the aged population disproportionally concentrates in the lower density areas.

Subnational population projections are informed by analysis of subnational variation in migration, mortality and fertility. In comparison to international migration, internal migration of the aged has been studied extensively from a theoretical and empirical perspective—aided by the addition of the internal migration question in the Australian Census in the 1970s. Sander, Bell and Brown (2007) estimate that if the migration rate between 1996 and 2001 remains constant, one million baby boomers will change residence between 2010 to 2030. Yet even specialised projections of the aged, such as the Gibson et al (2001) projection of aged population from culturally and linguistically diverse backgrounds, assume that internal migration among the aged is zero. This approach means that while internal migration approaches are well understood, the projections are not incorporating knowledge about conditions affecting the distribution of the aged population in Australia.

Older Australians move for different reasons—with some moves being initiated for lifestyle reasons and others a reaction to change of circumstances such as the onset of frailty for the individual and/or their partner (Maher and Stimson 1994). Bradbury (2014) examines the reasons the Australian population 60 years and over moved using the longitudinal Household, Income, Labour Dynamics of Australia Survey. The most frequently cited reasons were to get a larger or smaller house, to live in a better neighbourhood, to be close to friends or family and for health reasons.

In a similar study, Marshall et al (2005) surveyed income support recipients and found more than 50 per cent of respondents rated crime, housing cost and housing quality as a very important or important reason to move. When the movement was from non-metropolitan locations to metropolitan locations, the most commonly cited reason for the move, identified by nearly 72 per cent of these movers, was a desire to be near family and friends. Other factors mentioned were a change in their relationship status, such as a death of a spouse, or the respondent's health or health of a family member.

Personal and housing factors appear also to be important to internal migration in Australia. Higher income people have the potential to move to improve lifestyle and those on lower incomes may to move to reduce housing costs (Hugo and Bell 1998; Maher and Whitelaw 1995). Life tenure in housing, through a stable rental arrangement of home ownership without a mortgage can significantly contribute to lower residential mobility (Piggott and Sane 2007).[38] Life events, such as retirement, are a trigger of downsizing. Sander (2010) dedicated her PhD research to the retirement mobility of baby boomers. In a subsequent publication, Sander and Bell (2014) report that retirement can trigger migration but the propensity to move falls as retirement age rises.

Because of the complexity of internal migration, it is difficult to identify with any certainty the propensity to migrate at a particular age and the spatial pattern of the migration flows. The current literature has established that while the flows are high in the age group 60 to 64 (Sander, Bell and Brown 2007), the probability of moving is highest among the population 80 and over (Piggott and Sane 2007). Similarly, the spatial pattern of internal migration is also difficult to determine. With the exception of the Australian Internal Migration database (mentioned above), the spatial pattern of internal migration research including both origin and destination research has been fragmented. There is research confirming that regions vary in attractiveness (see Section 2.2.4 and also, for examples, Alexander and Mercer 2007; Holmes, Charles-Edwards and Bell 2005; Hugo 2005; Jackson 2004; Martel 2010; Vintila 2001; Walmsley, Epps and Duncan 1998).

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[38] In fact, Piggott and Sane (2007) further argue that policy settings in Australia which exempt the primary residence from means testing arrangements for the Age Pension could be supressing residential mobility among the elderly. Judd et al (2012) further found over the period 1996 to 2006 there was little evidence of aged Australians downsizing.

Extensive studies on mortality trends in Australia have been produced by the ABS and AIHW. The AIHW (2006) has reported falling mortality in the 20th Century, with the exception of a stagnate period in the 1960s, and a concentration of mortality and mortality change in the aged years. Data from both agencies show mortality rates highest in very remote areas and lowest in major cities (ABS 2013c). The AIHW (2007b) also examined excess death, finding it occurred most at older ages in regional and remote areas. Above the age of 85, there are lower rates of mortality in very remote locations, possibly due to outward migration of the frail aged (AIHW 2007b; AIHW 2014).

Among the characteristics of the aged, health and disability are among the most studied. These are important indicators of care need (Broe et al 2002, Jorm et al 2010). Most studies of disability in Australia examine past trends using the ABS Survey of Disability, Ageing and Carers (SDAC). The inclusion of a disability question from the 2006 Census has made possible new analyses into regional differences in disability, an area of research I take forward in this study. Howe (2008) studied the differences between the SDAC and Census definitions of disability, finding that the disabled population estimated by the Census is much smaller compared with the profound and severely disabled population estimated in the SDAC. Over the age of 55, Census estimates were between 63 and 81 per cent of the prevalence identified in the SDAC, but the differences reduce at older ages (Howe 2008).

There are differing views on the trends in disability-free life expectancy in Australia. There has been an expansion of years lived with disability and years lived without disability, and the balance between the two can vary depending on the level of disability, time period and age (Davis et al 2002; Mathers 1991; Robine and Michel 2004). Robine and Michel (2004) find the proportion of life lived in disability increased over time after age 65. In a 2012 study examining the period 1998 to 2009, the AIHW (2012) concluded around half the life expectancy gains of older Australians were disability-free. The most recent study by the AIHW (2014a) found there more years gained without severe disability than with it.

Australian researchers have also sought to understand the characteristics of the aged population. A significant theme for this research is the differences between the ageing baby boomer generation and the current or past generations of aged Australians (see, for example, Hugo (2003) and Humpel et al (2010)). There is consensus that baby boomers are different: Hugo (2003, 112), for example, observes “the Australian aged population of 2031 will differ from the current aged population because it will have lived through different life events". Further, he speculates baby boomers will be living by themselves in increased numbers and in lower density housing where accessing services can be more difficult; have fewer children and live further from their children; be more educated and enjoy higher levels of private income; be more ethnically diverse; and, experience higher levels of chronic illness and disability as a result of being 'rescued from death' while being healthier in some areas. Wood et al (2010) agrees, arguing baby boomers are approaching their retirement in better health and richer than previous generations.

In summary, current research into population dynamics in Australia are often outdated and rarely undertaken on a subnational basis with national geographic coverage. Current studies are also narrow in design, yielding significant insights into a location or population subgroup. No recent study was identified that examined the aged at small areas and provided national coverage. This research can fill gaps in Australia's experience and expectations of the aged and ageing processes.

3.3 CONCLUSION

Much is already known about the population dynamics causing populations to age and increasing knowledge of the characteristics of the aged. I have outlined the evolution of the demographic research. Research has shown that ageing is not stable, the dynamics of change and the characteristics of the aged population are evolving across space and time. While fertility was once a strong driver of growth of the aged population, in more recent years it is improving mortality conditions which are supporting growth of the aged population. The characteristics of the aged are changing; so too is the life course with researchers increasingly disputing concepts of the aged as frail dependents and instead identifying evidence of the aged, particularly in the early-aged years, as independent, healthy and active within their communities. Some researchers are also stepping back to examine if population ageing is a trigger for more fundamental change in the life course.

Trends in Australia are consistent with the international research. However, there are some limitations in the Australian research. Few studies investigate subnational characteristics of the aged, subnational projections of the aged, life span inequality, working-life expectancies or the threshold of the aged. Additionally, my own interpretation is that is that government conceptions of the aged have been too homogenous. There has also been little discussion of life inequality, the life course or the spatial and temporal variation in the ageing processes. In the following Chapter I draw on this research and the insights from Chapter 2 regarding the current policy settings to respond to population ageing and propose four policy directions to guide the future response to population ageing in Australia.

Chapter 4

Directions for the future policy response to population ageing in Australia

The problem is that there are few 'easy' reforms left

(Banks 2009, 3)

With these contextual factors in mind, the focus of this Chapter is to consider the policy directions the demographic evidence-base for Australia should inform. I outline four policy directions relevant to population ageing: increased policy differentiation between the early-aged and late-aged years; a comprehensive approach to longevity risk; increased responsiveness to variation within the aged population and ageing processes; and, the distribution of the benefits of the increased life span to increase wellbeing across the life course. Before explaining these directions, I briefly discuss options to influence Australia's demographic future. I include this section to make a single important point: that policy effort should be directed to responding to demographic conditions rather than trying to manufacture demographic conditions.

In response to favourable demographic and economic conditions during the 21st Century policy makers expanded the provision of education, health, care and income support programs (Herscovitch and Stanton 2008). Now, with a growing aged population, policy makers are once again examining current policy and program settings to ensure the needs of their changing constituency are met. Changing policy direction in the current environment is challenging with both fiscal and political factors affecting constraining change. While hard, reform is necessary and achievable.

Population ageing is not a crisis. But, it does require a response. As Rowland (2012, 16) observes, "present trends is likely to prove economically unsustainable and socially disruptive". Introducing new directions for the policy response can be gradual and framed as progressive reforms as demographic conditions change. Ensuring there are services available in the locations the aged reside is a problem with a technical solution, but changing the life course in response to very long lives is an adaptive process. The solution and endpoint cannot be known at the outset because the precise trajectory for both policy and demographic conditions is uncertain.

To move forward, it will be necessary for both researchers and policy makers to see population ageing as a dynamic process, one shaped by program and policy settings. There is support for such as shifts in the research literature, with Bloom et al (2015) arguing that it will be the policy response to ageing that determines the extent of the macroeconomic difficulties arising from a growing aged population. Kinnear (2001) also reminds us that many assumptions about the aged may not be as problematic as first thought. It is not ageing that produces the policy challenge, but the characteristics associated with life in the aged years. Some of these characteristics are outside the reach of programs and policy; some will be responsive to a policy 'nudge'. Further, the more we learn about the aged and ageing processes, the better able we will be to design the policy and program interventions to shape the characteristics of the aged.

Demographic change occurs in the context of broader social and economic change. In Australia, like many developed countries, fiscal pressures are mounting and potential economic growth has slowed relative to historical standards. If fertility remains below replacement level, or Australia struggles to attract the highest quality immigrants, public resources may shift to support policy initiatives addressing these challenges. More generally, other challenges co-exist with the pressures to respond to population ageing—the infrastructure demands of a growing population, industry restructuring, high youth unemployment, pressures to upskill the population and to provide the population with the latest medical and pharmaceutical technologies.

As Patrick Dunleavy observed, "new ideas most often reflect the patient accumulation of layers of small insights and intuitions that only taken together allow an alternative view of a problem to crystallize" (Dunleavy 2003, 40). The four policy directions discussed in this section are the result of accumulated insights from the analysis during the life of this study.

4.1 INFLUENCING AUSTRALIA'S DEMOGRAPHIC FUTURE

There is momentum for both growth in the aged population and population ageing. Given population ageing is shaped by the population age structure and population processes of fertility, mortality and migration, it is change in these demographic processes that change the shape of Australia's current demographic trajectory. Recall from Chapter 3, these processes affect demographic outcomes differently. Fertility is an efficient way to offset structural ageing by producing a younger age structure in a population. In contrast, immigration can immediately increase the size of the working-age population, although these immigrants will ultimately age the population. Changes in mortality can produce a younger or older age structure depending on the age structure of mortality change.

In theory, just as changes to fertility, migration and mortality are the drivers of an ageing population in Australia, these same demographic processes could be used to produce a younger age structure. In practice, however, there are many challenges. Fertility rates are difficult to increase (McDonald 2007). Australia's migration program is intractably linked to labour market conditions (Spinks 2010). Further, signals from the health sciences point to further increases in longevity and increased access to medical interventions (Australian Government 2014b).

An area requiring continuing attention is falling fertility. Most recently, fertility in Australia has fallen from 1.9 to 1.8 births per woman (ABS 2014e). While it is too early to know if this is a short-term effect from the increasing age of mothers, a sustained fall in fertility would intensify population ageing in Australia. Taking a medium-term perspective, any action now to increase fertility would pay dividends in twenty years when these young Australians enter the labour market at the time the large baby boomer cohort turn age 85.

In Chapter 8 I show growth in the aged population is uneven at a subnational level. These local populations will be influenced by the same factors as at the national level, and additionally may also be responsive to local push and pull factors. Governments cannot influence all push and pull factors, but can have some influence in some regions. The placement of aged care facilities is one example where governments may be able to influence the size of the aged population at the local level. These may also be learnings from working-age policy interventions which could be applied to encourage redistribution or movement of the aged population, such as relocation assistance into towns offering specialised services or locations where social support is available. A shift in emphasis from ageing-in-place to ageing-in-community could support relocations within the aged years. However, even growth in the aged population at the subnational level is not the goal. Some interventions may increase the size of the aged population in some areas; this is an acceptable policy outcome provided these communities are better equipped to support their needs.

While demographic futures are mostly concerned with the size and age structure of the aged population, the characteristics of the aged population have the potential to be even more important in shaping the impacts of the aged (both positive and negative). This is an area where governments can have more influence, and the in the following section I outline four policy directions to shape the future policy response.

4.2 RESPONDING TO POPULATION AGEING: THE POLICY DIRECTIONS

Given population ageing is slow moving, the policy response needs to consider both short-term change and the long-term horizon. As outlined in Chapter 2, the policy response in Australia is incomplete and there are specific concerns relating to work and training, health and care, and retirement incomes. These concerns provide the starting point from which new policy trajectories can emerge. I will not be making comments about these reforms in this context. Instead, in the following subsections I propose whole-of-government policy settings relevant for a growing aged population in Australia and population ageing—thus, relevant to both structural and numeric ageing.

Two conceptual shifts are needed to be open to future policy directions set out in this Chapter. The first is recognition that a more nuanced conceptualisation of the aged is needed. In policy settings, the current homogenously defined aged population is based on retrospective chronological age measures such as age 65. This study tests, and ultimately shows, an increasing disconnect between this traditional threshold of the aged and demographic conditions. Additionally, at set out in Chapter 3, demographic and social theory is moving in new directions to challenge the traditional concept of the aged as frail and redefine the life course (see also Asquith 2009).

The second conceptual shift needed is to recognise the complexities in population ageing. Not all patterns of population ageing have equivalent policy implications. It is possible, for example, to have an increase in the median age of the population without growth in the aged population. Population ageing in Australia, however, like other developing countries, is associated with policy relevant characteristics, including:

- growth in the late-aged population who are more likely to have complex support needs including higher demand for income supplementation, assistance with core activities of daily living, management of complex medical conditions, social support and housing assistance compared with other population segments;

- growth in the proportion of the population not in the labour force (if labour force participation rates stay constant), meaning fewer people to fuel economic growth and support the aged population; and
- a lengthening of the life span, particularly average remaining life expectancy for those who survive to age 65, increasing the potential for lengthening labour market connection and/or a longer period of healthy and active retirement following withdrawal from the labour market.

Australia is already well positioned to respond to the immediate concerns of a growing aged cohort. However, population ageing is likely to continue well beyond the ageing of the large baby boomer cohort making the response to population ageing a continuous reform process.

4.2.1 Increased policy differentiation between the early-aged and late-aged years

The first policy design principle is to differentiate the policy response between the early-aged and late-aged years. In Chapter 3 I identified that in the research context there is already significant differentiation within the aged, but such differentiation is yet to be reflected in policy settings. To support this view, I reviewed aged-based policy settings across key policy and program settings and found aged-based policy in Australia differentiate between youth, working-age and the aged. In recent years, policy has been introduced to shift boundaries supporting these life stages. Examples are the increase in the eligibility of the Age Pension and the encouragement of lifelong learning through the working-age and aged years (Australian Government Department of Social Services 2014; Australian Government 2012b).

In the current aged program settings, there is very little differentiation within the aged population. Policy settings regarding the Age Pension do not change after the age of eligibility of age 65. Eligibility for Home Care Packages and aged care starts from age 65; although providers will moderate access based on need and need increases with age. The retirement income superannuation scheme is fully accessible from age 65. Around the edges of these program settings there are weak signals of differentiation: superannuation is accessible earlier than age 65 in the case of permanent withdrawal from the labour market; planning for home care and aged care focuses on the population over 70; increasing investment in labour market programs to extend the connection to the labour market; and there are incentives to work while receiving the Age Pension to smooth the transition to retirement.

With remaining life expectancy at age 65 of 19.2 years for males and 22.0 years for females in 2011, it is important to evaluate both the threshold demarcating the commencement of the aged years and consider if there is another threshold differentiating within the aged years. A stylised interpretation of what this might look like, based on Laslett (1989) conceptualisation of the aged years, is shown in Figure 20. Laslett's theory (described in more detail in Section 3.1.4) is that the aged years include a third age characterised by health and activity and a fourth age characterised by frailty and decline. The presence of distinct phases within aged years creates the opportunity, and possibly also the need, to differentiate the public policy response within the aged group.

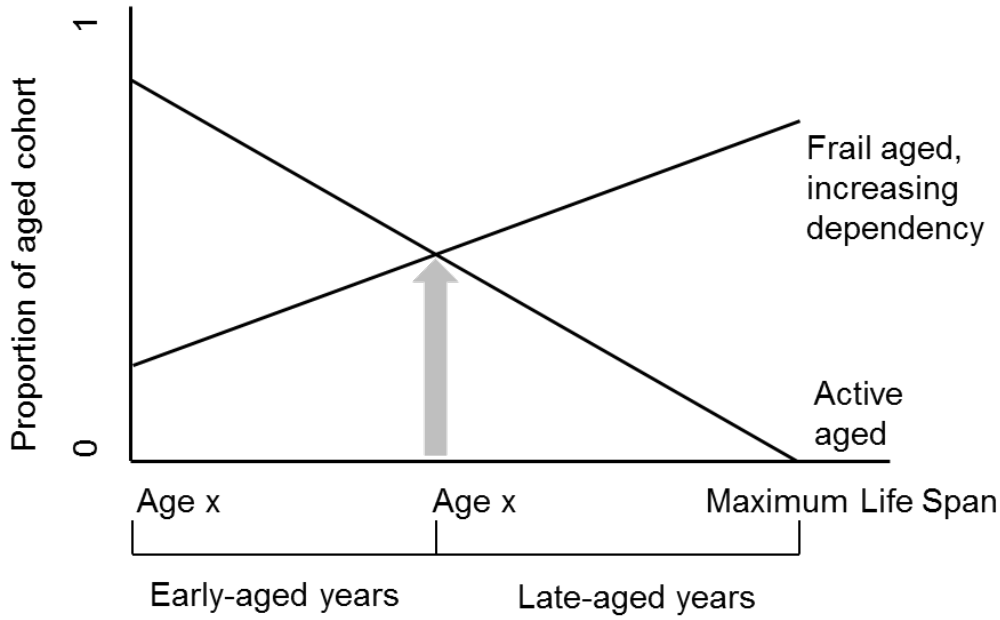

Figure 20 Stylised framework for examining age structure within the aged years

This suggests the early-aged years would be a time of minimum government support. A safety-net would be provided, consistent with the existing Australian welfare policy, but it would be up to individuals (partners and families) to support themselves during the early-aged years. For some this may involve lengthening their working life, for some there may be a long transition to permanent retirement and for others their goal may be to work and save and retire well before the effects of ageing are apparent. A range of complementary policies would be needed to support this policy direction, including redesigning training, employment and health programs to focus on independence and the delay (or prevention) of frailty.[39] Retirement income policy would also need reform and different design directions could be pursued. Accumulated assets, for example, could be made available to support the early-aged years as determined by the individual or, alternatively, these resources could be utilised for costs associated with the late-aged years.

In contrast, the late-aged years would be a time of increased government support. A safety-net would be provided incorporating both financial and social support. This would be a shift in current welfare settings to give greater attention to social support to ensure minimum levels of social connectedness and engagement. By doing this, the active ageing philosophy continues to be supported. The current relationship between *age* and *aged* would be broken down, and the concept of *aged* reconnected with a higher degree of frailty and dependency. However, such a shift would also need to occur concurrently with adequate recognition of the value of individuals in the late-aged phase of their life. Recall from Section 3.1.4 the criticism of Laslett's fourth age; policy makers could design policy and program settings to avoid negative perceptions of the aged.

Differentiating between the early-aged and late-aged populations in this way allows the pursuit of key objectives: supporting active ageing, providing adequate care and fiscal sustainability achieved within and across the generations. It would signal to individuals a greater responsibility to plan for the years when they are independent and assure individuals, that when they need it, their care (financial, health and social) will be adequate. This approach will also enable government to address longevity risk by reducing, on average, the years in which the aged are supported by government services. This is not equivalent to reducing transfers to individuals (although it may be at particular ages)—the overall costs may be the same or even higher—it is about aligning these supports to where there is most need.

This approach would also address a related weakness in current policy and program design, that being a broad approach to intergenerational conflict. Intergenerational conflict is typically considered in the context of youth, working-age and the aged (Bengston and Achenbaum 1993; Bristow 2015). As average life span increases, the potential for intergenerational conflict within each life stage could increase. The aged

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[39] Jorm et al (2010) provide a starting point, finding that recipients of home and community care services in Australia have high rates of modifiable lifestyle risk factors. They propose that this service setting provides an opportunity to implement preventative care programs.

years are vulnerable to this type of effect, particularly if there are distinct life stages within the aged years (such as Laslett's third and fourth age (Laslett 1989)). The aged compete for resources relative to the working-age and youth, but so too is there competition between the early-aged and late-aged.

What is less clear is the age differentiating the early-aged and late-aged years. I test, and ultimately show in this study, there are differences between the early-aged and late-aged years. The early-aged years are often a period of health and activity, particularly when a broader definition of activity is used to encompass a mix of labour market activity, civic and social participation activities. It is also clear, the frail aged can have high, complex and sustained care needs; that they are at high risk of social isolation and that they have high needs for income support. However, I also test, and ultimately demonstrate in this study, inequality within the population with regards to work, disability-free life expectancy and life expectancy. Additionally, concepts such as frailty are not easy to define for use in an aged-based policy setting; it is rather a "biological syndrome of decreased physiological reserves and resistance of stressors causing vulnerability to adverse outcomes, independent of disability or comorbidity" (Fried et al 2001, M146). Unlike the pictorial representation in Figure 20, there is no clear threshold age to define the aged or differentiate between the early-aged and late-aged phase of the aged years.

Consequently, in addition to increased policy differentiation between the early-aged and late-aged years, this threshold should be individually defined. The criteria for the threshold could still be set at a population level, but would be applied at the individual level. The criteria should encompass health, labour market and income. A key criterion should be permanent and involuntary withdrawal from the labour market combined with appropriate income and asset testing. Defining the threshold on an individual basis would be more responsive to inequality providing protection for individuals and an incentive for governments to reduce inequality. In addition, policy settings would not need to be adjusted based on population level changes in the length of life or healthy life expectancies.

This is a not a policy direction which could be achieved overnight, but may be acceptable to the community if introduced gradually over a decade or more. Additionally, it will be important to emphasise that differentiating policy settings between the early-aged and late-aged phases of the aged years does not automatically reduce support available across the life course. Instead, it involves shifts in the relative balance of support from the early-aged phase to the late-aged phase. New narratives would be needed to highlight tradeoffs occurring within the aged years and to demonstrate how the benefits of the lengthening life span can be spread across the life course.

4.2.2 A comprehensive approach to longevity risk

In the academic literature longevity is the capability to survive beyond the species-specific average of age (De Benedictis and Franceschi 2006). For policy makers, the focus is on the potential for people to outlive their assets. Through the research of psychologists and behavioural economists it is well known that people are poor at managing their own longevity risk (Zamir and Teichman 2014) and where individuals fail governments step in to provide an income safety-net. Thus, much of the longevity risk rests with the state. In response government has an interest in managing longevity risk policies to nudge behaviour toward the independent management of longevity risk.

Currently, a key policy setting for managing longevity risk in Australia has been the Superannuation Guarantee introduced in 1992 (see Section 2.3.3). The policy has been reformed regularly to adapt to changing conditions including increasing the Superannuation Guarantee and the potential to accumulate superannuation in the pre-aged and aged years through incentive arrangements. While these are positive reforms from the perspective of fiscal sustainability; they focus on a narrowly defined concept of longevity risk.

In the future, policy responses to population ageing will need to be concerned with a broader range of longevity risks. Concern about the length of life will persist, but in addition policy makers need also be concerned about longevity risks affecting the life course. Life course longevity risks are concerned with the duration of a life course stage. In the context of increasing life span and a growing aged population, the key life course risk is the length of working-age. An example of a life course risk is if the period of education during the youth years does not sustain a connection to the labour market through to the aged years. A broader range of factors may be involved in life course longevity risks, such as health, disability and education.

A key reason to adopt a comprehensive approach to longevity risk is to integrate life span and life course perspectives of successful ageing into a single policy framework. *Successful* ageing, defined currently by activity and independence from government income support and only minimal requirement for health support in later years, will depend on events and circumstances during the youth and working-ages. Consequently, policies targeting successful ageing need to target the pre-aged years.

As part of a comprehensive approach to longevity risk, policy makers could also have an increased role in communicating what the longevity risks are—both life span and life course. I will return to this argument in Chapter 9, where the analysis supports the argument that individuals should plan for longevity. People need to know the average length of life and inequality in the length of life. It also important to communicate some of the known uncertainties, particularly the potential for mortality conditions to change during the aged years. Also, communication could include the pre-aged years particularly in relation to life course longevity risks. For example, based on current demographic conditions, the generation entering the workforce now may need to sustain a labour market attachment for fifty years (or more). In this context, "time-out" for additional education may be seen as a necessity rather than a luxury.

This approach requires substantive policy change in additional to communication strategies. Several policy initiatives could be introduced to support a comprehensive approach to longevity risk. This is not necessarily new policy, but more focused leverage of the current policy momentum to support work and training at older ages (see Section 2.3.1). An example may to be strengthen training through the mid-career to refresh skills or shift to growth industries. The traditional policy area of retirement incomes will continue to be a priority; but this too should change. There needs to be much more focus on the decumulation of retirement income and true longevity risk products such as deferred annuities (see, for example, Iskhakov, Throp and Bateman 2014). Continuous monitoring of policy settings will also be required; in a world of increasing life spans there is a risk of every generation of retirees entering retirement based on a set of policies designed for out-of-date demographic conditions.

A comprehensive approach to longevity risk is also not a policy direction which can delivered overnight. These are complex changes which require careful planning and design work. They are worth pursuing, and it will be increasingly important for policy makers to be aware of the complexities of longevity risk in a population facing the dynamics of change associated with a lengthening and (ultimately) uncertain life span.

4.2.3 Increased responsiveness to variation within the aged population and ageing processes

The heterogeneity comes from spatial and temporal variation in the characteristics of the aged and the dynamics of ageing at the subnational and individual level. Understanding and responding to this variation offers opportunities to improve both the efficiency and equity of the policy response to a growing aged population; as Carstensen and Fried

(2011, 16) observe “forward-thinking societies should plan for older populations that are heterogeneous”. In Australia, there is already advocates for regionally-appropriate policy (see, for example, Jackson 2004).

Australia’s aged population is unevenly distributed at the subnational level. I show in Chapter 8 that this is unlikely to change, and additionally, I project growth rates of the aged population to vary between flat and around 5 per cent for the 327 regions examined. Beneath this headline figure there are many examples of variation. For the majority of regions (80 per cent), growth will be more rapid in the ten years to 2021 compared with the ten years to 2031. Another example is growth of the late-aged years, which is typically expected to exceed growth in the early-aged years but does not in around 25 per cent of regions examined in this study. Each region examined has unique demographic conditions and the policy response will need to be sufficiently responsive to the range of demographic conditions observed.

The characteristics of the aged population varies between subnational regions. For example, the proportion of the aged population with severe or profound disability can vary between 10 per cent and 30 per cent between the 327 regions examined in this study. These characteristics can be shaped by a range of demographic, social and economic conditions. For example, one of the reasons explaining the uneven distribution of the aged within capital cities is the settlement pattern of these capital cities over the last few decades—outer regions attract young families who aged in place and eventually contribute to a sizeable aged population (Hugo 2003 and Chapter 8). In regions attractive to retirement migration, the early-aged population can be boosted by internal migration, and additionally internal migrants will typically have better health and resources relative to average (Hugo 2003). Understanding these differences could lead to better targeting in locally responsive policy and program initiatives.

It is also important to be alert to temporal change in the characteristic of the aged. I discuss these further in Section 9.2. In short, drawing from the insights of Hugo (2003), the baby boomer cohort will be more travelled, health conscious, with higher levels of private superannuation and more gender equality. Significantly, the baby boomers have fewer children, higher levels of education and are more likely to be living greater distances from their children (Hugo 2003). These cohort characteristics can also be important signals of the services needs and expectations of each aged cohort.

There are sources of variation in the aged population and ageing processes that indicate inequality within the aged population. For example, individual and regional characteristics can be associated with longer or shorter lives. These are not random processes; as van Raalte and Caswell (2012, 20) observe “although individual stochasticity leads to variation in ages at death, it is unlikely that the current distribution is owing entirely to individual stochasticity.” In Australia, it is clear that the Indigenous population has substantially higher mortality (Australian Government 2016), but the extent to which other socioeconomic characteristics are contributing to life span inequality is less certain. In Section 10.2.2 I test, and ultimately quantify life span inequality, and show that while it has reduced at birth it has persisted at older ages. I also show temporal, spatial and sex differences in the life course markers of ageing. Key differences were apparent between females and males, with females working less than males and spending more years living with severe disability. Governments should address variation arising from inequality.

Being responsive to variation in the aged and ageing processes means designing policy and program settings which are informed by evidence of variation which could be spatial, temporal and or characteristics. The goal is not produce a homogenous aged population, but to ensure access to services and opportunities for activity and independence are available for all aged Australians regardless of where or when they live, or their characteristics. It also means being responsive to the local area demographic conditions shaping the size, age structure and characteristics of the local aged population.

4.2.4 Distribute the benefits of increased life span to improve wellbeing across the life course

Too often policy concern relating to population ageing focuses on the technical challenge of responding to the growing aged population. The growing aged population is also an adaptive challenge requiring consideration of a more fundamental issue of individual, community and societal adaptation to a lengthening life. Recognition of these broader complexities relating to population ageing is one of the reasons research agendas have shifted from conventional demographic studies of the size and age structure to focus on new life course dimensions of the aged and ageing processes (see Chapter 3). These life course perspectives are particularly useful to see the aged years in the context of the life course and for health and independence in the aged years to rely on success in youth and the working-age years.

To date the policy response to population ageing has not sought to challenge the fundamental life course: youth, followed by working life and exit from the labour market. The reality of these life stages is more complex. The working life and even the post working life are periods often accompanied by child rearing and care for elderly parents. The working life can be accompanied by periods of education and training to ensure a sustained connection to the labour market. In Chapter 9 I test, and ultimately outline the demographic evidence supporting the potential for the aged years to include a period of health and activity before a period of frailty and decline. In the first of the policy design directions I proposed, I argue for leveraging from these demographic conditions to increase policy differentiation between the early-aged and late-aged years.

The lengthening life span provides an opportunity to redefine the life course. The current approach is to try to reclaim some of the additional years of life for the working life through delaying retirement in order to boost retirement income. Pursuing this as the only strategy means opportunities to distribute the benefits of increased life span across the life course will be lost. I am not the first to propose such a shift in thinking. Vaupel and Kistowski (2008), for example, argue working lives should be extended but the average working hours should reduce. Coole (2012) argues for a radical reappraisal of the life cycle and that it is the baby boomers who can be the frontier of this change. There are many options which could be pursued—more leisure, more education, more care, more community engagement—concurrently to the working-aged years, just as the aged years could be accompanied by more work or other activities.

There are both practical and principled reasons why policy makers could consider distributing the benefits of increased life span across the life course. From a practical perspective, more education and work can protect against early retirement and boost the potential for independence in the aged years (Australian Centre for Financial Studies 2014; Humpel et al 2010). Additionally, during the working-age years, the greater ease of managing work and caring responsibilities can boost fertility and labour force participation (McDonald 2007). Achieving this better distribution could also improve equity, which I have also argued should be a priority for policy makers. In a world where life is often but not always long, a better balance between work and life across the life course could mean that a higher proportion of individuals can experience the benefits of a period of leisure within the life course.

In practice challenging traditional life course approaches faces significant practical barriers. During the working life, there is high demand on individuals for income. Individuals and families are purchasing homes, accumulating assets and saving for retirement. They may also be raising children and, thus, family income is reduced to a single income or part-time income. The income safety-net arrangements, for those in need, are not available once an individual has accumulated even modest assets. This means people who save to support a period of "time-off" will be required to expend those resources before accessing income support payments. The circumstances where an exemption may be warranted would be limited; but policy makers need to evaluate if there are circumstances, such as to pursue training to increase longevity in the labour market, where additional support from government should be provided.

There are a few examples in current policy settings which could become the foundation of policy change distributing the benefits of increased life span across the life course. For example, the superannuation arrangements in Australia allows for access to retirement savings during times of financial hardship or permanent disability. Another example comes from the Northern Territory Government which makes available to its employees a five-year employment cycle comprising four years working on 80 per cent salary followed by one year of paid leave (Office of the Commissioner for Public Employment 2011). While these initiatives were introduced for non-ageing related reasons, similar approaches could be considered to spread the benefits of the increased life span across the life course. such as to make time and resources available to pursue training or other interests.

This policy approach is a step-change from both the current arrangements and the planned response to a growing aged cohort. Distributing the benefits of the increased life span across the life course should not be a coercive policy setting. As Tomasik and Silbereisen (2013) observe, coercive policies are likely to be less effective and preference should be given to policies that support individuals to determine a path that is suitable for them. The role of policy makers is to establish coherent and holistic policy architecture to support individuals to distribute the benefits of increased life span across the life course. Government has a role to communicate demographic conditions and to encourage individuals to plan for long lives. For some, this may mean working intensely and saving, and for others they may extend their working lives, as Vaupel and Kistowski (2008) suggest, but reduce the numbers of hours worked per week or through extended time away from work to pursue other activities. The key principle: the increased life spans most now enjoy can change our lives more fundamentally than a few extra years in healthy retirement.

4.3 CONCLUSION

Despite progress in reforms across the areas of work and training, health and care and retirement incomes, the policy response to population ageing is incomplete. The future response to population ageing will be progressed as one of many challenges facing Australia, and in the context of challenging fiscal and political conditions. Effectiveness, efficiency and innovation will be important in the policy response. The response should encompass both technical and adaptive. Technical solutions are needed to address complex challenges such as spatial equity in the distribution of services and the rate of age pension or accumulation of retirement incomes. Adaptive solutions are needed to reshape the life course in response to the lengthening life span.

In this Chapter I propose four policy design directions to guide future policy development to population ageing in Australia; the directions which demographic analysis should inform. There needs to be increased differentiation in the policy response within the aged years to better recognise the differences in the early-aged and late-aged years. Also required is a more comprehensive approach to longevity risk to incorporate longevity risks associated with both the life span and life course, such as early exit from the labour market. Policy and program settings also need to be responsive to variation within the aged population and ageing processes to reflect the subnational demographic reality. Lastly, the benefits of increased life span could be distributed across the life course to generated even greater improvements to wellbeing.

When taken together, these directions would change the policy response to population ageing. Their implementation could be slow—introduced over a decade or more. Progressive reform, however, would demonstrate the benefits of such an approach—early access to support for those that need it and better support for everyone in their frail and aged years. Regardless of the specific policy directions pursued, policy settings must provide flexibility to respond to uncertainty in demographic conditions and the growth and characteristics of the aged population. New policy challenges will inevitably emerge to which policy makers will need to respond. A mortality shock is possible, but perhaps more likely is the emergence of a growing population of individuals with very long lives. Part of the adaptive challenge to responding to population ageing is acceptance that the policy response to ageing is likely to be a continuous and uncertain process, at least for the foreseeable future.

In the subsequent chapters I consider the specific demographic analysis needed to inform these policy directions and then apply this analysis to the Australian context to examine what this reveals about the aged and ageing processes in Australia. The analysis will inform the policy directions identified in this Chapter, including by differentiating within the aged years, examining the aged population at small areas across Australia, looking at its characteristics and life course perspectives. With such analysis, it will be easier for policy makers to begin the process of differentiating the policy response between the early-aged and late-aged years, to target policy responses at small areas and to develop more comprehensive approaches to longevity risk.

Chapter 5

A multidimensional approach for examining population ageing in Australia

With the scene now set, and the policy directions which this study will inform laid out, in this Chapter I shift in focus to outline a multidimensional approach to expand the demographic evidence-base to better understand the aged and ageing processes in Australia. This approach is designed to inform the future policy response to population ageing, particularly the policy directions proposed in Chapter 4. A multidimensional approach should underpin future demographic analysis to ensure policy development is informed by a thorough understanding of the aged population. The focus of this study is on analysis for national level policy response. Both national and subnational perspectives are important to inform national level policies, but national level policy requires a distinct analysis. For example, a nationally designed care program needs to be responsive to the local demographic conditions, such as the size and characteristics of the aged population, and sufficiently flexible in its design to allow for local level variation (such as a preference for transport relative to home care services). Local initiatives, in contrast, are likely to be more specifically concerned with the residential location of the aged population, or its preferences, so that actual services can be designed for specific individuals. Thus, the analysis in this study will be one input among many informing the national response to population ageing; other demographic analyses may be required, as well as complementary studies using economic, political and sociological techniques.

There are four sections in this Chapter. In the first section I introduce a multidimensional approach for examining the aged in Australia. Such an approach should be based on geodemographic and life course perspectives of the aged population. Additionally, the analysis should encompass national and subnational approaches and different time periods so that spatial and temporal variation of the aged population and ageing processes can be examined. The geodemographic perspective includes the conventional demographic dimensions of size, age structure and characteristics of the aged population while the life course perspective incorporates new analytical approaches from current and emerging demographic theory. The focus here is on age-transitions to better understand the threshold age demarcating the commencement of the aged years, mortality conditions such as the length of life and inequality in the length of life, and life course markers of ageing such as working-life and disability-free life expectancies. The remainder of the Chapter is dedicated to the practical issues of the study, in this case the spatial and temporal analytical units selected for study.

5.1 A MULTIDIMENSIONAL APPROACH TO EXAMINING THE AGED IN AUSTRALIA

Both the policy response and the analytical approaches to population ageing are evolving. I argued in the preceding Chapter for four principles to guide the future national level policy response to population ageing. These are increased policy differentiation between the early-aged and late-aged years, a comprehensive approach to longevity risk, increased responsiveness to variation within the aged population and ageing process, and a better distribution of the benefits of increased life span across the life course to improve wellbeing. A policy response of this nature requires us to move beyond the conventional demographic analyses, those largely limited to projections of the size and age structure of the population and relative terms such as the old age dependency ratios.

Currently, a comprehensive framework for understanding the aged and ageing processes does not exist in Australia. However, Temple and McDonald (2006) provide a starting point. They also argue for a multidimensional approach including numeric, structural, compositional, spatial and temporal perspectives of the aged and ageing. As a first step to build on this approach, I separated the spatial and temporal dimensions from the others. The spatial and temporal dimensions are different because they must be studied concurrently with another analysis (i.e. spatial or temporal variation in the number of the aged). Next, I grouped the remaining dimensions (numeric, structural and compositional) elements in the Temple and McDonald (2006) framework into a conventional geodemographic perspective. I also rename these size, age structure and characteristics.

Conventional geodemographic perspectives are well understood and should be the foundation analysis of the aged population. Understanding the size and age structure of the aged population informs macroeconomic modelling, labour market analysis and planning for service delivery such as income support, health and care services. While national level analysis remains important, subnational analysis will become more important as population ageing accelerates. The baby boomers, who have already begun to qualify for aged-related services, will be a key driver of local level demand over the next twenty years. To be responsive to these local level conditions requires understanding of both the current and emerging demographic conditions at the local level.

Furthermore, there is an established and growing evidence-base linking the characteristics of the aged to both service needs and population processes of mortality and migration (see Section 3.1.3). A multidimensional approach to understanding the aged population in Australia should also include analysis of the characteristics of the aged. This should be analysis at the individual level (i.e. such as average level so income or home ownership) and analysis of the area level (i.e. the characteristics of the aged within an area and the differences between areas). Given the strong relationship between characteristics and locally delivered services (such as care), analysis of the characteristics of the aged should also be undertaken at the national and subnational level.

Life course perspectives of the aged are less well defined and understood in public debate. George (2003, 671-672) argues life course approaches "focus on time, timing and long-term patterns of stability and change" and are often concerned with the "intersection of social context and personal biography". In this study, the life course perspective is concerned with the issue of the timing of transitions between key life events such as transitions into the aged years, work to retirement, health to disability and life to death. Understanding these life course transitions is needed to inform policy responses addressing longevity risk and distributing the benefits of the increased life span across the life course. For national level policy, understanding population-level transitions is more important than individual transitions. However, in the context of supporting policy responsiveness to variation within the aged population, it is also important to better understand inequality in these transitions (such as variation in working-lives, disability-free lives and the length of life).

As a quantitative science, demographic analysis is built on quantitative analysis. Better understanding the Australian aged population using the geodemographic and life course perspectives outlined requires a set of specific analyses. I leave the detailed introduction of these analyses to Chapters 8, 9 and 10. At a high level, the geodemographic perspectives include analysis of the head count of the aged population, retrospective and prospective age structure measures, a subnational projection of the aged population and a geodemographic classification of the aged population. The life course perspective includes an examination of age-transition trajectories, a decomposition of life span change, the quantification of life span inequality, and an analysis of working-life expectancies and disability-free life expectancies.

I considered several other analyses to support the multidimensional approach. Two that ultimately were not included are a time series of population characteristics and a single index to summarise characteristics of the aged. A time series of characteristics analysis is highly relevant for policy makers, both in terms of evaluating the impact of policy interventions and understanding the service needs of the population over time. However, because of changes in the substate spatial boundaries (see Section 5.2), a historical time series for characteristics variables is not available prior to 2011. The use of indices is increasingly popular, particularly in international comparative work.[40] Developing an index suitable for the Australian data is a significant undertaking and could be considered for future research. An alternative is to apply an established index to the Australian data, but this can require substantial compromise if the Australian data is significantly different to the data used to develop the index. As a result, a summary index of the characteristics of the aged population is not included in the analysis.

Finally, while the study is structured around analysis of the size, age structure, characteristics, age-transitions in the threshold age demarcating the commencement of the aged years, life span and life course markers of ageing, the analysis does not always fit neatly into one of these groups. The projections, for example, cross over the analytical perspectives of size and age structure and incorporate analysis of the length of life and how it is changing through the projection horizon. While I structure the results around these analyses, the analysis is designed to be complementary and, when combined, produce a better understanding of the aged and ageing processes in Australia.

5.2 SPATIAL ANALYTICAL UNITS TO EXAMINE THE AGED IN AUSTRALIA

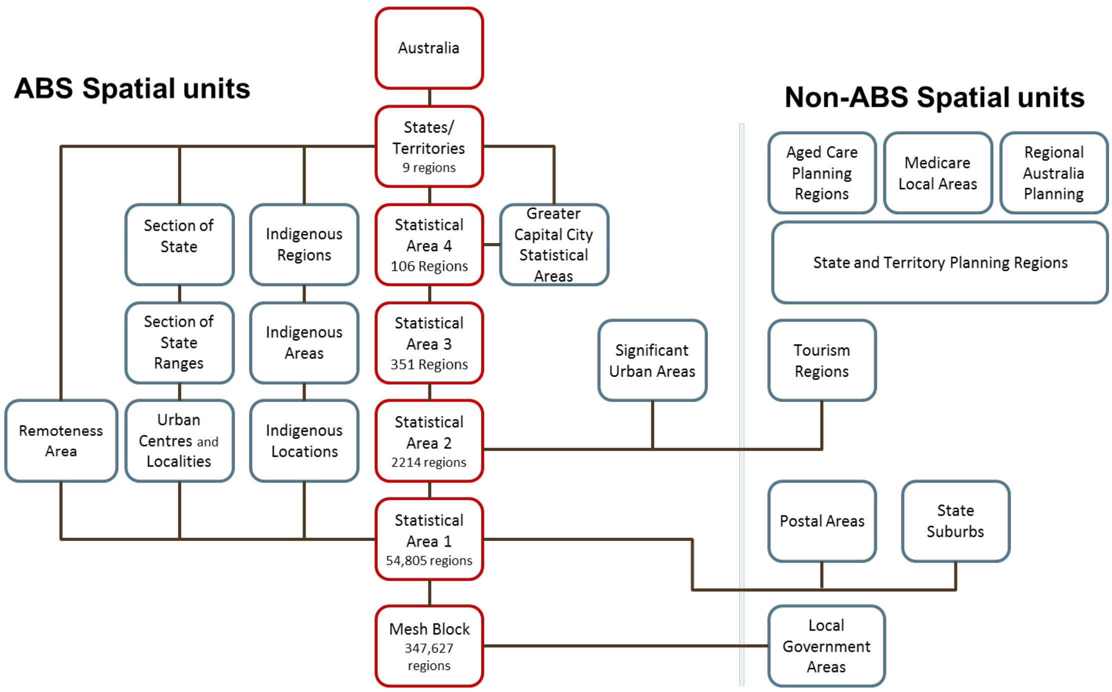
The selection of the spatial analytical unit is an important decision in subnational analysis. First identified by Gehlke and Biehl (1934), the modifiable areal unit problem is a problem affecting spatial analysis where insights vary depending on the spatial unit selected for study (see also Robinson 1950). For example, if two regions are aggregated—one region with no aged population and an adjacent region with a large aged population—the result would appear to be a region with a moderately sized aged population even though this is a poor representation of the two smaller regions. The modifiable areal unit

[40] For example, the SCL/PRB of Wellbeing in Older Populations (Kaneda, Lee and Pollard 2011) examines material wellbeing, physical wellbeing, social wellbeing and emotional wellbeing; and the European Active Ageing Index examines capacity and the enabling environment for active ageing, employment, participation in society, and independent, healthy and secure living (Zaidi et al 2013).

problem can be examined but not avoided and it is important to keep this in mind when selecting spatial units and drawing conclusions from spatial analysis.

There are many spatial units available to study the Australian population, and a selection is shown in Figure 21. In response to concerns about instability in Australian subnational spatial units, the ABS introduced the Australian Statistical Geography Standard in 2011. The Australian Statistical Geography Standard comprises the units highlighted in red in Figure 21. This is seven spatial units increasing from 347,627 mesh blocks to a single unit for Australia. In addition to the Australian Statistical Geography Standard, the ABS uses other spatial units including the remoteness structure based on the Accessibility/Remoteness Index of Australia, the "selection of state" which differentiates between urban and rural areas within the state level, the Indigenous structure, the greater capital city statistical areas defining the economic area around state and territory capitals, and the Significant Urban Areas to represent urban areas typically with a core population exceeding 10,000 people (ABS 2013b). There are also options to use non-ABS spatial units and some of these connect with the ABS spatial units.

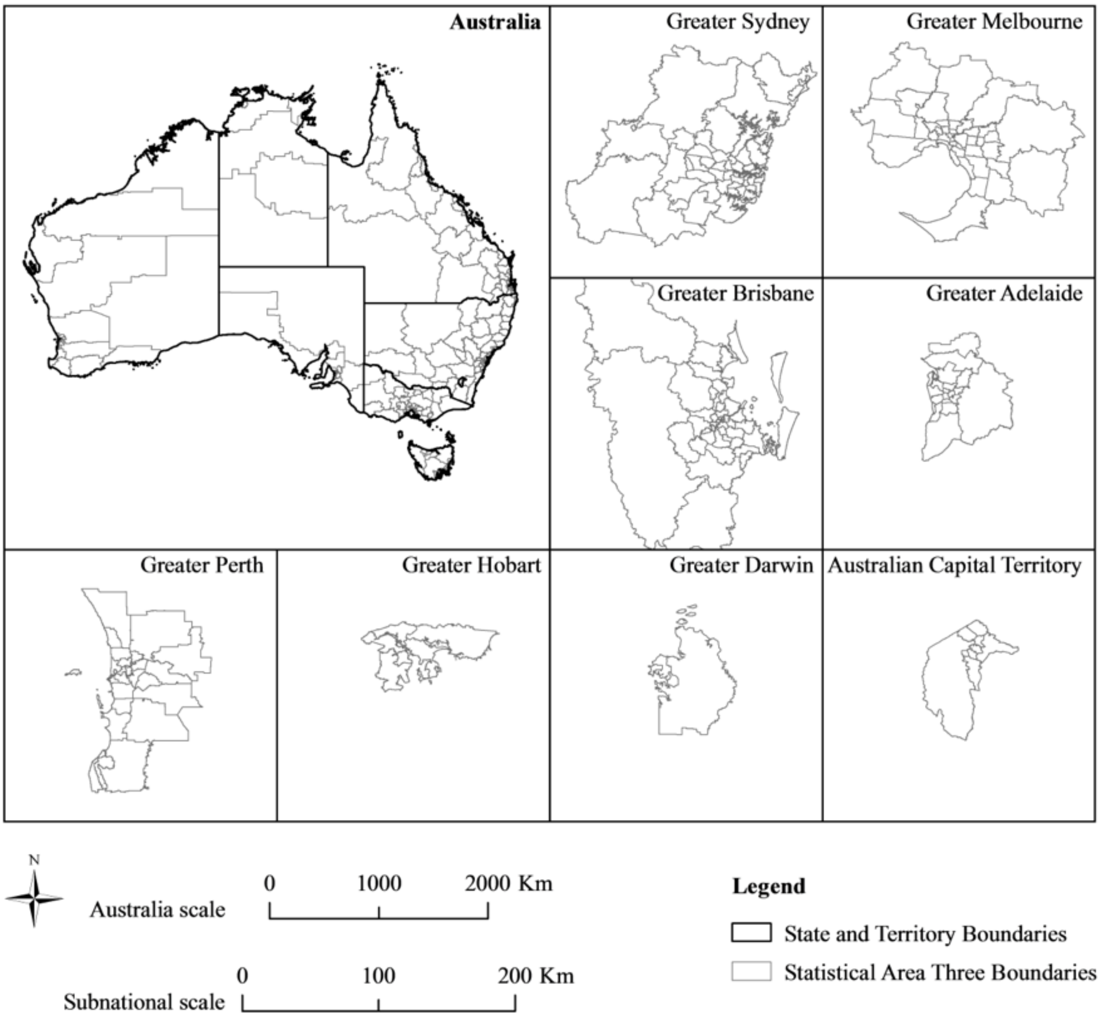
One of the significant limitations in Australian population studies is that neither the Australian Statistical Geography Standard nor its predecessor, the Australian Standard Geographic Classification, provides spatial units that can be used for a time series analysis of population at the substate level. While the Australian Standard Geographic Classification was in place from 1984 to 2011 its spatial units were not kept stable over time. The Australian Statistical Geography Standard is designed to be a stable spatial unit so that time-series analyses can be conducted in the future. However, it was only introduced in 2011.



Source: Adapted from the Australian Statistical Geography Standard: Structure and Summary (ABS 2013b).

Figure 21 Selected spatial analytical units from the ABS Australian Statistical Geography Standard and non-ABS Geography Units, 2011

The main spatial units from the Australian Statistical Geography Standard used in this study are the national unit for Australia and the substate unit of Statistical Area 3. I also refer to the states and territories and within these regions to the capital city area and rest of state area to assist describe where Statistical Area 3 regions are located. These spatial units are part of a hierarchy, with small units aggregating to form the larger units without gaps or overlaps. Several alternatives to the Statistical Area 3 regions were considered. There is a trade-off between selecting a small spatial unit to understand local level conditions and a spatial unit large enough to produce stable and plausible results. Other spatial units considered were the planning region of Medicare Local Areas (a health planning region), local government areas, postcodes, remoteness and alternatives within the Australian Statistical Geography Standard. During the initial phase of the study, the future of Medicare Local Areas in Australian Government policy was in doubt. Local government areas offered the advantage of being policy relevant, but analysis at this level cannot be easily replicated over time because local government boundaries are unstable. Furthermore, as non-ABS spatial units, both local government areas and postcodes could only be used with data apportioned (based on population weights) from the ABS spatial units. This would introduce errors which are difficult to evaluate. Lastly, I considered developing spatial units specifically for this analysis using the developing approaches to identify functional areas (Mitchell and Watts 2010), but again this would be hindered by not having the population data to match the spatial unit and would make replicating the analysis in the future a time intensive process.



Source: ABS 2013b.

Figure 22 Map of the Statistical Area 3 Regional Boundaries from the Australian Statistical Geography Standard, 2011

The four substate spatial units from the Australian Statistical Geography Standard were also evaluated for use in this study. Age disaggregated estimates are not released for two of these spatial units—the mesh block and Statistical Area 1. The smallest region where age disaggregated estimates are available is the 2214 Statistical Area 2 regions across Australia. However, distributing the aged population across these small areas yields a high number of results subject to small cell randomisation (discussed in Section 6.2.2). The next smallest spatial unit is the Statistical Area 3 which divides Australia into 351 regions. While estimates produced for these regions are still affected by small cell randomisation, the numbers of areas affected is substantially reduced. If the largest substate spatial unit is selected—Statistical Area 4—the geographic size of these regions would become so large that the results would be more vulnerable to the modifiable areal unit problem and the analysis less useful for policy makers considering local level service needs.

Ultimately, I determined the Statistical Area 3 regions from the Australian Statistical Geography Standard should be used in all substate analysis included in this study. A map of these regions is shown in Figure 22.[41] At this level the aged population is large enough to be sensibly examined and the spatial units are small enough to ensure the analysis contributes local level insights. While this spatial unit is not currently used in planning or administrative purposes, it offers the highest potential for accurate analysis and a stable spatial unit in the future. Given this feature, I expect it to be used more frequently in other studies.

Some adjustments to the Statistical Area 3 spatial units are required because this structure includes a number of units known as non-spatial units that are not suited to this study. The units excluded from the analysis are "other territories" with a total population of around 3000 (fewer than 150 age 65 and over) comprising the offshore islands of Cocos and Christmas Island and the primarily defence base at Jervis Bay; non-spatial units covering people classified as migratory (or in transit on Census night), offshore, shipping and people with no usual address; and areas covering large natural or industrial areas and with a population of zero or near zero.[42] The total number of Statistical Area 3 units retained in this analysis is 328 regions of the 351 available. However, one of the areas located in the Australian Capital Territory, Cotter-Namadgi, had a very small aged population (fewer than 30) and is combined with the adjacent region of Tuggeranong. As a result, I subsequently refer to the 327 Statistical Area 3 regions in this analysis.

5.3 TEMPORAL ANALYTICAL UNITS USED TO EXAMINE THE AGED IN AUSTRALIA

This study incorporates historical, current and forward looking analysis of Australian demographic conditions. The current analysis focuses on 2011 because this is the year of the most recent Australian Census at the time this study was conducted. The forward projection horizon is twenty years. Additionally, the purpose of the projection analysis is to assist policy makers to understand and, where appropriate, to respond to variation in

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[41] To see the distribution of Australia's aged population by these regions, refer to Figure 20.
[42] For list of these areas with additional details about how they are defined is the Australian Statistical Geography Standard (ABS 2013b).

subnational population dynamics. A projection horizon of twenty years is adequate for this purpose.

The historical analysis begins from 1901, but is more detailed from 1961. The 1901 to 2011 timeframe equates roughly to life span of the population alive at the time of this study. The 1961 to 2011 equates roughly to the working lives of the baby boomer birth cohort born between 1946 and 1966. The availability of data is the key limiting factor for the historical analysis. As mentioned elsewhere, this affects the study of subnational population characteristics over time.

5.4 CONCLUSION

To better understand the aged and ageing processes in Australia, and to expand the demographic evidence-base, a multidimensional approach is required. It should include geodemographic perspectives covering the size, structure and characteristics of the aged and life course perspectives to better understand the threshold age demarcating the commencement of the aged years, mortality conditions including the inequality in the length of life and life course markers of ageing such as working-life and disability-free life expectancies. These insights are all valuable to a policy response focused on increased differentiation between the early-aged and late aged years, a more comprehensive response to longevity risk, increased responsiveness to variation in the aged and ageing processes and a better distribution of the benefits of increased life span across the life course.

A multidimensional approach to examining the aged and population ageing should incorporate analysis of spatial and temporal variation. In this Chapter I introduced the subnational analytical unit selected for this study, the 327 Statistical Area 3 regions from the Australian Statistical Geography Standard. I also introduced the temporal unit of analysis selected as 1901 to 2011 for the historical and current analysis and 2011 to 2031 for the forward-looking analysis. The current analysis uses 2011, as this is the year of the last Census in Australia. In the next two chapters, I continue to outline the practical issues needed to examine the aged in Australia focusing on the demographic data for Australia and calculating key demographic variables.

Chapter 6

Demographic data for Australia

In this Chapter, I discuss the demographic data available for Australia and introduce the data selected for this study. This is an introduction to the data and should be read in conjunction with the following Chapter focused on calculating key demographic variables for the multidimensional approach to examining the aged in Australia. It will become clear in the following chapters that the analysis—geodemographic and life course—is built on a common platform of demographic variables, spatial analytical units and temporal analytical units.

At the outset of the study a data review was undertaken to identify potential sources of data. This included demographic data produced by the ABS, databases prepared by other researchers, surveys released by Australian academic institutions and administrative data.

Three key databases were considered: the Human Mortality Database, Australian Internal Migration (AIM) Database and the Australian Urban Research Infrastructure Network (AURIN) Database. The Human Mortality Database offers only minimal additional information to the official Australian historical statistics and the methodological differences in its construction mean it is difficult to use its data alongside the official Australian statistics.[43] The Australian Internal Migration (AIM) database is unique. Developed by the University of Queensland, AIM provides a rare insight into internal migration using a stable geographic framework over time. However, at the time of the analysis it was not up-to-date, used spatial boundaries now superseded and its open-ended age interval—which starts at age 75—is younger than I would prefer for this study (Blake, Bell and Rees 2000). The AURIN database offers significant potential but it was too early in its development to incorporate into this study.[44]

Several longitudinal data sources were identified. These include the key longitudinal surveys such as the Household Income and Labour Dynamics in Australia, Australian

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[43] See http://www.mortality.org/, developed by the University of California (Berkeley) and Max Planck Institute Max Planck Institute for Demographic Research (Germany).
[44] See http://aurin.org.au/ and Salut, Bell and Brown (2008).

Longitudinal Study on Women's Health, Australian Longitudinal Study of Ageing, New South Wales 45 and Up and the Dynamic Analyses to Optimise Ageing. While these sources provide opportunity for longitudinal analysis, the data available do not support detailed subnational analysis and access can be costly.

Administrative data sets were considered to examine spatial differences in service demand particularly for the home and care programs. However, there were several significant challenges. The administrative data and population data is typically coded to different spatial units. While it is possible to transpose the data to a common spatial unit, this process introduces significant errors.[45] Additional problems with the data were also apparent including coding services to the business address of the service provider, not the location of the service delivered, and high incidence of missing values when sample sizes were small to preserve confidentiality. These problems can be reduced by working with larger spatial units and not disaggregating data by age, sex or other characteristics; but the results produced from such analysis are not particularly meaningful. A further challenge is that aged care programs in Australia are typically not demand driven, meaning that administrative data is often a better indication of supply (and possibly supply constraints) than demand for services. While understanding the service needs of the aged population is an important endeavour, the complexities mean it warrants its own dedicated analysis.

At the conclusion of the data review, I selected official demographic data produced by the ABS. Not only is this data of high quality, but its regular release (for no cost or low cost) means the results of this analysis can be updated following future releases and extended to support time series analysis. Additionally, from 2011 the Australian Census and the official demographic statistics use the Australian Statistical Geography Standard (see Section 5.2). The Australian Statistical Geography Standard provides a flexible platform and opens the possibility of this analysis being calculated for additional spatial units in the future.

In the following subsections I describe the data sources selected for the study, focusing on the historical, current and future estimates of the resident Australian population, mortality, internal migration, international migration and population characteristics.

[45] The ABS publishes geographic correspondences to support transposing data (ABS 2012c). However, the correspondences work for total population counts. Correspondences based on age are not available; therefore, the results will only be accurate if the spatial distribution of the aged population is consistent with the spatial distribution of the total population. Most regions violate this assumption.

Fertility data is not required for this study as the projection model for the aged population begins at age 45.

6.1 POPULATION ESTIMATES

The ABS produce estimates of national, state and territory population on a quarterly basis (see for example, ABS 2014b). For the Census year, the resident population is estimated using the Census count and adjusted for the Census undercount and population change from natural increase and net international migration between Census night and the preceding 30 June. It includes any person who is (or is expected to be) resident in Australia for a period of 12 months in a 16 month period. Thus, population counts include people who are not Australian citizens, with the exception of foreign diplomats and their families who are excluded from the estimates.

Estimated resident population estimates are released throughout the intercensal period using vital records for birth and death registration and administrative records for net international migration. These estimates are initially referred to as preliminary estimates, then revised estimates, and then final estimates. Final estimates are produced following the subsequent Census to improve the accuracy of intercensal estimates. This revision process is referred to as rebasing. The population estimates used in this analysis are final estimates.

Once a year estimates of the estimated resident population are disaggregated to the substate geographies included in the main spatial structure of the Australian Statistical Geography Standard (see for example, ABS 2013b and ABS 2014a). These estimates are produced using a similar adjustment process to the Australian and state and territory estimates. The Census counts are adjusted for the net Census undercount disaggregated by age, sex, Indigenous status, state and territory and broad region. During the intercensal years, migration is estimated using a mathematical model incorporating dwelling approvals, Medicare enrolments and counts of people on the Australian Electoral Role with some adjustment for local level knowledge. The total population is then disaggregated into age and sex by single year of age. The single year of age estimates, however, are not publicly released; instead a total population estimate is released for Statistical Area 1 and population counts aggregated into five-year age intervals (with an open-age interval beginning at age 85) for the remaining substate geographies.

Historical population estimates are available for Australia and the states and territories since 1901. Historical population estimates using the Australian Statistical Geography

Standard are not available at the substate level prior to 2011. For this, correspondences must be used to map spatial units from the Australian Geographic Classification to the Australian Standard Geographic Classification (see Section 5.2). In this study, I use historical population estimates from the 2014 Australian Historical Population Statistics release (ABS 2014c). Estimates between 1901 and 1971 are derived from the Census based on place of enumeration and adjusted for registered births and deaths, internal migration (for subnational estimates) and international migration. From 1971, the estimates are based on place of usual residence and have also been adjusted for Census undercount. This methodological change has a negligible impact on the results in this study.

During the study, the ABS undertook extraordinary steps to revise its historical population estimates, affecting the period 30 June 1991 to 30 June 2011. Following the 2011 Census additional revision was necessary to smooth the effects of a change in methodology for the post-enumeration survey used to quantify the Census undercount. The change in method resulted in a 40 per cent reduction in the estimate of the Census undercount compared with the method used in the 2006 Census. Absorbing this revision across a single intercensal period (from 2006 to 2011) would have produced unrealistic growth rates. Instead the ABS revised the Census population estimates from 1991. As a consequence of the revisions, the ABS also revised historical demographic growth rates. This study uses the revised estimated resident population estimates and historical demographic rates.

Future estimates of the national, state and territory populations are released after each Census using a cohort component projection methodology (ABS 2013g). The forecast accuracy of the ABS projections has improved since the 1980s, but is (like all projections) still subject to forecast error (Wilson 2007). The most recent population projection (released in 2013) includes 72 potential growth scenarios from the base year of 2012 to 2101 for the Australian population (using the best preliminary estimate of the 2012 population available at the time). Estimates of the population for the state and territories, capital cities and balances of states (the region of a state outside the capital city) were also released for 2012 to 2061. The projections are disaggregated by age and sex, but large age groups are used for the substate estimates (i.e. under age 15, age 15 to 64, age 65 and over and age 85 and over).

In this study, I use the lead higher, medium and low growth scenarios from these projections. The lead projection scenario is known as *Series B*. It is a long-term trend scenario assuming fertility falls to 1.8 births per woman by 2026 and then remains constant, life expectancy increases but at a slower rate than long-term trend and net international migration increases to 240,000 people per year by 2020-21. The lead high growth scenario, known as *Series A*, assumes fertility increases to 2.0 births per woman by 2026 and then remains constant, life expectancy increases at a rate consistent with long-term trends and net international migration increases to 280,000 people per year by 2020-21. The lead low growth scenario, known as *Series C*, assumes fertility declines to 1.6 births per woman and then remains constant, life expectancy increases but at a slower rate than the long-term trend and net international migration increases to 200,000 people per year by 2020-21 (ABS 2013g).

6.2 POPULATION CHARACTERISTICS ESTIMATES

A key source of information on the characteristics of the population is the Australian Census. The Australian Census is the largest statistical collection since the population was first enumerated in 1911. The Census has been collected every five-years since 1961, with the most recent Census undertaken on 9 August 2011. The Census aims to record every person in Australia as at Census night except for foreign diplomats and their families. The population characteristics in the Census include age, sex, Indigenous status, country of birth, language, relationships, household, employment, income, and dwelling information—these are all used in this study. In this study, Census data from 2006 and 2011 is used and extracted directly using Table Builder (see for example, ABS 2006; ABS 2011d).

The ABS tries to ensure consistency across the Censuses to support the use of Census data in time series analysis. Despite this, change in the Census collection process, Census questions and collation of results can occur. Fortunately, these changes have minimal impact on this study.

The Australia Census is a high quality enumeration, but it is not immune from errors. In the subsections following I discuss key data issues arising from the undercount in the Census, small cell randomisation and differences between variables calculated based on place of enumeration and place of usual residence. There are other sources of error to be aware of, including partial response, respondent error and processing error. In 2011, the national average non-response rate was 3.7 per cent. To minimise the impact of these errors the ABS imputes responses where the likely response can be derived from responses to related questions as well as to critical questions such as age or sex.

6.2.1 Undercount in the Census

The ABS concluded that 98.3 per cent of the usually resident population were enumerated in the 2011 Census, with the undercount varying by age and location (ABS 2012a).[46] The undercount also varies by characteristics. Young adult males, never married, Indigenous people and foreign born populations (particularly people born in China and India) more likely to be missed in the Census. The Census is not corrected for the undercount. Consequently, caution should be exercised when utilising Census data for counts of the population. The estimated resident population data introduced above (see Section 6.1) is preferable for population counts and used wherever possible in this analysis. However, Census data is ideal for examining the characteristics of the population.

6.2.2 Small cell randomisation in the Census

The ABS use randomisation and small adjustments to preserve confidentiality of individual responses (ABS 2011c). Randomisation occurs when any cell in a data table has a count of one, two or three. Following randomisation small adjustments may be made to other cells in the data table so that the true value of any small cell cannot be deduced. The randomisation process leads to some distortions in the data and unreliable results. For example, in this study multiple implausible scenarios were observed in the results, including proportions of a population subgroup exceeding one, results that misrepresent actual population characteristics and difficulties replicating results.

I developed a handling strategy to minimise the errors that could be introduced into the analysis as a result of the small cell randomisation. It involved selecting a substate spatial unit and variables to minimise the incidence of small cells; minimising disaggregation when extracting estimates from the Census (i.e. extracting estimates for the age group 65 to 84 instead of extracting several five-year age groups and aggregating them to derive the age group 65 to 84); and, where a proportion of a population subgroup exceeds one, adjusting the result to equal one.

Extensive experimentation was undertaken to identify the effects of small cell randomisation on the results and test additional strategies. The key additional strategy tested was to replace any cell with a count of less than four (below which cells were most likely to have been affected by randomisation). This strategy was problematic because adjustments were only performed on some of the cells affected by small cell

[46] Note that this publication does not include age disaggregation of the undercount above the age of 55.

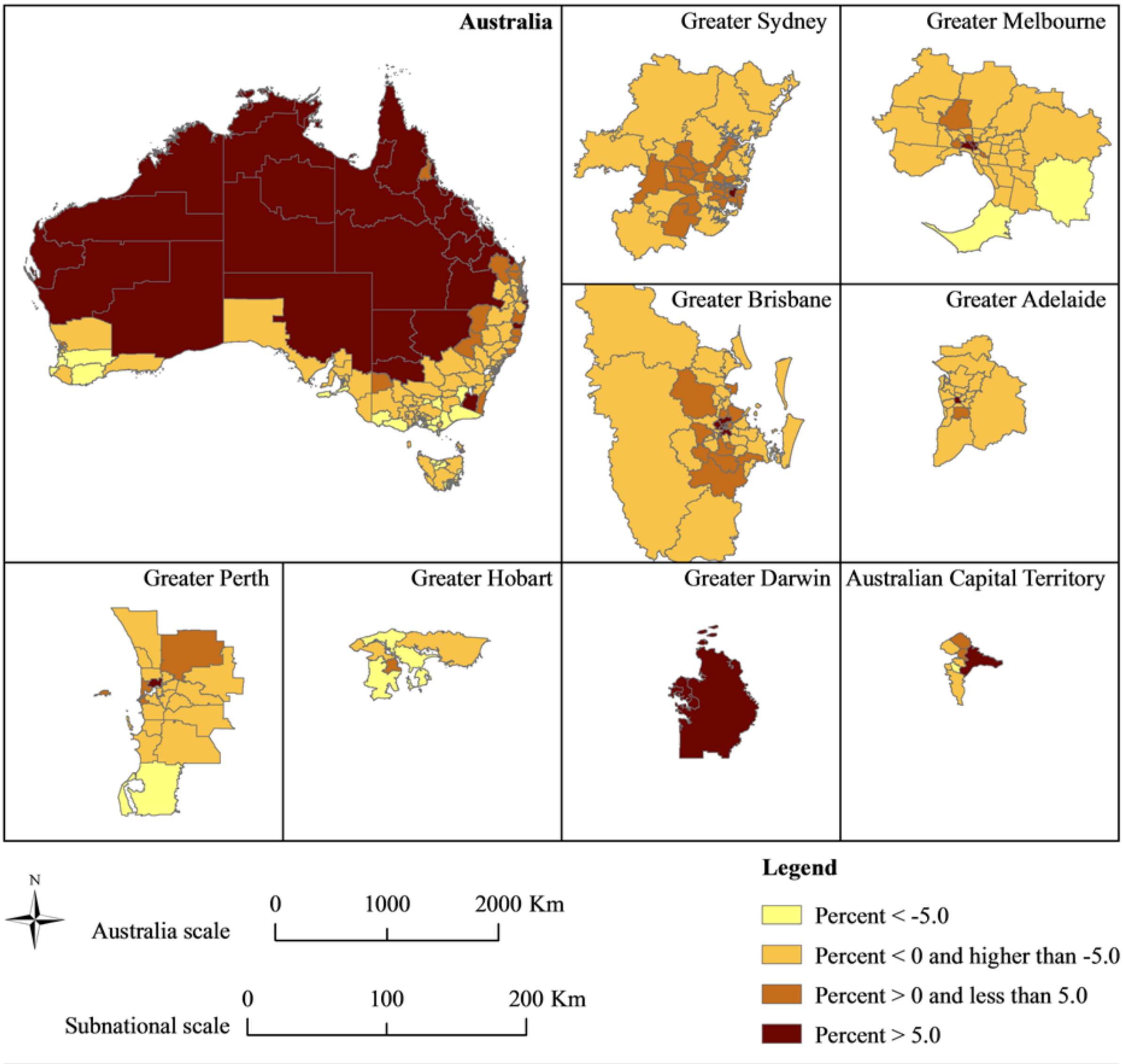
randomisation. As mentioned, it is not possible to identify the true values of any cell, and therefore only adjusting small cells leaves other cells in the data table unadjusted. Ultimately this strategy is not recommended. Additionally, the results produced when this strategy was applied, had only marginal effect on the overall findings. However, it was not possible to determine whether the results based on this strategy are more or less accurate.

The numbers of small cells differ depending on the analysis and characteristic. The analysis using variables with a lot of disaggregation by sex, age, characteristics and/or location are the most affected. The characteristics which occur less frequently or are spatially concentrated in few regions and dispersed across others (such as the Indigenous or high income population) are also affected. Typically, however, the number of regions with identified small cell adjustments is less than 5 per cent.

6.2.3 Place of Enumeration and Place of Usual Residence

The ABS count the population by place of enumeration and place of usual residence. Usual residence is defined as "that place where each person has lived or intends to live for six months or more from the reference date for data collection" (ABS 2011c). The place of enumeration population is the population count of every person who spends Census night in Australia. At the national level the proportion of the population aged 65 and over away from their usual residence on Census night in 2011 was 6 per cent. At the subnational level this can vary between zero and 25 per cent. The place of enumeration population can be higher or lower than the usual resident population as shown in Figure 23. Significantly, the remote and northern regions of Australia have a higher enumerated population compared with the usual resident population, as the Census is undertaken during the cooler months of the year when many people take the opportunity to travel to the desert and remote regions in Australia.

Understanding the differences between the place of enumeration and place of usual residence is important because the ABS does not publish all Census data for place of usual residence (although these may be available for a fee). I decided to include variables based on place of enumeration in this study because, on balance, it is better to include these variables and acknowledge their limitations than exclude all Census variables not published for place of usual residence. In some cases I make amendments to these variables to compensate for these limitations using the method I outline in Section 7.3.



Source: ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2)

Figure 23 Difference between the count of the population aged 65 and over between place of enumeration and the usual resident population: Statistical Area 3 Australia, 2011

6.3 MORTALITY ESTIMATES

ABS mortality estimates are available via three sources: the historical population statistics, the annual releases of death estimates and life tables (see for example, ABS 2014c; ABS 2013f and ABS 2013c). The historical estimates include some death counts from 1824, complete death estimates for Australia and the states from 1911, standardised death rates from 1971, and single year of age life tables for selected years from 1881.

Death data is released annually for the substate geographies. The estimates for 2011 are used, which are actually based on a three-year average (to ensure a smoother time series).

The death estimates can be disaggregated by selected subnational spatial units, sex, age and the population characteristics of marital status, country of birth and Indigenous status. However, significantly for this study, death estimates are not disaggregated by age and sex for substate regions and must be indirectly estimated if they are required.

Estimates for mortality improvements are not directly available but can be derived from the projection assumptions published with the ABS population projections (see Section 6.1) (ABS 2013g). Specifically, the published assumptions include estimates of the probability of death (the q_x value in the life table) for Australia and the states and territories disaggregated by sex and single year of age (with an open-age interval starting at age 101). The projection assumptions are based on historical mortality change since 1996 by age and sex.

As mentioned, the ABS include multiple scenarios for future mortality trends. These include morality improvements consistent with the long-term trend (referred to as 'trend' in this study) and improvements at a slower rate than the long-term trend (referred to as 'slowing' in this study). These scenarios are the same until the year 2016 but then deviate. For the trend scenario, the increase in life expectancy is around 0.25 years per year for males and 0.19 years per year for females over the period 2012 to 2031. Under the slowing scenario, the rate of increase falls from 0.25 years to 0.10 years per year for males and 0.19 years to 0.08 years per year for females over the period 2016 to 2031.

6.4 INTERNATIONAL MIGRATION ESTIMATES

The ABS releases migration estimates annually with estimates of international arrivals and departures based on administrative records (see for example, ABS 2015c). The ABS define an immigrant as a person who has "been (or are expected to be) residing in Australia for a period of 12 months or more over a 16 month period". Thus, international migration is related to residency status and not citizenship status. Migration estimates are published for calendar years and financial years. The financial year estimates are used in this study. Migration estimates can be disaggregated by state and territory, by sex and five-year age groups (with an open-age interval starting at age 65).

Future estimates for international migration can also be derived from the projection assumptions published with the ABS population projections (see Section 6.1) (ABS 2013g). This includes estimates of high, medium and low levels of international arrivals and departures by sex and single year of age for Australia and the states and territories. The open-age interval for the forecast estimates begins at age 100. The ABS projects three scenarios for international migration: high, medium and low. The projected estimates for three scenarios change in level up to 2021 and are constant from 2021 to 2031. The high scenario projects the addition of 280,000 people per year from 2020-21, the medium scenario projects 240,000 people per year and the low migration scenario projects 200,000 people per year.

In this study, I include both actual and forecast estimates of international migration. I use actual estimates up until June 2014 for the population aged 45 and over. The estimates to June 2013 are final estimates and the estimate for 2013-14 is a preliminary estimate. From July 2014 to 2031 I use the projection assumptions published by the ABS. It is worth noting that in recent years the projected migration estimates have tended to overestimate actual migration.

6.5 INTERNAL MIGRATION ESTIMATES

The ABS estimate internal migration by age and sex for the purposes of producing subnational population estimates (ABS 2015d). While these estimates are published annually, the published estimates are limited to large age groups (i.e. age 45 to 64 and age 65 and over). Due to this limitation, the estimates of internal migration used in this study are instead calculated using Australian Census data, which provides better age disaggregation. In addition, Census data contains information on usual place of residence at the time of the Census, one year prior to the Census and five-years prior to the Census (ABS 2011d).

The Census data can be used to estimate internal migration by age, sex and location. Beyond this, insights from the data are limited. It is not possible to calculate internal migration by characteristics because characteristics at the time of migration are not recorded in the Census. Census data also does not record multiple moves within a reference period. Census data records residential status at the beginning, end and one year prior to the end of a reference period. It will not, however, accurately capture mobility if the individual undertook additional moves within the period. Also, it is not possible to evaluate if moves are permanent or temporary using Census data.

Forecasts of internal migration are not published.

6.6 CONCLUSION

In this Section I outlined the data selected for the study. All the data is official demographic data selected produced by the ABS. Not only is this data of high quality, but its regular release (for no cost or low cost) means that the results of this analysis can be replicated following future releases to update the results and support it enhancement through time series analysis. In the next Section I outline the methods to estimate key demographic variables using this data.

Chapter 7

Calculating key demographic variables to use in the multidimensional approach

In Chapter 5 I outlined a multidimensional approach to inform the policy response to population ageing in Australia. The multidimensional approach includes geodemographic and life course perspectives of the aged and ageing processes. In this Chapter I outline the methods to calculate the key demographic variables to examine these dimensions, specifically estimates of population counts, population characteristics, mortality and migration (international and internal). These form a set of variables that are used throughout the study.

Some the calculations presented in this Chapter are highly detailed. It may not be clear also how each variable sits will be used for the study. Part of the challenge is that many of the variables are used across multiple analyses. To illustrate this point, consider how widely used the life table is in this study (for readers not familiar with the life table, it is introduced in Section 7.3.1 and the methods of these analyses listed below are introduced in Chapter 8, 9 and 10). In this study life table quantities are used to calculate the prospective aged proportion of the aged population, the projection of the size and age structure of the aged population, the decomposition of the life table, the age-transition trajectories to examine change in the threshold of the aged, the decomposition of life span change, the life span disparity analysis and threshold age separating early and late deaths uses deaths, and, disability-free life expectancy and working life expectancy analysis.

The development of these variables was also an iterative process. As the analysis progressed I returned to earlier analysis and made revisions to change methods, improve calculations and amend age segmentation. The goal was to produce a single set of variables which could be used flexibly to examine the geodemographic and life course perspectives of the aged. Effectively what is needed for the study, and what is outlined in the following subsections are calculations for:

- counts of the population segmented into different age groups;

- counts of the aged population by characteristic;
- mortality conditions at the national and subnational level with:
  - mortality conditions at the national level covering the period 1901 to 2031; and
  - mortality conditions at the subnational level covering the period 2011 to 2031.
- estimates of international and internal migration suitable for use in the subnational projection model of the aged.

7.1 POPULATION COUNT VARIABLES

Population count variables are at the core of much of the analysis in this study. Most of the population count variables can be calculated from the estimated resident population data or Census (see Section 6.1). Estimated resident population data is preferred for variables requiring a measure of the size of the population because, as explained, these estimates are the most accurate population estimates available. However, as estimated resident population data is released only by age and sex, counts of the population with specific characteristics must be derived from the Census.

Calculating the population count variables requires segmentation of the population estimates into age groups. A common way to segment the population is based on the life course stages of youth, working-age and the aged. In this analysis, I use age 0 to 19 to represent youth, age 20 to 64 to represent working-age and age 65 and over to represent the aged. The definition of youth in this analysis is older than definitions in other studies which define youth as age 0 to 15 (United Nations Population Division 2015). In Australia, the average years of education is increasing and, therefore, I consider extending the youth category up to and including age 19 to be more appropriate for current and future conditions.[47] Using age 65 as the threshold of the aged ensures consistency with other Australian research (although recall from Chapter 4 that I recommend a non-age based measure of the threshold of the aged be used in the future).

I further segment the aged population into two groups: age 65 to 84 to represent the early-aged years and age 85 and over to represent the late-aged years. In early iterations of the analysis I experimented with different groupings, including a three age group approach

[47] In Australia, secondary education is typically completed at age 17 or 18 and the proportion of the population in 2011 aged 15-64 years with a post-school qualification is increasing and approaching 60 per cent (ABS 2012e).

(such as age 65 to 79, age 80 to 94 and age 95 and over). I considered a three age group approach would better reflect current literature identifying a period of healthy-aged years characterised by work or other productive activity, a period of declining-aged years characterised by withdrawal and increasing ailments and a frail-aged period covering the days or months (and possibly years) of dependency. As the analysis progressed it became clear that these were overlapping and non-linear trajectories and, with the data available, I could not determine population level criteria to accurately distinguish these groups. Additionally, I also considered studying centenarians as a stand-alone age group; however, in Australia centenarians are still few in number (approximately 3000 people in 2011 (ABS 2014b)) and, once disaggregated to the substate spatial units, the group is too small to produce accurate or useful insights.

At the present time, it may appear that an early-aged group of 65 to 84 is too large and too old to represent the early-aged group. The purpose of the age groups, however, is not to segment the aged into two equal groups. Consistent with the literature on active ageing, the goal is to extend active and healthy life into the aged years (Kalache and Kickbusch 1997). I use age 65 as the lower bound to be consistent with other Australian research but the analysis presented in Chapter 10 shows that the threshold of the aged years could already have shifted into the early 70s. Any distinction between the early-aged and late-aged years will be arbitrary; the goal of this study is move the existing analysis forward by differentiating within the aged population.

Some of the analysis in this study requires population counts for age groups not available in the publicly available data. I use indirect methods to calculate these counts. The launch population for the projection model requires a population count variable for age 45 to 110 segmented into five-year age groups for the 327 regions included in the analysis. Estimates for the launch population use estimate resident population which, recall from Section 6.1, is segmented into five-year age groups with an open-age interval beginning at age 85. Indirect estimation is needed to produce estimates of population counts from age 85 to 110. Using the 2011 Census I calculate the proportions of the population aged 85 and over in each five-year age group from age 85 to 104. I then apply these proportions to the count of the age 85 and over population from the estimated resident population, giving estimates for the population aged between 85 and 104 in five-year age groups. The counts of the population aged 105 to 110 is zero for all regions and consequently the launch population incudes a population count of zero for the age group 105 to 110 for all

327 substate regions.[48] Using the same method, the estimates of population counts for the ages 0 to 5 are disaggregated into the ages 0 to 1 and 1 to 4. These estimates are used in the calculation of the substate life tables (discussed in Section 6.3).

7.2 POPULATION CHARACTERISTIC VARIABLES

Population characteristics variables are used to examine the population characteristics in the geodemographic perspective and the life course markers of ageing in the life course perspective. Population characteristics variables are organised into three domains: individual, economic and social. The individual domain includes characteristics measuring age, sex, disability, Indigenous status, country of birth and language. The economic domain includes characteristics measuring income, education, employment and housing tenure. The social domain includes characteristics measuring children, marriage and domestic support. Due to limitations with the data available, additional variables to study family relationships or the family unit are not included.[49]

All characteristics variables are from the Census (see Section 6.2). A summary of the Census indicator, Census database, variable name, denominator and variable-specific non-response rate is included in Table 6. For the majority of characteristics the calculation of the variable is straightforward. Where explanation is required, I include the additional commentary following Table 6. In addition, for ease of reference, I dedicate separate subsections to the calculation of the disability prevalence and working-life prevalence variables used in the Sullivan life expectancy analysis presented in Chapter 10.

7.2.1 Individual Characteristics

In addition to the characteristics variables associated with being aged (aged, early-aged and late-aged), the individual characteristics included in the study cover sex, disability, Indigenous status, country of birth and language. *Disability* is calculated for both 2011 and 2006, and the remaining individual variables are only calculated for 2011. All individual variables are counts of the population based on their usual residence.

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[48] Note: these are estimates of the population aged 105 to 110 extracted from the Census database for the substate Statistical Area 3 regions. When estimates are calculated for larger geographies a small number of peopled aged between 105 and 110 are identified.

[49] More family and household variables are available from the Census but the data extraction tool supports only limited interaction with the age variable. For these variables to accurately measure the aged population I need to be able to extract data by age of each person in the family our household—this is not currently possible.

Table 6 Characteristics included in the analysis from the 2011 and 2006 Census of Population and Housing

	Characteristic	Census Indicator	Non-response rate (%)	Census Database(s)	Variable names (in italics) and construction (if required)	Denominator (if applicable)
Individual characteristics utilised from the 2011 Census	Age	AGE	4.2	Usual residence Place of enumeration	*Aged* (head counts aggregated into age 65 and over) *Early-aged* (head counts aggregated into age 65 to 84) *Late-aged* (head counts aggregated into age 85 and over)	Census, usual residence Census, place of enumeration
	Sex	SEXP Sex	2.2	Usual residence	*Male* *Female*	Census, usual residence
	Disability	ASSNP Core Need for Assistance	5.7	Usual residence	*Disabled*	Census, usual residence
	Indigenous	INGP Indigenous Status	4.9	Usual residence	*Indigenous* (aggregated from variables Aboriginal OR Torres Strait Islander OR both Aboriginal and Torres Strait Islander)	Census, usual residence
	Country of Birth	BPLP Country of Birth of Person	5.6	Usual residence	*Foreign born (similar)* (comprising of North-West Europe, North America, New Zealand, the United Kingdom and Ireland) *Foreign born (dissimilar)* (comprising of Sub-Saharan Africa, North Africa and the Middle East, Southern and Eastern Europe, South-East Asia, North-East Asia, Southern and Central Asia, Oceania and Antarctica, South and Central America and the Caribbean). *Australian born* (comprising of Australia but excluding external territories)	Census, usual residence
	Language	ENGLP Proficiency in Spoken English	5.0	Usual residence	*Speaks English only* *Poor proficiency in English* (aggregated from speaks other language and speaks English not at all OR speaks other language and speaks English not well)	Census, usual residence

	Characteristic	Census Indicator	Non-response rate (%)	Census Database(s)	Variable names (in italics) and construction (if required)	Denominator (if applicable)
Individual characteristics utilised from the 2006 Census	Disability	ASSNP Core Need for Assistance	6.4	Usual residence	*Disabled* (Same as for Census 2011)	Census, usual residence
Economic Characteristics from the 2011 Census	Income	INCP Total Personal Income Weekly	7.9	Usual residence	*Low income* (aggregation of nil income OR $1-$10,399 OR $10,400-$15,599 OR $15,600-$20,799) *Middle income* (aggregation of $20,800-$31,999 OR $31,200-$41,599 OR $41,600-$51,999 OR $52,000-$64,999 OR $65,000-$77,999) *High income* (aggregation of $78,000-$103,999 OR $104,000 or more)	Census, usual residence
	Education	HSCP Highest Year of School Completed QALLP Non-School Qualification	8.4 (HSCP) 17.1 (QALLP)	Usual residence	*Incomplete secondary schooling* (aggregation of did not go to school OR Year 8 or below OR Year 9 or equivalent OR Year 10 or equivalent OR Year 11 or equivalent) *Highest education of secondary schooling* (aggregation of HSCP Year 12 or equivalent AND QALLP Non-School Qualification Not Applicable) *Highest education of vocational education training* (aggregation of Advanced Diploma OR Diploma OR Certificate Level) *Highest education of degree* (aggregation of Degree OR Graduate Diploma OR Graduate Certificate OR Postgraduate Degree Level)	Census, usual residence

	Characteristic	Census Indicator	Non-response rate (%)	Census Database(s)	Variable names (in italics) and construction (if required)	Denominator (if applicable)
	Employment	LFSP Labour Force Status	5.6	Usual residence	*Not in the labour force* *Labour participation* (aggregation of working and unemployed) *Working* (aggregation of the working part-time, working full-time variables and working and hours not specified)	Census, usual residence
	Employment	HRSP Hours Worked	2.2	Usual residence	*Full-time equivalent* See description below for details on the calculation of this variable Note: the apportionment strategy is detailed below	Not applicable
	Housing tenure	TENLLD Tenure and Landlord Type	6.1	Place of enumeration, private dwellings only	*Home owner without mortgage* *Home owner with mortgage* *Private renter* (comprising of rented from a real estate agent OR rented from a person not in the same household OR rented from other land lord type OR rented from landlord type not stated) *Public renter* (comprising of rented from state or territory housing authority OR rented from housing co-operative, community or church)	Census, place of enumeration
Economic Characteristics, 2006 Census	Employment	LFSP Labour Force Status	6.53	Usual residence	See above. Same as for Census 2011.	Census, usual residence
	Employment	HRSP Hours Worked	2.79	Usual residence	See above. Same as for Census 2011.	Not applicable
Social Characteristics, 2011 Census	Children	TISP Number of Children Ever Born	6.0	Usual residence	*Women without children* *Women with children* (comprising of females with at least one child)	Census, usual residence, females
	Marriage	MDCP Social Marital Status	Not available.	Usual residence, private dwellings only	*Married* (aggregation of married in a registered marriage OR married in a de facto marriage)	Count, usual residence, private dwellings only

Characteristic	Census Indicator	Non-response rate (%)	Census Database(s)	Variable names (in italics) and construction (if required)	Denominator (if applicable)
Domestic support	RLHP Relationship in Household	Not available.	Usual residence, private dwellings only	*Lone person household*	Count, usual residence, private dwellings only
Domestic support	NPDD Type of Non-Private Dwelling	Not available.	Place of enumeration	*Resident of non-private dwelling* (aggregation of hostel for the disabled OR nursing home OR accommodation for the retired or aged (not self-contained) OR other welfare institution)	Census, usual residence

Disability is used in both the geodemographic and life course analysis. These comments give the general background to the Census measure of disability, and the detail on how it is used to calculate disability prevalence for the *disability-free life expectancy* is covered in a separate section below (see Section 7.2.1.1). There are many ways to calculate disability including self-defined or independently assessed and by the degree of disability or frailty. In the Australian Census, disability is a measure of core activity limitation. It is a new addition to Census, introduced in 2006. The ABS calculates the presence of a core activity limitation based on three Census questions:

- Does the person ever need someone to help with, or be with them for, self-care activities?
- Does the person every need someone to help with, or be with them for, body movement activities?
- Does the person ever need someone to help with, or be with them for, communication activities?

This is a self-assessment approach with the respondent assessing his or her own capability or the capability of the household member they are responding on behalf of. The respondent can select the following response options: yes, always; yes, sometimes; or no. A further question assesses if the need for assistance is expected to last six months or more. Only people with a response of "yes, always" or "yes, sometimes" on the three core activity limitation questions who also identifies the causal factor of the disability lasting six months or more are determined to have a core activity limitation. This measure of disability has been purposefully designed with a high threshold for disability so that it is broadly equivalent to severe or profound disability (see Howe 2008).

The *Indigenous* variable is uniquely relevant to the Australian context given the historical significant of the Australian Indigenous population. The Australian Indigenous population is also highly disadvantaged in comparison to the non-Indigenous population (Australia Government 2016). The service needs of the Indigenous population are often distinct—targeting different locations and designed with cultural sensitivities in mind. For this reason, I include a dedicated variable for the Indigenous population using the Census variable INGP Indigenous Status. Data relating to the Indigenous population can have quality issues (Biddle 2015), but the ABS uses a dedicated Indigenous Enumeration Strategy to improve the quality of Census data collected for the Indigenous population to improve the quality of the enumeration (ABS 2012b).

The *foreign born culturally and economically similar* and *foreign born culturally and economically dissimilar* are calculated from the Census using the BPLP Country of Birth of Person variable. In this study country of birth is a proxy for ethnicity to measure, in the British definition of the concept, “a sense of belonging to a group of people who share characteristics such as cultural values, language, religion, history and skin colour” (Willis, Price and Glaser 2013, 279). In the initial iterations of the analysis, eleven country of birth variables were used representing groupings of countries (such as south-east Asia). In the final iteration this is simplified to three variables representing the Australian born, foreigners born in regions culturally and economically similar to Australia (*foreign born similar*), and foreigners born in regions culturally and economically dissimilar from Australia (*foreign born dissimilar*).

Language is examined using two variables: *speaks English only* and *poor proficiency in English*. Both are calculated from the Census variable ENGLP Proficiency in Spoken English which requires the respondent to self-assess his or her English ability if they speak a language other than English at home. Response options include: “very well”, “well”, “not well” and “not at all”. The response options of “not well” and “not at all” were aggregated to identify the people who have poor proficiency in English. Consequently, the *poor proficiency in English* variable is not a measure of poor literacy in English if English is the respondent’s only language.

7.2.1.1 Disability prevalence for disability-free life expectancy

A disability prevalence variable is needed to calculate disability-free life expectancies. Disability prevalence is calculated using the Census variable ASSNP Core Activity Need for Assistance using counts of persons with a core activity limitation (the same as the *disability* variable mentioned above) divided by the usual resident population. At the national level disability prevalence is calculated for 2006 and 2011 using single year and single sex counts with an open-age interval beginning at age 100 (to match the national life tables). At the subnational level disability prevalence is calculated for 2011 using the Statistical Area 3 regions. Disability prevalence at the subnational level is calculated by sex and the age groups 0 to 1, 1 to 4 and in five-year age groups until age 110 (to match the substate life table). For the subnational disability prevalence indirect estimation is required for the population aged 105 to 110. For this age group I assume prevalence is the same as the population aged 100 to 104.[50]

Additional indirect estimation is used to adjust the subnational disability prevalence. In the original data two issues cause particularly concern: implausible zero counts and potential inaccuracies due to small population counts (which I defined as five or fewer people). I use a Standardised Disability Ratio to adjust these estimates—specifically if a subnational disability estimate was zero or based on a small population count then I replace it with the Australian prevalence estimate (by age and sex) multiplied by the Standardised Disability Ratio. To calculate the Standardised Disability Ratio I adapt Jain's (1994) equation for the Standardised Mortality Ratio (outlined in Section 7.3) by replacing observed total deaths with total people with disability. The standard population is the Australian population.[51] Unlike the Standardised Mortality Ratios calculated for the substate regions which are not calculated for males and females separately, the Standardised Disability Ratios are sex specific.

This method tends to reduce disability-free life expectancy, but by very small amounts—for 75 per cent of regions, adjustments reduce disability-free life expectancy at birth by less than 0.1 years. However, for a few regions the impact is significant, including a reduction of 5.1 years in one location.

7.2.2 Economic Characteristics

There are economic characteristics included in this analysis covering income, education, employment and housing tenure. The specific variables include *low income, middle income, high income, incomplete secondary schooling, highest education of secondary schooling, highest education of vocational education and training, highest education of degree, not in the labour force, labour force participant, working, full-time equivalent, home owner with mortgage, home owner without mortgage, private renter, public renter.* All variables are calculated for 2011 and the *working* and *full-time equivalent* variables are also calculated for 2006. The income, education and employment variables count the population based on their usual residence. The housing variables enumerate the population based on place of enumeration.

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[50] While the Census includes people aged between 105 and 110 at the national level, when data is extracted for the Statistical Area 3 regions included in this study the population counts for the age groups between 105 and 110 are zero.

[51] Note for this calculation, the Australian disability prevalence is calculated for single sex and the age groups 0,1 to 5 and in five-year age groups until age 110.

In this analysis income is aggregated from the Census variable INCP Total Personal Income Weekly into a low, medium and high income variable. It is a measure of gross income expressed as the equivalent annual amount. The source of income is not recorded in the Census. The low income variable includes people with income up to $20,799, which is roughly equivalent to the base rate of the Australian Age Pension (Australian Government Department of Human Services 2016). Among the population aged 65 and over, approximately 61 per cent are in the low income category, 36 per cent are in the middle category and 4 per cent are in the high income category. Approximately 3 per cent of respondents to the INCP Total Personal Income Weekly record multiple responses to this question and the ABS included the first response as the valid response. Given the income categories appear from highest to lowest on the Census form, the effect would be to overestimate of income.

Not all of the education variables can be identified directly from Census variables. The variable *highest education of secondary schooling* is calculated using the Census variables HSCP Highest Year of School Completed and QALLP Non-School Qualification. It is calculated by cross-tabulating the persons with a Year 12 certificate (using HSCP Highest Year of School Completed) and persons with either no tertiary qualification or included in the not applicable category for the Census variable QALLP Non-School Qualification. These are the people who have completed secondary schooling but not indicated a further qualification. Consequently, the *highest education of secondary schooling* is likely to overestimate the population with this characteristic. This is likely to be an overestimate because the not applicable category of QALLP Non-School Qualification variable includes people who have a qualification not included in the Australian Standard Classification of Education and people studying for a first qualification. The *highest education of secondary schooling* variable is the most complicated and imprecise of the Census variables included in the analysis. Consequently, this variable is not central to the analysis and is not included in the geodemographic classification of the aged population (see Section 9.3). On balance, I consider the inclusion of this variable in a single variate analysis outweighs the quality risks.

The employment variables are calculated from the Census variables LFSP Labour Force Status and HRSP Hours Worked and cover work experience in the week prior to Census. The population aged less than 15 years is excluded from this data. The *not in the labour force* variable excludes people who are unemployed. Unemployed people are included in the *labour force participant* variable but this variable is only used in the analysis of working-life expectancy (see Section 7.2.2.1 and Section 10.3.1 below). Unemployment is not suitable as a standalone variable because the prevalence is low and most values are zero. The *full-time equivalent* variable is also only used to study working-life expectancy (see Section 7.2.2.1 and Section 10.3.1 below).

The housing category includes two variables representing *private rental* and *public rental* arrangements. These are calculated in such a way that the majority of rental arrangements in Australia are captured by one or the other of these variables. The life tenancy rental arrangement is not included as it cannot be isolated in the response options. I consider this acceptable because life tenancies are a secure form of accommodation and the rental variables are included to examine potential insecurity in housing.

7.2.2.1 Work prevalence for working-life expectancy

Work prevalence is needed to calculate working-life expectancies. Two work prevalence variables are used to form the basis of two models of working-life expectancy. I call these the labour participation and full-time equivalent work prevalence variables respectively. The work prevalence variables are calculated using the Census variables LFSP Labour Force Status and HRSP Hours of Work.[52] Both variables are calculated for the national level in 2011 by single sex and single year of age with an open-age interval beginning at 100 (to match the age groups in the national life table). In addition, the labour participation prevalence variable is calculated for 2006 based on actual estimates at the time and 2021 and 2031 based on future scenarios.

The labour participation model focuses on the length of labour market connection and the full-time equivalent model focuses on the depth of labour market connection by measuring the expected full-time equivalent working hours. These give distinct perspectives about the nature of labour market connection in Australia. The full-time equivalent model cannot be calculated in 2006, but is possible for 2011 because the HRSP Hours of Work variable is coded by single hours from 0 to 99 from the 2011 Census.

There are similarities in calculating both models. Labour force participation begins at age 15 and is assumed to be zero after the age of 95 (the age at which estimates becomes highly unstable). The non-stated responses are allocated to the response options (based

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[52] Consideration was also given to using the ABS Labour Force Survey to provide a time series but because the data is only released for five-year age groups and an open-aged interval beginning at age 65 there is insufficient detail available to produce an accurate estimate of working life expectancy.

on age and sex and the frequency distribution of the response options). Firstly, the non-stated responses to the Census variable LFSP Labour Force Status are allocated to the response options. This is all that is needed to calculate the labour participation model. Only people who respond to the LFSP Labour Force Status question are included in the HRSP Hours of Work variable. So any additions to the employed categories must also be included in the full-time equivalent model. The additions to the employed full-time are simply added to the employed full-time count. The additions to the employed part-time are added to the non-stated responses to the HRSP Hours of Work variable (and, in this, I include the hours of work of zero as a non-response) and allocated to the other response categories based on the frequency distribution of responses (by age and sex).

From this base, labour force prevalence is the more straightforward of the variables, simply calculated as the count of people employed and unemployed in the week prior to Census divided by the usual resident population. The full-time equivalent variable is more complex to calculate. Any person working 35 or more hours per week is considered to be working full-time and added to the numerator (consistent with the ABS definition, see ABS 2015b). The full-time equivalent of the people working part-time is also added to the numerator (calculated by aggregating all the hours worked and dividing by 35).

Unemployment is handled differently in the models. Unemployed people are included in the numerator of the labour participation model but not in the full-time equivalent model (and in the denominator for both models). As mentioned, the labour force participation model is concerned with the length of the labour market connection. Because periods of employment and unemployment can occur in a life time of work, I considered it appropriate to include both employment and unemployment in the model. Thus, I assume the rate of unemployment measured by the Census is an estimate of the life time rate of unemployment. In reality this assumption is not likely to hold, and an alternative that could be considered in future analysis is to incorporate the long-term full-employment assumption used by the Australian Government (which at the time of the analysis was five per cent (Australian Government 2014a). In contrast the full-time equivalent model is concerned with the depth of labour market connection, as a proxy for potential accumulation of labour market income. Consequently, it is appropriate to exclude periods of unemployment.

There are three scenarios for the projected labour participation variable. In the first scenario, labour participation does not change. In the second scenario, labour participation does not change at ages younger than 45 or older than age 80 years, but from age 45 to 79 I continue the trend in labour force participation observed between 2006 and 2011 through to 2021 and 2031. Overall labour force participation increases in this scenario with the exception of some fall in labour participation for males at some ages around age 45. I considered this to be a plausible scenario given industry restructuring and increasing involvement by males in care for children and parents. In the third scenario, the adjustments are more arbitrary. Labour participation does not change at ages younger than 45 or older than 80 years, but from age 45 to 74 I reduce the rate of exit by half and then smooth labour participation between ages 75 to the rate observed at age 80 in 2011.

7.2.3 Social Characteristics

There are three social characteristics include in this analysis, all from the 2011 Census. These are children, marriage and domestic support and include the variables *women without children*, *women with children, married*, *lone person household* and *resident of a non-private dwelling*. All social variables count the population based on their usual residence. The *children* variable is only calculated from the female population because the Australian Census does not ask males to identify the number of children they have. Similarly, the *married* and *lone person household* variables are calculated from the subset of people living in private dwellings (see below for further explanation). All variables are affected by non-stated answers (see Table 6 for the percentage of respondents). In the construction of the social variables the non-stated responses are excluded from the analysis.

The denominators for the social characteristic variables are more complicated than variables in the individual and economic domain. All variables use usual residence as the denominator; including the *resident of a non-private dwelling* which is calculated by place of enumeration. The usual resident population is preferable because it is more accurate and I considered, on-balance, to be a better match with the non-private dwelling population on the basis that the non-private dwelling population is not typically mobile. For the *children*, *married* and *lone person household* variables I adjusted the denominators so they only relate to the population from which the variable is calculated. This is straightforward for the female population, but for the private dwelling population this is calculated by proxy using the “not applicable” category from the Census variable RLNP Residential Status in a Non-Private Dwelling. These denominators are likely to be a small overestimate of the persons residing in private dwellings because the people residing in migratory, off-shore of shipping locations are also included.

The *married* variable is calculated using the Census variable MDCP Social Marriage. It counts persons in either formal registered marriages or marriage-like relationships as married. The alternative Census variable, MSTP Registered Marital Status, only identifies people in formal registered marriages. The MDCP Social Marriage variable is included in this analysis because it is a better indicator of the potential for informal care than registered marriages. However, people residing in non-private dwellings are not counted in this variable. The percentage of people in a non-private dwelling in a marriage-like relationship is not known, but approximately 20 per cent of people are in registered marriages. People in "living apart together" relationships are also not included in the *married* variable. The ABS does not publish a non-response rate for this item and will input a response where possible.

The count of persons residing alone is measured using RLHP Relationship in the Household. This measure identifies relationships between people in the household and the reference person. The response option is "lone person household' is used to count persons residing alone. The NPDD Type of Non-Private Dwelling measure includes a large variety of communal accommodation including hotels, hospitals and nursing homes. A subset of this measure, targeting non-private dwellings indicative of aged care, is used to calculate the *non-private dwelling* variable. This is a count based on place of enumeration; however, given the characteristics of the non-private dwellings including in this variable the difference between usual residence and enumeration is likely to be small.

7.3 MORTALITY VARIABLES

Improved survival through the aged years increases the size of the aged population. Thus, it is important to understand mortality conditions and the potential influence on the size and age structure of the aged population. In this study mortality variables are also used in the life course analysis to examine age-transitions in the threshold age demarcating the commencement of the aged years, life span and markers of ageing. There are many ways to examine and forecast mortality (Booth 2006). I use the life table, which is a model of mortality conditions most often used to determine the expectation of remaining years of life. However, as this study shows, the life table can reveal much more about the ageing population.

This section focuses on the methods to calculate national and subnational life tables. Because mortality varies by age and sex, mortality assumptions must be sex and age-specific. Consistent with best-practice, mortality assumptions used for projections should also be zonally-differentiated (Holmes, Charles-Edward and Bell 2005). Therefore, for each of the 327 regions examined in this study a region-specific life table is developed. I also develop forecasts of mortality conditions using the official projections developed by the ABS (see Section 6.3). While there has been some criticism of the ABS mortality models—particularly a lack of range in the mortality assumptions, underestimation of mortality improvements and slow convergence in male and female life expectancy (Booth and Tickle 2003; Booth 2004)—the ABS has taken steps to improve its mortality forecasting (ABS 2013f).

I begin this section with a brief introduction to calculating life tables and then describe the development of historical national life tables, projected national life tables, substate life tables for the launch year of the projection model, and the projected substate life tables used in my study.

7.3.1 A general introduction to life tables

The life table was developed by John Graunt (Hald 2005) to study mortality conditions in a population. Life tables can be developed for period or cohort demographic conditions: period life tables represent synthetic populations calculated from estimates of demographic conditions at one point in time while cohort life tables represent actual populations. Cohort life tables are rare because they require long time series of mortality estimates as a cohort ages. This analysis uses period life tables. For period life tables, changes in mortality are dependent on conditions that prevail at the point in time the life table seeks to represent (Kannisto 1994). Thus, estimates of life expectation in life tables will only be accurate if mortality conditions remain constant. In recent experience, life expectancy has increased, causing period life tables to underestimate life expectancy (Wilmoth 2005).

Life tables can be complete or partial (Hickman and Estell 1969). Complete life tables produce the expected number of life years remaining for a randomly selected person between his (or her) current age and the upper age limit of human life. Partial life tables support detailed examination of life expectancy within an age group, bounded between his (or her) current age and a fixed terminal age. A partial life expectancy is the years expected to live in the age group by a randomly selected person.

Preston, Heuveline and Guillot (2001) outlines the formula required to calculate life tables. These are reproduced in Table 7. Briefly, life tables are calculated using two inputs, a synthetic birth cohort (for example, 100,000 people) and mortality rates at age

(m_x). From the mortality rate, it is possible to calculate the probability of dying (q_x) and deaths (d_x) between x and $x + n$, where n is the length of the age interval. These deaths (d_x) are subtracted from survivors of the birth cohort (l_x). Deaths (d_x), survivors (l_x) and average years lived in the age interval by those who die within the age interval (a_x) enable the calculation of person-years lived (L_x). Remaining life expectancy at age x (e_x) is calculated as the person-years lived above age x (T_x) divided by the survivors (l_x) at age x. Different formulas are used to calculate the open-age interval, see Table 7.

Table 7 Formulas for calculating life table quantities

General	Specific age
${}_nm_x \approx {}_nM_x = \frac{{}_nD_x}{{}_nN_x}$	${}_\infty m_x = \frac{{}_nd_x}{{}_nL_x}$
$q_x = \frac{n \cdot {}_nm_x}{1+(n-{}_na_x) \cdot {}_nm_x}$	${}_\infty q_x = 1.00$
${}_np_x = 1 - {}_nq_x$	
$l_{x+n} = l_x \cdot {}_np_x$	$l_0 = 100{,}000$
${}_nL_x = n \cdot l_{x+n} + {}_na_x \cdot {}_nd_x$	${}_\infty L_x = \frac{l_x}{{}_\infty m_x}$
$T_x = \sum_{a=x}^{\infty} {}_nL_a$	
$e_x^0 = \frac{T_x}{l_x}$	

Where,
a_x depends on the age group, sex and mortality rate.
If ${}_1m_0 \geq 0.107$, for males ${}_1a_0 = 0.330$ and for females ${}_1a_0 = 0.350$.
If ${}_1m_0 < 0.107$, for males ${}_1a_0 = 0.045 + 2.684 \cdot {}_1m_0$ and for females ${}_1a_0 = 0.053 + 2.800 \cdot {}_1m_0$.
If ${}_1m_0 \geq 0.107$, for males ${}_4a_1 = 1.352$ for females ${}_4a_1 = 1.361$.
If ${}_1m_0 < 0.107$, for males ${}_4a_1 = 1.651 - 2.816 \cdot {}_1m_0$ and for females ${}_4a_1 = 1.522 – 1.518 \cdot {}_1m_0$.
For all remaining values, a_x values are 0.5 for single year calculations and 2.5 for five-year calculations.

Source: Preston, Heuveline and Guillot (2001, 48-49)

7.3.2 Historical and current national life tables

The historical national life tables used in this study are based on the official ABS life tables. Official single sex life tables are available for selected years since 1881. The published life tables are single year life tables but based on average mortality of three or more years. The open-age interval for these life tables begin at age 100. This study utilises the 60 period life tables published for the periods 1901-10, 1920-22, 1932-34, 1946-48, 1953-55, 1960-62, 1965-67, 1970-72, 1975-77, 1980-82, 1985-87, 1990-92, 1993-95, 1994-96, 1995-97, 1996-98, 1997-99, 1998-2000, 1999-2000, 2000-02, 2001-03, 2002-

04, 2003-05, 2004-06, 2005-07, 2006-08, 2007-09, 2008-10, 2009-11 and 2010-12. To simplify notation, life tables are referred to by the mid-point year of their range.

Some adjustments to these life tables are required to fill gaps in the published estimates. The official life tables include survivorship (l_x), person-years lived (L_x), probability of dying (q_x) and life expectancy (e_x). Of the 60 life tables used, 34 life tables are missing values which I calculate using the Gompertz mortality model and the survivorship (l_x) column of the life table. The reason the Gompertz model is used is that it is the best alternative to produce the substate life tables (outlined below), and therefore using this approach to indirectly estimate missing values in the national life tables ensures consistency of an approach throughout the study. The Gompertz mortality model is given by:

$$l(x) = C \cdot a^{b^x}$$

Where $C = l(y) \cdot \exp(-b^y \cdot \ln a)$, $b = \left(\frac{ln \frac{l(y+2n)}{l(y+n)}}{ln \frac{l(y+n)}{l(y)}} \right)^{\frac{1}{n}}$ and $a = exp \left(\frac{ln \frac{l(y+n)}{l(y)}}{b^y (b^n - 1)} \right)$ (Preston, Heuveline and Guillot 2001, 193). In two-thirds of the life tables the Gompertz mortality model is fitted using ages 98, 99 and 100 ($y = 98$ and $n = 1$) and for the remainder the model is fitted using ages 97, 98 and 99 ($y = 97$ and $n = 1$). One of the limitations of the Gompertz model is that the open-age interval cannot be calculated with the estimates available. Instead, once fitted, the Gompertz model is used to estimate survivorship until 110 and the person-years lived between age 100 and 110 is used to estimate the person-years lived above age 100.[53] With the survivorship (l_x) and person-years lived (L_x) variables complete, the remaining variables of the life tables are calculated using the formula set out in Table 7.

The historical life tables are not a perfect time series. In addition to the small adjustment made (outlined above), there have been methodological changes over time (see ABS 2013f). Additionally, official life tables are not included in the rebasing process used to revise estimates of the population after each Census (see Section 6.1). If life tables were included, mortality rates would likely be revised. Life tables were also not recalculated following the extraordinary revisions in 2011 (see Section 6.1). The 2011 life table is

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[53] When analysed over successive life tables, some of individual results individual results for person-years (L_x) lived at older ages appear implausible and the pattern over time fluctuates more than is expected. I caution against relying on any of these results individually but the effect on the overall findings of the study is minimal.

developed using population estimates after the standard rebasing and extraordinary revision process. Usually the effect of not including life tables in the rebasing process is small but the effect is more significant in 2011 because of the extraordinary revisions of that year. The impact on the time series is most significant between the 2010 and 2011 life table; the 2010 life table is calculated using mortality rates for a smaller population at risk than would be the case if the recast estimates were used (see Section 6.1). The effect is to increase mortality risk in the 2010 life table, and inflate the apparent fall in mortality between the 2010 and 2011 life table.

In addition, for the 2011 life table, the ABS addressed concerns that the official life tables had overestimated life expectancy over the age of 90 by reducing the probability of dying (q_x) declines. The impact of the methodological change is a reduction in life expectancy at birth of 0.03 years for males and 0.02 years for females and, at age 90, of 0.10 years for males and 0.05 for females. It should be noted that this occurred in the context of improving mortality conditions overall.

7.3.3 Projected national life tables

The projected national life tables build on the ABS projections (ABS 2013g). As mentioned in Section 6.3, the ABS publishe estimates of the probability of dying (q_x) by single year of age from 0 to 101 for their projection horizon (currently 2012 to 2101). The probability of dying at 101 or above is 1. Using these values, combined with indirect estimation, it is possible to calculate single year life tables for any year in the projection horizon.[54] In this study national life tables are calculated for 2021 and 2031 for the two mortality scenarios: decreasing mortality consistent with trend ('trend') and decreasing mortality but at a slower rate ('slowing').[55] Consistent with the historical and current life tables these are single sex and single year life tables.

The life tables for 2021 and 2031 are calculated with the standard life table formulas using the estimates of probability of dying (q_x) and a Gompertz mortality model. The estimates of probability of dying (q_x) are used to calculate estimates of survivorship (l_x) up to the age of 101 (using the standard life table formula $l_{x+n} = l_x(1 - q_x)$). The Gompertz mortality model (introduced above) is then fitted for the ages 99, 100 and 101 and used to estimate

[54] Note, unlike the historical life tables, the projected life tables at the national and subnational level are calculated using single year data. Taking an average over three years (as is the case with historical life tables) was not considered necessary because the projected series is inherently smoother than actual data which can fluctuate between years.

[55] These scenarios are compared with the constant mortality scenario where the 2011 life table is assumed constant.

survivorship (l_x) to age 110 and person-years lived between ages 100 and 110 (as a proxy for person-years lived in the open-age interval). With complete estimates of survivorship (l_x) and person-years lived (L_x), the remaining life table quantities are calculated using the formula set out in Table 7. To simplify the calculations, the value of ${}_1a_0$ for 2011 is held constant in the 2021 and 2031 life table (at 0.057830 for males and 0.062605 for females).

The results are consistent with the ABS projected life expectancy gains. Life expectancy is highest under the trend scenario. At birth, males can expect to live to 82.1 years in 2021 rising to 84.6 years in 2031. Females can expect to live to 86.0 years in 2021 rising to 87.9 years in 2031. Under the slowing scenario, males can expect to live to 81.8 years in 2021 rising to 83.1 years in 2031. Females can expect to live to 85.8 years in 2021 rising to 86.7 years in 2031. Under the trend scenario, at age 65, males can expect a remaining life expectancy of 20.7 years in 2021 rising to 22.5 years in 2031. Females can expect remaining life expectancy at age 65 of 23.3 years in 2021 rising to 24.7 years in 2031. Under the slowing scenario, at age 65, males can expect remaining life expectancy of 20.5 years in 2021 rising to 21.4 years in 2031. Females can expect remaining life expectancy at age 65 of 23.2 years in 2021 rising to 23.9 in 2031.

7.3.4 Substate life tables for the current demographic conditions

Substate life tables are used in the projection of the size and age structure of the aged population and in the markers of ageing analysis. Specifically, for these analyses, life tables should be uniquely calibrated for each substate region and sex. In this study, current demographic conditions are the conditions in 2011, which aligns with the launch year of the projection and last Census. As mentioned, there is no time series of historical mortality estimates for the substate regions as the spatial unit used (Statistical Area 3) was introduced in 2011. However, the ABS do publish expectation of life at birth for Statistical Area 4 which provides a reference point to examine the credibility of life tables produced for the Statistical Area 3 regions.

In the absence of detailed mortality estimates, life tables cannot be calculated using the standard method. However, the total death estimates for each Statistical Area 3 region can be used to calculate a Standardised Mortality Ratio for each of these regions, which in turn can be used to adjust the national life table to produce the substate life tables required for my study (this is similar to the approach used by Isserman (1993)).[56] Life expectancy in a region is lower than the national life expectancy if the Standardised Mortality Ratio is less than one, the same if it is equal to one and higher if it is greater than one.

The Standardised Mortality Ratio is given by Jain (1994):

$$SMR^{c,i} = \frac{D^{c,i}}{\sum_j \sum_x {}_np_x^{j,i} \cdot {}_nM_x^{c,j,s}} \cdot 100$$

Where $D^{c,i}$ is the observed total deaths in the region *i* and cause *c*, ${}_np_x^{j,i}$ is the population of sex *j* aged *x* to *x*+*n* for region *i* and ${}_nM_x^{c,j,s}$ is the death rates by sex, age and cause in the standard population *s*. In this study c = 1; the analysis does not differentiate by cause. In this application, Australia is the standard population, the actual deaths is the total number of deaths for each region and expected deaths is the deaths expected for the region if the national death rates were applied to the region's population (calculated for males and females separately and age groups of 0 to 1, 1 to 4 and then five-year age groups to an open-age interval of 85 and over).

Using this method, I calculate 327 unique Standardised Mortality Ratios. With only total deaths available for each Statistical Area 3 region, the Standardised Mortality Ratio is the same for males and females in each region. Across all regions, the standardised mortality ratios have a mean of 1.05 and a median of 1.02, suggesting a reasonable alignment of these substate mortality perspectives with the national mortality data. The next step is to produce the 654 substate life tables needed for 2011, the launch year of the projection model. Revised death counts are calculated by multiplying the national deaths (disaggregated by age and single sex) by the Standardised Mortality Ratio for each Statistical Area 3 region. With the revised death counts, I use the national population counts to calculate mortality rates (m_x) and then survivorship (l_x) to an open-age interval of aged 85 and over using the standard formula (see Table 7). This produces substate life tables that reflect regional variations in mortality but preserve the national relative differences by age and sex.

[56] A similar calculation could be performed using the Statistical Area 4 data. This would not produce region specific life tables but may be more stable over time. However, given the ABS uses a three year average in its calculations of death data, I was comfortable using the death data for Statistical Area 3 regions.

To extend the life tables within the open-age interval, the Gompertz mortality model is fitted using survivorship (l_x) at ages 75, 80 and 85 (see above for the relevant equations). Once fitted, the Gompertz parameters are used to extrapolate values for survivorship to age 90, 95, 100, 105 and 110. It is not possible to calculate the open-age interval using the Gompertz model. However, by extrapolating to 110 the survivorship is practically zero (from a synthetic cohort of 100,000, the maximum value of survivors across all the substate life tables is 9 for females and 7 for males) so person-years above 110 are disregarded. The remaining life table quantities are then calculated using standard formulas (see Table 7). At the conclusion of the analysis a single sex life table is available for each Statistical Area 3 region with an age structure of 0 to 1, 1 to 4 and then by five-year age groups to 110. The estimates from ages 45 and over are utilised in the projection model (see Chapter 8) while the complete life tables are used for selected markers of ageing (see Chapter 10).

While the Gompertz model has been used in other studies (Baudisch 2011), there are many options available to model mortality in the absence of direct observations (Booth 2006). Additionally, there is some concern that the Gompertz mortality model, which provides for exponential increase in mortality at older ages, is a poor fit with some empirical observations of later-life mortality deceleration (Bebbington et al 2014). Interestingly, the Bebbington et al (2014) study found that mortality data in Australia was compatible, at least for females, with the Gompertz model.

Out of concern about the fit of the Gompertz model, I compared its performance to the logistic model of mortality observed by (Kannisto 1994). The force of mortality at older ages is lower in the Kannisto model compared with the Gompertz model, which suggests it may be more consistent with a deceleration of mortality at older ages. There are limited options to empirically evaluate the performance of each model. However, it is possible to test the models by examining life expectancy at birth for each Statistical Area 3 region compared with life expectancy at birth for the larger Statistical Area 4 regions published by the ABS. The outcome of these tests supports the use of the Gompertz model. The Gompertz model extending the life table to 110 years produced the smallest difference. For about 90 per cent of regions the effect is a small reduction in life expectancy, compared with the Statistical Area 4 region. For about ten per cent of regions there is an increase (60 regions of the 654 life tables). This analysis supports the credibility of using the Gompertz model and the method described above to produce the substate life tables for the launch year of the projection.

7.3.5 Projected substate life tables

Substate life tables are needed for the launch year of the projection model (2011), and every five-years through the projection horizon (2016, 2021 and 2026). Consistent with the projected life tables for Australia, I project two scenarios for the substate life tables: improving mortality consistent with trend ('trend') and improving mortality but at a slower rate ('slowing'). While the national life tables are single year life tables, at the substate level I keep a consistent age structure with the 2011 life tables (0 to 1, 1 to 4 and five-year age groups to 110).

To calculate the substate life tables I use the formulas in Table 7 and the ABS estimates of the probability of dying values (q_x) for the years 2012, 2013, 2016, 2021 and 2026. Instead of using the national estimates, I use the state and territory estimates. This should improve the quality of the substate life tables, as mortality changes will be more closely linked to local mortality conditions. Exploratory work was undertaken to devise a method and then the full set of substate life tables were produced by replication of the method by region, sex and year.

The method involves several steps. The first step is to transform the state and territory estimates of probability of dying values (q_x) from single year estimates to estimates for five-year age groups between 5 and 110 and for the ages 0 to 1 and 1 to 4 for every five-years through the production horizon (2016, 2021 and 2026). Consistent with the method used for the national life table I use the standard life table formula $l_{x+n} = l_x(1 - q_x)$ to calculate survivorship up to the age of 101. I then abridge the life table into the ages 0 to 1, 1 to 5 and in five-year age groups to age 100. Next, using the now familiar procedure, fit the Gompertz mortality model to the survivorship (l_x) values 90, 95 and 100 and then use the model to estimate survivorship (l_x) to ages 105 and 110. The remaining life table quantities are calculated using the formula set out in Table 7. This produces single sex life tables for ages 0 to 1, 1 to 4 and subsequently in five-year age groups until age 110 for the years 2012, 2013, 2016, 2021 and 2026 for each sex and state and territory.

The next step is to use these state and territory life tables to calculate mortality change over time by age and sex. I call the products of these calculations "probability of dying (q_x) adjustment factors". Each adjustment factor is simply the difference between the (q_x) values at two time points. I calculate adjustment factors for each state and territory, for each sex and age group, between the time periods 2012 to 2013, 2012 to 2015, 2016 to 2020 and 2021 to 2025. I then add the 2012-13 and 2012-15 adjustment factors to produce an adjustment factor for 2011-15 (thus using the 2012-13 adjustment factor as a proxy for mortality change between 2011 and 2012).

As expected, the adjustment factors are small and mostly positive. However, there are exceptions, two of which are worth highlighting. The first is the probability of dying of the age of 100 increases reflecting the shift of mortality within the life course to older ages. The second is an increase in the probability of dying at most ages for females in the Northern Territory through to 2016 in both the *trend* and *improving* scenarios. This reflects a changing composition of the Northern Territory population to be a higher proportion of Indigenous (and therefore the higher mortality rate at all ages).

Finally, the substate life tables for 2016, 2021 and 2026 are calculated from a probability of dying (q_x) value for the same years calculated by adjusting the probability of dying (q_x) in 2011, 2016 and 2021 by relevant adjustment factor (i.e. 2011-15, 2016-20 or 2021-25). Some further adjustments are needed at the oldest ages. Where the probability of dying is close to one, the effect of the adjustment can be to increase the probability of dying above one. This is implausible and so these values are adjusted downwards to 1.0.

With the necessary probability of dying (q_x) values calculated for 2016, 2021 and 2026 the subsequent life table quantities are calculated using the standard methods set out in Table 7. To simplify the calculations, the value of ${}_1a_0$ and ${}_4a_1$ for 2011 is held constant through the projection horizon. Information about changes in life expectancy as a result of improving survival is included in Section 8.2.2.1.

7.4 MIGRATION VARIABLES

Migration variables are used for the analysis of the size and age structure of the population, specifically in the substate projection model examined in Chapter 8. Two sets of variables are required—international migration and internal migration. I outline how these are calculated below.

7.4.1 International migration

The substate projection model requires estimates of international arrivals and departures for each Statistical Area 3 region for three net international migration scenarios (high, medium and low) over four time periods (2011 to 2015, 2016 to 2020, 2021 to 2025 and 2026 to 2030). These estimates are further disaggregated by sex and five-year age groups from 45 to 110 (given the projection model begins at age 45). As noted in Section 6.4, my data sources comprise the ABS projected international migration series as well as actual arrival and departure estimates for financial years 2011-12 and 2012-13 and preliminary estimates of arrivals and departures for 2013-14 (ABS 2013g; ABS 2015c). The ABS actual migration estimates have an open-age interval beginning at age 65 and its projection estimates have an open-age interval beginning at age 100.

To calculate the international migration variables required for this study, I use the state and territory estimates of international migration as the starting point for indirectly estimated international migration for each Statistical Area 3 region. This should improve responsiveness to local migration conditions. From here, there are two key tasks to calculate the international migration variables. The first is to calculate levels of arrivals and departures for each state and territory by sex for the year and age groups required. The second is to disaggregate the state and territory level to the relevant Statistical Area 3 regions.

There are several steps in the first task. For the actual migration estimates (up to 2014), the open-age interval of age 65 and over must be disaggregated into five-year age groups between age 65 and 110. I use the projected international migration series noted above for this calculation to calculate the age distribution of international migration over the age 65 (by sex, separately for arrivals and departures and using the average age distribution for the high, medium and low forecast scenarios). The estimates for the age group 100 and over are allocated solely to the age group 100 to 104. Similarly, projected forecast estimates for age 100 and over are allocated to age 100 to 104. Both the actual and projected estimates for international migration between the ages 105 and 110 are assumed to be zero. Note the international migration counts are small, even in the ages 100 to 104. These calculations produce estimates of international arrivals and departures by sex and five-year age groups between ages 45 to 110 for each state and territory. These are single year estimates. I then aggregate these to produce estimates for the years 2011 to 2015, 2016 to 2020, 2021 to 2025 and 2026 to 2030.

The second task is to disaggregate the state and territory migration estimates I have generated to produce estimates for each Statistical Area 3 region. To disaggregate the departures estimates, the estimates are allocated to the Statistical Area 3 regions based solely on population proportion (by sex and age). This assumes a probability of international migration across all Statistical Area 3 regions tied to population size. To disaggregate the arrivals estimates, two methods are compared: this first uses population proportions in the same manner as for the departure estimates; the second uses settlement proportions for international arrivals identified using the Census (from the "overseas" responses to the Census variable PUR5P Place of Residence Five-years Ago).

Disaggregation using the settlement proportion is based on the proportion of the population residing in each Statistical Area 3 region that indicated they lived overseas five-years before the Census. Settlement proportions are only available for the population up to age 100. Consequently, the settlement proportion for the age group 100 and over at the time of the Census is assumed to be the same as the settlement proportion for the age group 95 to 99.

I used the settlement proportion method to disaggregate state and territory estimates wherever possible as it is more accurate than the population proportion method. However, when there was no settlement proportion available for a Statistical Area 3 region (i.e. there was a count of zero from the Census), I used the population proportion method instead.

7.4.2 Internal migration

The substate projection model requires estimates of net internal migration for each Statistical Area 3 region for the periods 2011 to 2015, 2016 to 2020, 2021 to 2025 and 2026 to 2030, disaggregated by sex and five-year age groups from 45 to 110 (given the projection model begins at age 45).

Several methods are available to calculate internal migration. The best method is often determined by the availability of data. In this study, the data source is the Census and the data are transition estimates—that is, counts are based on moves between time *t* and *t+5* (assuming five-year projection intervals). Additional moves within the time period are not counted. While it is possible to estimate moves in the year prior to Census, Bell and Muhidin (2009) recommend using the five-year interval if possible as it is less vulnerable to short-term period effects. Approximately 13 per cent of the Australian population reported moving in the year prior to the 2011 Census and 31 per cent reported moving in the five-years to the 2011 Census.

I use net internal migration. This is a common approach (Isserman 1993; Plane 1993; Rogers 1990; Wilson and Bell 2004b; Wilson 2011c), but not without criticism. As Wilson and Bell (2004b, 131), drawing on Rogers (1990), explain there are both conceptual and practical problems with this approach:

> The key problem lies in the fact that there is no such thing as a 'net migrant' (Rogers 1990). Models of net migration and therefore poor representations of reality, and projections that use net migration models are similarly flawed. More serious are the practical limitations. In a net migration model, fixed flows fail to capture the effects of changes in age structure and geographical distribution on the propensity to move. This type of model can also generate impossible results. Where net migration is negative there is no mechanism to ensure that the aggregate loss does not exceed the available population".

Additionally, there are empirical problems to be aware of, specifically a tendency of net migration models to overestimate growth in faster growing regions (Wilson and Bell 2004b).

I considered alternative theoretical and empirical approaches to developing internal migration estimates. Empirical approaches (such as net migration) can be relatively straightforward but are also narrow because they disregard much real-world information. Theoretical approaches (such as spatial interaction models) incorporate determinants of the level, age structure and spatial pattern of internal migration using information such as the attractiveness of the destination, services in an area and the relatively higher probability of moving between near regions (Hugo and Bell 1998). Constructing a model with a theoretical underpinning is resource intensive and the quality of the result is highly dependent on the quality of the underlying model. At this stage, with the data available, the net migration model I use is preferable, as it offers both an improvement on currently available analyses and considerable efficiency.

To calculate net internal migration I use the Census question "where did the person usually live five-years ago?" (Census variable PUR5P Place of Residence Five-years Ago, see ABS 2011d). Briefly, using this question, an origin-destination migration flow matrix can be calculated. The column sums are total migrants into an area and the row sums are total migrants leaving each area. The diagonal in the matrix is the count of people moving within an area. The net migration for each area is calculated by subtracting the counts of people leaving the area from the counts moving into each area.

Several matrices are needed—for males and females and each age group from age 40 in five-year age groups. Each origin-destination migration flow matrix has dimensions of 369 origins and 351 destinations.[57] The 369 origins include the 351 Statistical Area 3 regions (comprising the 328 Statistical Area 3 regions used in this analysis and additional spatial analytical units not included in this analysis as explained in Section 5.2) and non-spatial units (such as "state undefined" and "no usual address"). These non-spatial analytical units are disregarded—the head counts in these categories are small and would

[57] As outlined in Chapter 5.2, two Statistical Area 3 regions were combined in the analysis. These regions (Cotter-Namadgi and Tuggeranong) are included separately in the origin-destination migration flow matrix until after the non-stated responses are allocated and then combined.

round to near zero of a person if distributed to the other response options. As a result, the origin-destination migration flow matrix reduces to 351 origins and 351 destinations.[58]

Next, the non-stated responses are incorporated into the origin-destination migration flow matrix. There are two types of non-stated responses: respondents who have not recorded their usual residence five-years earlier (so it is not possible to determine if they are an internal migrant); and, respondents who have indicated a different usual address five-years earlier but have not specified the location of that address.

The strategy I use to incorporate the non-stated responses is to allocate them to other relevant response options based on the proportion of stated responses in each response category. The respondents that have not recorded their usual residence five-years earlier are the first to be allocated to response options (i.e. did not move, lived elsewhere in Australia, lived overseas). This produces additional internal migrants who have destinations recorded in the Census (their usual residence in 2011) but not an origin. These internal migrants are added to the group of respondents who have indicated a different usual address five-years earlier but not specified the origin. These migrants are allocated to an origin based on the proportion of total flows attributed to each origin-destination migration flow pairing. These are small adjustments overall: for all the origin and destination pairings combined, the average not-stated adjustment is 0.25 per cent of the count value. However, there is variation and for 92 of these pairings the adjustments are greater than the original head count (affecting older ages in particular).

Data from the 2011 Census can only provide net migration estimates up to age 95 and over. This is because the Census question records movements between the current age and five-years younger at the time of the previous Census. In other words, if in the 2011 Census the respondent is aged 50 to 54 then his or her migration pattern contributes to net migration for the ages 45 to 49. Using this approach, the 2011 Census provides net migration estimates up to age 99. Even this, however, assumes the migration estimates for the 100 and over population is a reasonable proxy for the population 95 to 99. This is a reasonable proposition given the population count for over 105 years in the Census is assumed to be zero (see Section 7.1).

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[58] Note that the starting original destination migration flow matrix has more origins than destinations with the out-migrants higher than the in-migrants. This is not problematic, given the disregarded data does not affect the regions of interest to this analysis.

Calculating the estimate of internal migration for the population aged 100 to 110 requires indirect estimation. Internal migration falls at older ages. An examination of net migration in the age group 95 to 99 shows that males have a net migration above zero in only three per cent regions and females have a net migration above zero in only seven per cent of regions. Together, this accounts for 33 regions. For these regions, a net migration rate is calculated for the age group 95 to 99 and applied to the population count between 100 and 105.[59] In general, this method produces very low estimates of internal migration over the age of 100 with the exception of the Barwon West region which has a high net migration figure for males aged 100 and over. While the estimate is high, it appears reasonable as the area is a township that is likely to be attractive to aged people relocating closer to services and/or families. Net migration over the age of 105 is assumed to be zero.

The result of these steps is an estimate of net migration for each area for the age groups 45 to 110 over by sex.

7.5 CONCLUSION

In this Chapter I outlined the methods to calculate key demographic variables for this study. Few datasets are perfect and the data used in this study is no exception. For several variables, indirect estimation techniques are required and the methods used were outlined above. The result is set of national demographic variables covering 1901 to 2011 for historical analysis and national and subnational demographic variables for a projection horizon of 2011 to 2031. This includes estimates of mortality, international migration, internal migration and individual, economic and social characteristics of the aged. In the next three chapters I use these demographic variables in a range of analyses to better understand the aged and ageing processes in Australia using a geodemographic and life course perspective.

[59] The denominator in this calculation was the destination region population count. This is not the ideal denominator; however, as the numbers are very small this adjustment is likely to have a negligible impact on the overall results of this analysis.

Chapter 8

Geodemographic perspectives of the aged: the size and age structure of the Australian aged population

In the preceding chapters I outlined the policy direction which demographic analysis should inform and designed a multidimensional approach to demographic analysis to inform these policy directions – the foundation for an expanded demographic evidence-base to information the policy response to population ageing in Australia. Now I turn attention to what this multidimensional analysis reveals about the aged and ageing process in Australia. The focus of this Chapter is the size and age structure of the aged population at the subnational level. Understanding how many aged people are in each location assists with planning for services delivered in home or communities. It provides an evidence-base for policy makers responding to local variation in the aged and ageing process, consistent with the policy directions outlined in Chapter 4. The aged population receiving locally delivered services is already significant, with more than 700,000 aged Australians receiving support in their own home or permanent residential care (Centre of Excellence in Population Ageing Research 2014). As the aged population increases in size the level of service provision will need to increase. Where the services should be and when they will be required depends on local level changes in the aged population.

The risk of needing aged care services increases with age (AIHW 2014c; Jorm et al 2010). The AIHW (2014c) estimates around 12 per cent of the population aged 65 to 74 used care services rising to 76 per cent of the population aged 85 and over. At the national level the population aged 85 and over is growing more rapidly than the population aged 65 to 84. Similar changes at the local level could have an even stronger impact on demand for services than change in the size of the aged population. A successful response to population ageing should also be looking for opportunities to shape the characteristics of the aged population. Where a region has a large aged population in their early-aged years, it may benefit from programs designed to prevent or delay the onset of frailty. Similarly, in regions with large aged populations in their late-age years there could be additional emphasis on care and social support.

To examine the size and age structure of the aged population, I develop a subnational projection model uniquely calibrated for 327 regions examined. Introducing this model and its key findings is the primary aim of this chapter. However, to set the scene I begin by examining the size and age structure of the aged population at the subnational level as it was in 2011. To do this I use three analyses at the subnational level—the head count as a traditional measure of the size of the aged population, an early-aged proportion to identify the regions with relative young aged populations and the proportion of the aged population nearing the end of life.

The remainder of the Chapter is dedicated to the design and results of the subnational projection model of the Australian aged population. I begin by outlining the projection methodology used—a cohort component model—and key design decisions. Next, I discuss sources of growth in the aged population—ageing-in-place, international migration and internal migration—using the partial projection scenarios to isolate each of these processes. Lastly, I examine change in the size and age structure of the Australian aged population over the twenty years to 2031.

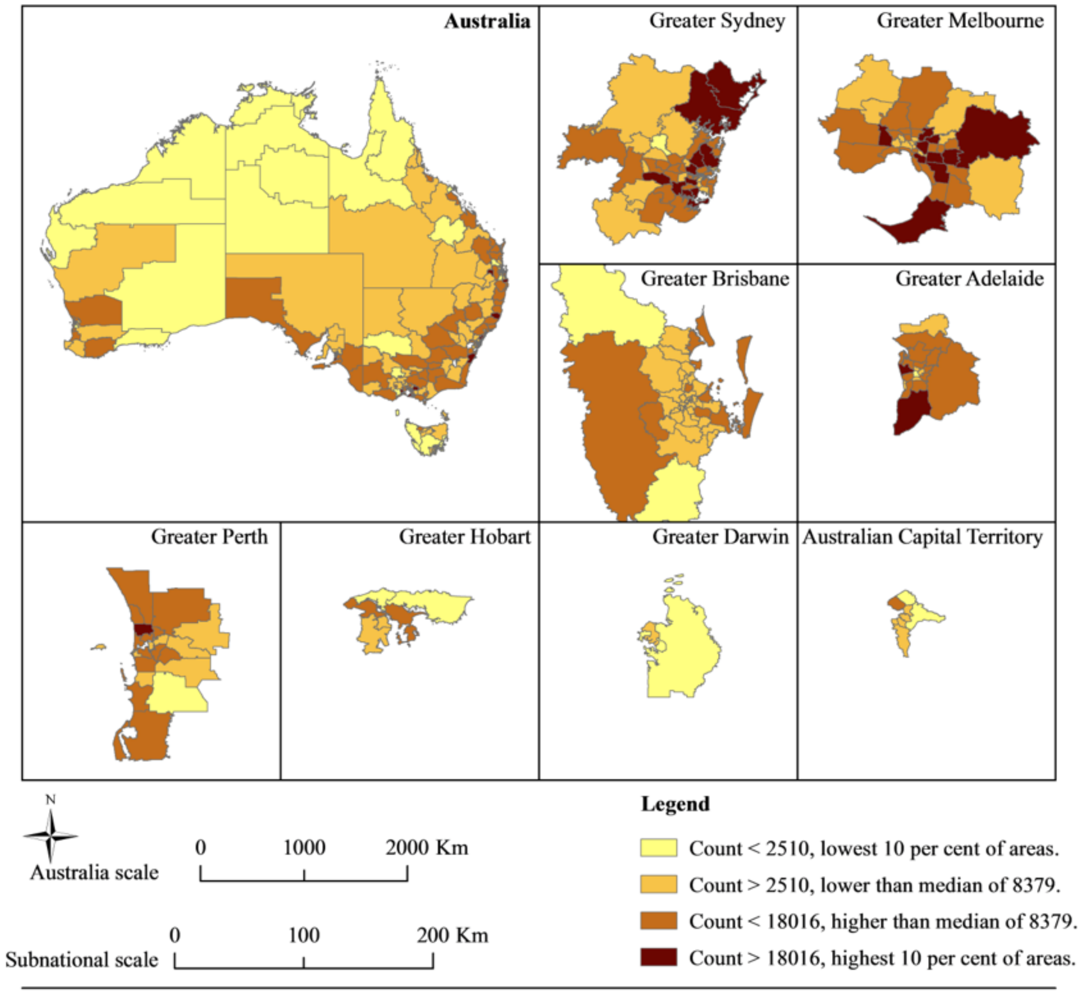
With more than 300 regions examined and twenty-four projection scenarios, this analysis produces more results than can be fully considered in this Chapter. I will focus on key insights from the analysis and the regions that illustrate these insights. I use subnational maps to provide a snap shot of the results and highlight the regions in the top and bottom ten per cent for each indicator (such as growth). The detailed results discussed in this chapter are included in the Appendix 1 and the coding using the R programming language for the projection model in Appendix 2. Additional results are available upon request.

8.1 THE SIZE AND AGE STRUCTURE OF THE AGED POPULATION FOR AUSTRALIAN REGIONS IN 2011

Recall from Figure 19 that the Australian aged population is unevenly distributed around the country. In this section, I disaggregate these populations further to show for 2011 the distribution of Australia's 3.1 million aged population across 327 regions. I also look at the structure of the aged population by region to identify the regions with relative young aged populations and regions with a high proportion of their population nearing the end of life. To identify this latter insight requires first understanding mortality conditions in each region, so in this section I also outline regional differences in mortality.

8.1.1 The uneven distribution of the aged population across Australia

An indicator of the size of the aged population in 2011 for each Australian region is shown in Figure 24. For the 327 regions examined, the mean head count of the aged population was 9443, the median was 8379 and varied between 70 and 32,036 aged persons. Fifty per cent of the regions had aged populations between 5206 and 12,371 people.[60]



Source: ABS 2014b.
Note: The regions are Statistical Area 3 regions (see Section 5.2).

Figure 24 Head count of the population aged 65 and over: Australian regions, 2011

The majority of regions with the largest aged population are in Sydney and Melbourne capital city regions. Relatively large aged populations, however, are present outside of

[60] Head count perspectives rely on the accuracy of the reporting of age. Howell (1986) identifies three main errors: age heaping, where there is an increase in ages ending in zero or five; age rounding, where there is a bias towards socially acceptable ages (which could favour younger or older ages); and age vanity, where there is a bias towards desirable ages (usually resulting in inflation among the youth and deflation at older ages). One way to minimise the effects of misreporting on the results—and an approach I use in this study—is to use age groups of at least five-years (Hobbs 2004).

capital cities. These are coastal areas including Geelong near Melbourne, Toowoomba near Brisbane and the densely populated coastal areas near Sydney including Newcastle, Shoalhaven, Lake Macquarie East, Tweed Valley, Wollongong and Port Macquarie. While not capital cities, McGuirk and Argent (2001) call regions such as these mega-metro regions because of the geographic proximity to capital city areas and growth due to emigration from capital city regions. Internal migrations into these areas—both amenity-led and welfare-led migrations—are part of the phenomenon of the "population turnaround" which has been observed in eastern Australia since the 1970s (Burnley and Murphy 2002; Gurran 2008; Hugo and Bell 1998).

Also notable is the relatively large aged populations in regional and remote locations in the south-east of Australia. Wagga Wagga in New South Wales for example had an aged population exceeding 14,000 in 2011. In Victoria, the aged population is around 10,000 people in Wodonga-Alpine, Gippsland-East and Latrobe Valley. Despite demographic and economic decline observed in inland regions, a relatively large aged population remains in inland Australia (Argent et al 2011; Hugo 2005).

8.1.2 Regional differences in the early-aged proportion of the aged population

The *age* of the aged population at the local level is important because a younger aged population is more likely to have better health and higher levels of activity, and less likely to need care services. Like any demographic dividend, however, demographic conditions alone are not sufficient to realise a dividend—economic and social conditions need to be supportive for it to be realised. Thus, in a policy environment being responsive to local level demographic conditions, there may be benefit in locally delivered initiatives to delay or prevent the onset of frailty. Another reason to examine the *age* of the aged population is the insight in can provide into likely change within the aged population. With the modal age of death exceeding age 85 in Australia, an early-aged population is comparatively further from death than a late-aged population.[61] Thus, *younger* aged populations will have higher survival through a projection period.

[61] Author's calculations based on ABS (2014c).

A crude but informative measure of the *age* of aged communities is the early-age proportion which is simply calculated as the proportion of the aged population in the early-age years:

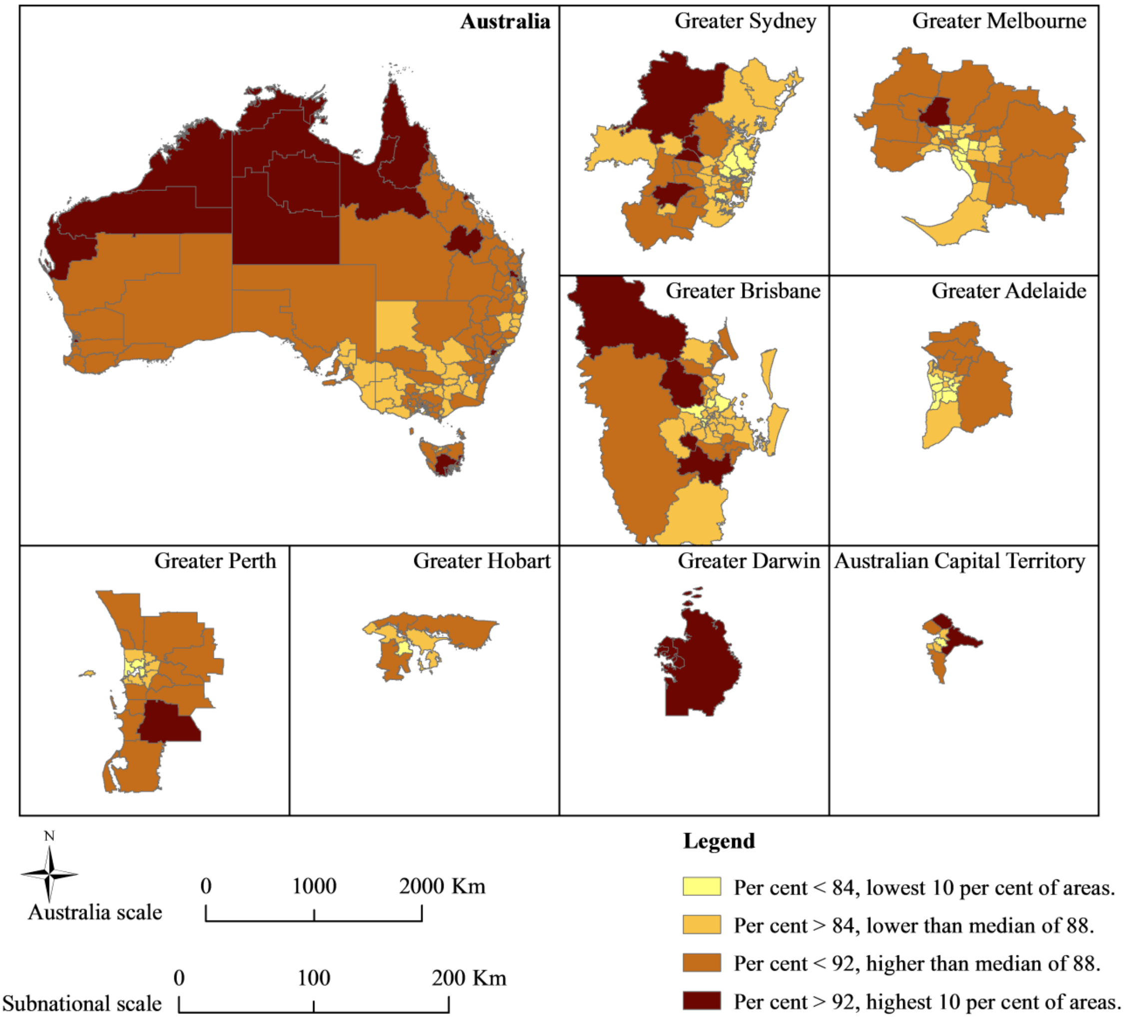
$$Early aged\ proportion = \frac{Population\ aged\ 65\ to\ 84}{Population\ aged\ 65\ and\ over}$$

The early-aged proportion has a range of 0 to 1, with higher values indicating the region has a higher proportion of their aged population in the early-aged years.

In June 2011, the early-aged proportion for Australia was 0.87 (ABS 2014b). It varies between 0.75 and 0.97 across the 327 regions examined, with an early-aged proportion between 0.86 and 0.90 for fifty per cent of regions. Even though the early-aged population is the large majority in most regions, there is still evidence of variation at the subnational level. I show the spatial pattern of this variation in Figure 25. A striking feature is the regions with higher than average early-aged proportions in the remote regions in the north and west of Australia. Regions with relatively high early-aged proportions, however, are located throughout Australia. Among the regions with the highest early-aged proportions (the top ten per cent), South Australia is the only state not represented.

Several factors are likely to explain the spatial pattern observed. Overall, the correlation between mortality conditions (measured by the region specific Standardised Mortality Ratio) and the early-aged proportion is moderate (at 0.40). However, most regions with the highest early-aged proportions have lower survival through the aged years relative to the national average. Further, of these regions, many are regions with a significant Indigenous aged population including Daly-Tiwi-West Arnhem, East Arnhem and Katherine in the Northern Territory and Far North Queensland. The Indigenous aged population group has lower life expectancy on average relative to the non-Indigenous population. However, some regions with the highest early-aged proportions have higher survival rates through the aged years relative to the national average including the regions of Gunghalin in the Australian Capital Territory, Hawkesbury in Sydney and Gold Coast Hinterland in Queensland. It is conceivable that an early-aged proportion is enhanced by favourable mortality conditions, if it supports growth in the early-aged population; however, in the long-term these early-aged populations will age into the late-aged years.

Internal migration conditions also appear to influence the early-aged proportion. Recall from Chapter 3, the Litwak and Longino (1987) framework for aged migration including moves in the early-aged years to high amenity locations and moves in the late-aged years to seek services and support. This study offers some support to this framework. In nearly all regions with the highest early-aged proportion, there is a net loss of the population aged 85 and over due to internal migration. The findings are more mixed for the 65 to 84 age group; for the majority of regions with the highest early-aged proportion, internal migration is contributing to growth of the early-aged populations. For example, regions such as the Central Highlands in Tasmania, Caboolture Hinterland in Brisbane and the South East Coast of Tasmania have all gained aged populations in the ages of 65 to 84 due to internal migration, while their populations aged 85 and over have reduced due to internal migration.



Source: ABS 2014b.
Note: The regions are Statistical Area 3 regions (see Section 5.2).

Figure 25 Per cent of the aged population in the early-aged years: Australian regions, 2011

8.1.3 Regional variation in the proportion of the aged population nearing the end of life

Just as a *younger* aged population has higher survival through a projection period, an *older* aged population is at greater risk of not surviving through a projection period. An *older age* aged community can also signal higher service needs (Jorm et al 2010; Seshamani and Gray 2004). The type of services needed may also be different—greater use of transport, home or residential care, and social and financial support.

Recall from Section 3.1.3 that prospective age perspectives were developed to identify the population closer to the end of their lives. There are many different ways to define an aged population using a prospective age perspective (see, for example, Lutz 2009). In this study, I define the prospective threshold of the aged as remaining life expectancy at age 65 less five-years. Using this prospective age perspective an *older* aged population has a higher proportion of the aged population above the threshold.

Therefore, prospective age in this study is calculated in two steps: first calculating the prospective threshold of the prospective aged (step 1) and then the per cent of the aged above the threshold (step 2):

Step 1:

$$Prospective\ threshold\ of\ aged = \ e_{65} - 5$$

Where e_{65} is remaining life expectancy at age 65.

Step 2:

$$Proportion\ of\ the\ aged\ above\ the\ prospective\ threshold\ of\ aged = \frac{Population\ older\ than\ the\ threshold\ of\ the\ aged}{Population\ aged\ 65\ and\ over} \times 100$$

While age is recorded in yearly increments, the prospective threshold of the aged is measured as a fraction of a year. To calculate the proportion of the aged above the prospective threshold of aged, I assume the population at age x is evenly distributed between the ages x and $x + n$. This assumption is reasonable given n is 1 in this analysis. Given life expectancy differs for males and females, I calculate the population nearing the end of life separately for males and females. I include the sex specific results in Appendix 1 but report here an average of the male and female proportion. The analysis has a range of 0 to 1, with higher values indicating a higher proportion of the aged population nearing the end of life. For this analysis, I use data from the Census.[62]

Regional differences in life expectancy at age 65 and 85

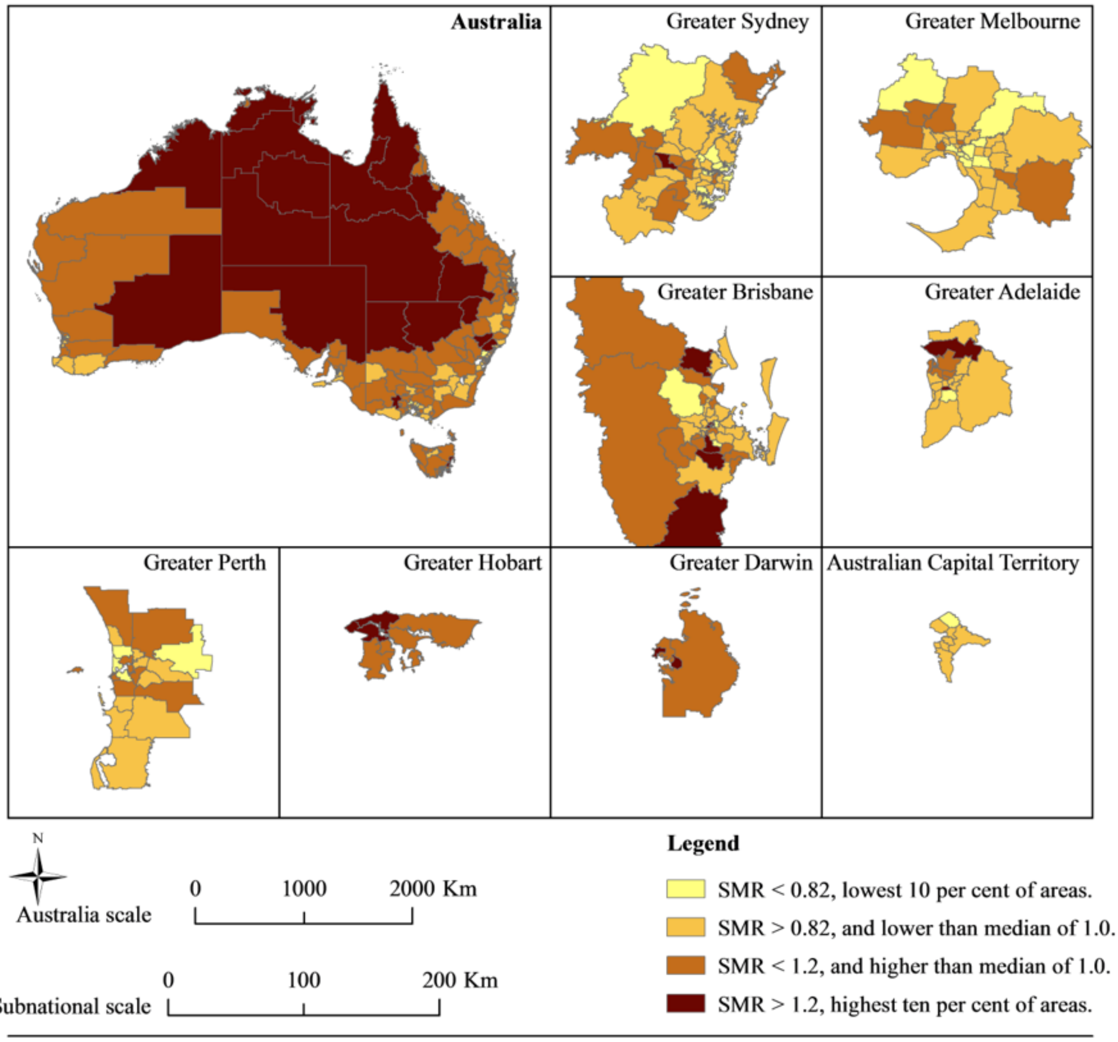
Before discussing regional variation in the proportion of the aged population nearing the end of life, it is important to outline regional differences in the life expectancy at age 65. This gives further insight into survival through the aged years as well as the prospective threshold of the aged as defined as remaining life expectancy at age 65 minus five-years in this study. Recall from Section 7.3.4 that I use a Standardised Mortality Ratio to estimate mortality conditions in each region, relative to national mortality conditions. A Standardised Mortality Ratio above one indicates survivorship through the aged years is less than the national average and below one indicates higher survival through the aged years relative to the national average. As shown in Figure 26, for the regions examined the Standardised Mortality Ratio varies from a low of 0.65 in Manly in New South Wales to a high of 3.2 in the Daly-Tiwi-West Arnhem region in the Northern Territory. These results are consistent with previous research finding regional variations in mortality with the lowest mortality in capital city regions (ABS 2013c; AIHW 2007b). Relative to coastal areas, mortality was higher inland and remote areas (AIHW 2006b).

This degree of variation in mortality has a significant effect on the proportion of the aged population surviving into and through the aged years in 2011. For females, remaining life expectancy at age 65 varies between 14.4 and 25.1 years and at age 85 varies between 3.6 and 9.1 years. For males, remaining life expectancy at age 65 varies between 11.5 and 22.4 years and at age 85 varies between 3.0 and 8.0 years. Focusing again on the regions with relatively low and high mortality (Manly and Daly-Tiwi-West Arnhem), the gap in survival to age 65 and through the aged years is stark. If measured using survivorship (l_x) from the substate period life tables, the highest survival is in the Manly region of New South Wales.[63] In Manly more than 92 per cent of males and 95 per cent of females are expected to survive to age 65 and 59 per cent of males and 72 per cent of females are expected to survive to age 85. In contrast, in the Daly-Tiwi-West Arnhem region survival

[62] Recall from Chapter 6.1 that population counts can be derived from either Census or the Australian Bureau of Statistics estimates of resident population. The estimated resident population is usually the better indicator of size because it is adjusted for the Census undercount while estimates based on the Census are not. For this analysis both options are imperfect. The estimated resident population is more accurate but data is only available in five-year age groups. The Census offers estimates by single year of age so it is preferable, particularly given this analysis is a measure of the age structure of the aged population.

[63] See Chapter 7.3.4 for the calculations of the substate life tables.

to age 65 is only 66 per cent of males and 78 per cent of females. Survival through the early-aged years is very low; just 6 per cent of males and 18 per cent of females are expected to survive to age 85. In Section 8.2.2.1 below, I return to this analysis to show how these differentials change over the projection horizon.



Source: Author's calculations using ABS 2013c and ABS 2014c.
Note: See Section 7.3.4 for the calculation. The regions are Statistical Area 3 regions (see Section 5.2).

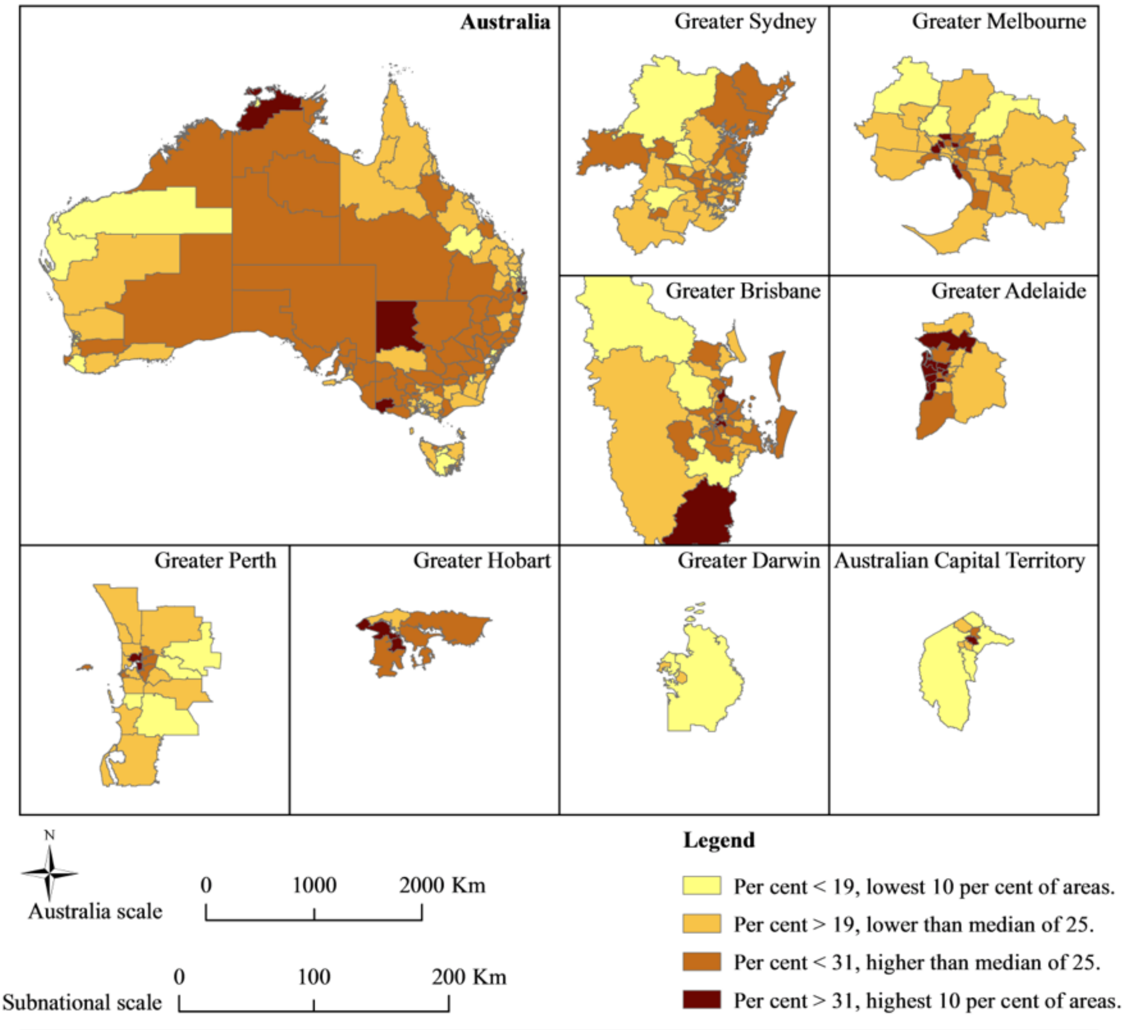
Figure 26 Standardised mortality ratios for Australian regions, 2011

The proportion of the aged population nearing the end of life

The proportion of population above the prospective threshold of the aged indicates the proportion of the aged population nearing the end of life. This is a function of both the age structure of the aged population in a region and the region specific prospective threshold of the aged.[64] For Australia, in 2011, the proportion of the aged population

[64] This correlation between the early-aged proportion and the proportion of the aged population nearing the end of life is -0.7.

nearing the end of life is 0.26 for males and 0.24 for females. For the regions examined, the median proportion of the aged population nearing the end of life is 0.25, and varies between 0.07 and 0.43 with fifty per cent of regions between 0.22 and 0.28. I show the spatial pattern of this variation in Figure 27.



Source: Author's calculations using ABS 2011d and ABS 2014c.
Note: See Chapter 7 for the calculation of the input variables. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 27 Per cent of the aged above the prospective threshold of the aged: Australian regions, 2011

Earlier studies have found the states of South Australia and Tasmania to be the frontier of population ageing in Australia (Jackson and Felmingham 2002b). Based on the proportion nearing in the end of life, and the more recent data used in this study, these states appear to be retaining their frontier positions. The regions of Unley, Playford, Holdfast Bay, Prospective-Walkerville, Port Adelaide (East and West) and West Torrens in Adelaide are among the regions with the highest proportion of the aged population near the end of life. In Tasmania, it is the regions of Launceston and Hobart Inner with the similar characteristics. In contrast, the regions with the lowest proportion nearing the end of life are Gunghalin and Tuggeranong in the Australian Capital Territory, the Pilbara in Western Australia, Jimboomba in Brisbane and the Gold Coast Hinterland in Queensland, and the Hawkesbury in Sydney. The composition of the regions included in highest and lowest areas can be significantly different for males and females and interested readers should consult Appendix 1.

8.2 GROWTH IN THE AGED POPULATION AT THE SUBNATIONAL LEVEL, 2011 TO 2031

Projections are undertaken to assist in planning for future demographic conditions. As set out in Section 3.2, there are numerous projections of the Australian population. This projection is unique, offering a subnational projection of the aged population covering all of Australia. In this section, I begin by introducing the subnational projection model. Next, I examine results from the partial projection scenarios to isolate the effects of mortality and migration (international and internal) on the growth of the aged population. With ageing-in-place such a strong force in population age structures, it is important to focus on the factor in isolation. However, no projections of the aged should be complete without an examination of migration, even if levels of migration are lower at older ages. As Rowland (2012, 103) observes, “migration adds complexity, extremes and unpredictability to the overall picture, especially in rural areas and smaller towns where migration rates are more likely to be high”. So, I will also review migration in isolation and, finally, examine the full projection model results focusing on the main variant of the projection.

8.2.1 The subnational projection model

Key to better understanding the aged and ageing processes in Australia is to understand how the size and age structure of the aged population may change over the near and medium-term. It is not sufficient to rely on national projections when so much of the response to population ageing will be at the local level. A subnational projection model of the aged population is needed, and one that can examine all regions of Australia using a consistent methodology.

A projection model needs to be fit for purpose, which Smith (1997) describes as accurate, timely, consistent with other projections, useful for policy makers and based on reasonable assumptions. The subnational projection model I have designed meets each of these criteria. The small area projections aggregate to an estimate of the aged population consistent with the official national projections; the projection assumptions are informed by recent and projected trends in mortality and migration; the projection can be easily updated with each data release; and, as a result of this model, policy makers will have more detailed information about change in the aged population across Australia regions.

I use a cohort component accounting framework for the subnational projection model. This is a well understood and often used method that can be efficiently produced (Preston, Heuveline and Guillot 2001). The method is also consistent with the approach used in Australia's official projections and, therefore, will be complementary to the official projections (ABS 2013g).

Alternatives to the cohort component model were considered.[65] Sometimes population projections for small areas use housing or land supply approaches (Wilson 2011c). Data of this kind was not available for the study, but additionally the regions examined in this study (Statistical Area 3 regions) are too large for population change to be constrained by housing or land availability. Probabilistic projections, a form of cohort component method, are being used to better understand uncertainty in projection outcomes. As Lutz, Sanderson and Scherbov (2008, 77) explain, the methods use "random draws from distributions of total fertility rates, life expectancies at birth, and migration rates to produce distributions of population and age structure outcomes". Establishing these distributions for the more than 327 regions examined, particularly without time series of substate data, would require resources beyond the scope of this study.

In contrast to the macrosimulation approach used in the cohort component method, microsimulation approaches modelling transitions at the individual level are used. The microsimulation approach uses sample data at the individual level and runs repeated random experimentations to produce population futures (van Imhoff and Post 1998). Wilson, a leading expert in small area projections of the Australian population, recommends against using microsimulation approach for small area analysis because the approach is too highly resource intensive to be practical for policy makers (Wilson 2011c). Hybrid approaches referred to as mic-mac models are also available to combine traditional projections of age and sex (macro models) with individual and multistate transition models capturing the events that shape the lives of individuals (micro models) (Willekens 2005). Incorporating a microsimulation approach into a multidimensional approach to better understanding the aged would be a worthwhile enhancement to this

[65] For discussion of range of projection alternatives see Wilson and Rees (2005).

study. But, the first step—and the priority here—is to achieve a functional macrosimulation model of population change at the substate level.

Turning now to the detail of the cohort component method. A stylised version of the cohort component model is shown in Figure 28. It is based on the Leslie Matrix (Leslie 1945). As a deterministic projection, the projection outcomes directly link to the assumptions included in the model (Booth 2004). The method works by surviving an initial population through a projection horizon and making adjustments for net migration (both international and internal migration). For closed-aged intervals—and assuming five-year age groups and a projection horizon of five-years—the estimate of the population five-years hence is given by Preston, Heuveline and Guillot 2001:

$$ {}_5N_x\,(t+5) = \left({}_5N_{x-5}(t) + \frac{{}_5I_{x-5}\,[t,t+5]}{2} \right) \cdot \frac{{}_5L_x}{{}_5L_{x-5}} + \frac{{}_5I_x[t,t+5]}{2} $$

If an open-age interval is required, with the same assumptions, the formula would be:

$$ {}_\infty N_{x+5}(t+5) = \left({}_5N_x(t) + {}_\infty N_{x+5}(t) + \frac{{}_5I_x\,[t,t+5] + {}_\infty I_{x+5}[t,t+5]}{2} \right) \cdot \frac{T_{x+5}}{x} + \frac{{}_\infty I_{x+5}[t,t+5]}{2} $$

In both formulas, N represents the size of the population, x is age and ${}_5I_{x-5}[t,\ t+5]$ is the number of net migrants during between t and $t+5$. The remaining terms are the life table quantities L_x and T_x which are the standard life table quantities introduced in Section 7.3.1 and Table 7. Half the migrants enter the population in the launch year and are added to the initial launch population and half are added to the survivors at the end of the projection interval. This means that half the migrants will age with the launch population and some will die within the age interval. Clearly this is a simplification of real world population change, but with 327 regions to project a simplified model offers considerable efficiency.

Age	Population Count				
	2011	2016	2021	2026	2031
45	${}_5N_{45}$				
50	${}_5N_{50}$	${}_5N_{50}$			
55	${}_5N_{55}$	${}_5N_{55}$	${}_5N_{55}$		
60	${}_5N_{60}$	${}_5N_{60}$	${}_5N_{60}$	${}_5N_{60}$	
65	${}_5N_{65}$	${}_5N_{65}$	${}_5N_{65}$	${}_5N_{65}$	${}_5N_{65}$
…	…	…	…	…	…
100	${}_5N_{100}$	${}_5N_{100}$	${}_5N_{100}$	${}_5N_{100}$	${}_5N_{100}$
105	${}_5N_{105}$	${}_5N_{105}$	${}_5N_{105}$	${}_5N_{105}$	${}_5N_{105}$
110	${}_\infty N_{110}$	${}_\infty N_{110}$	${}_\infty N_{110}$	${}_\infty N_{110}$	${}_\infty N_{110}$

Survival of cohort and growth (decline) due to migration

Figure 28 A stylised cohort component projection

Recall also from Chapter 3, demographic theory would suggest ageing-in-place will contribute the most to the growth of the aged population (Rogers and Raymer 2001). International migration will offset growth in the aged population given the typically younger ages of migrants. Internal migration will redistribute the aged in favour of higher amenity areas and capital cities. Using the subnational projection model I develop, I can examine these theories in the context of a growing aged population in Australia.

To explore a range of population futures, it is best practice to include scenarios in the projection. In this subnational projection model, I include the 24 different scenarios set out in Table 8. These include partial projection models to isolate sources of growth in the aged population and full projection models for a range of mortality and migration scenarios. I introduced these scenarios in Chapter 7 where I set out the steps to calculate the key demographic variables used in this study. To recap, there are three mortality scenarios: constant mortality using a continuation of the mortality conditions in 2011 through the projection period, trend mortality where mortality continues to decline consistent with recent trends and slowing mortality where mortality continues to decline but at a slower rate. There are three international migration scenarios: high, medium and low, with the level of international migrants linked to assumptions used in the official ABS projections (ABS 2013g). There is one internal migration scenario based on the level and spatial pattern of internal migration calculated from the Census continuing through the projection horizon.

Also, consistent with best practice, I use zonally-differentiated assumptions (Holmes, Charles-Edward and Bell 2005). The projection model is unique, calibrated for each region. To recap again from Chapter 7, life tables were calculated for each substate region, substate estimates of international immigration was determined by the settlement share of recently arrived internal migrant, international emigration was determined by population share and the level and spatial pattern of internal migration was informed by an origin-destination migration flow matrix estimated from the Census.

Small area projections can quickly become complicated, and the more complicated methods do not automatically produce better results (Smith 1997). Some of the design decisions in this projection model minimise complexity, including limiting the projection horizon to 20 years. Given the goal is to project the population aged 65 and over, only the population aged 45 and over needs to be projected with a 20 year projection horizon. As a result, fertility estimates are not required in this model.

There are multiple sources of uncertainty associated with population projections. Hoem (1973) and Keilman (1990) identify different sources of forecast error including incorrect estimation of the launch population, and registration errors, pure randomness, random vital rates, unincorporated gradual changes in mean vital rates, gross shifts, and serious model misspecification. The design of the projection can also be important. Smith and Tayman (2003) observe differences in the launch years, projection horizon and levels of geography could explain differences in empirical results. Increasing the forecast length also increases uncertainty (Smith and Tayman 2003; Tayman 2011).

The likelihood of errors in projection outcomes increases when demographic conditions are changing. Swanson and Tayman (2012, 285) observe "estimate accuracy is generally greatest for places with small but positive growth rates and decreases as growth rates deviate in either a positive or negative direction from those low levels" (Swanson and Tayman 2012, 285). During times of higher demographic change, there will also be more uncertainty in the performance of the projection model (Wilson and Rees 2005). The youth and aged projections are typically more uncertain (Smith and Tayman 2003) because fertility and mortality conditions strongly influence these groups. Regions with a small population are particularly vulnerable to change as the effects of local conditions (the opening or closing of a business or even an aged care facility) may be directly apparent in the size and age structure of the population. It is important to understand the limitations of projections—they are not forecasts, but illustrate plausible scenarios to assist to plan the response to population ageing in Australia.

Table 8 The different projection scenarios

Projection Model	Number	Scenario: Mortality	Migration: International Migration	Migration: Internal Migration
Partial model: mortality only	1	Constant	Nil	Nil
Partial model: mortality only	2	Trend	Nil	Nil
Partial model: mortality only	3	Slowing	Nil	Nil
Partial model: mortality and internal migration	4	Constant	Nil	Constant
Partial model: mortality and internal migration	5	Trend	Nil	Constant
Partial model: mortality and internal migration	6	Slowing	Nil	Constant
Partial model: mortality and international migration	7	Constant	Low	Nil
Partial model: mortality and international migration	8	Trend	Low	Nil
Partial model: mortality and international migration	9	Slowing	Low	Nil
Partial model: mortality and international migration	10	Constant	Medium	Nil
Partial model: mortality and international migration	11	Trend	Medium	Nil
Partial model: mortality and international migration	12	Slowing	Medium	Nil
Partial model: mortality and international migration	13	Constant	High	Nil
Partial model: mortality and international migration	14	Trend	High	Nil
Partial model: mortality and international migration	15	Slowing	High	Nil
Full model	16	Constant	Low	Constant
Full model	17	Trend	Low	Constant
Full model	18	Slowing	Low	Constant
Full model	19	Constant	Medium	Constant
Main projection model	20	Trend	Medium	Constant
Full model	21	Slowing	Medium	Constant
Full model	22	Constant	High	Constant
Full model	23	Trend	High	Constant
Full model	24	Slowing	High	Constant

8.2.2 Subnational variation in the sources of growth for the aged population: results from the partial projection models

In the following subsections, I examine regional variation in sources of growth using partial projection models. I begin with mortality, then international migration and internal migration. Each of these processes has a different impact on the growth of the aged population: mortality and emigration reduce the size of the aged population, while immigration can increase the aged population. Internal migration does not affect the size of the aged population at the national level but does redistribute the aged population at the subnational level.

8.2.2.1 Ageing-in-place: survival

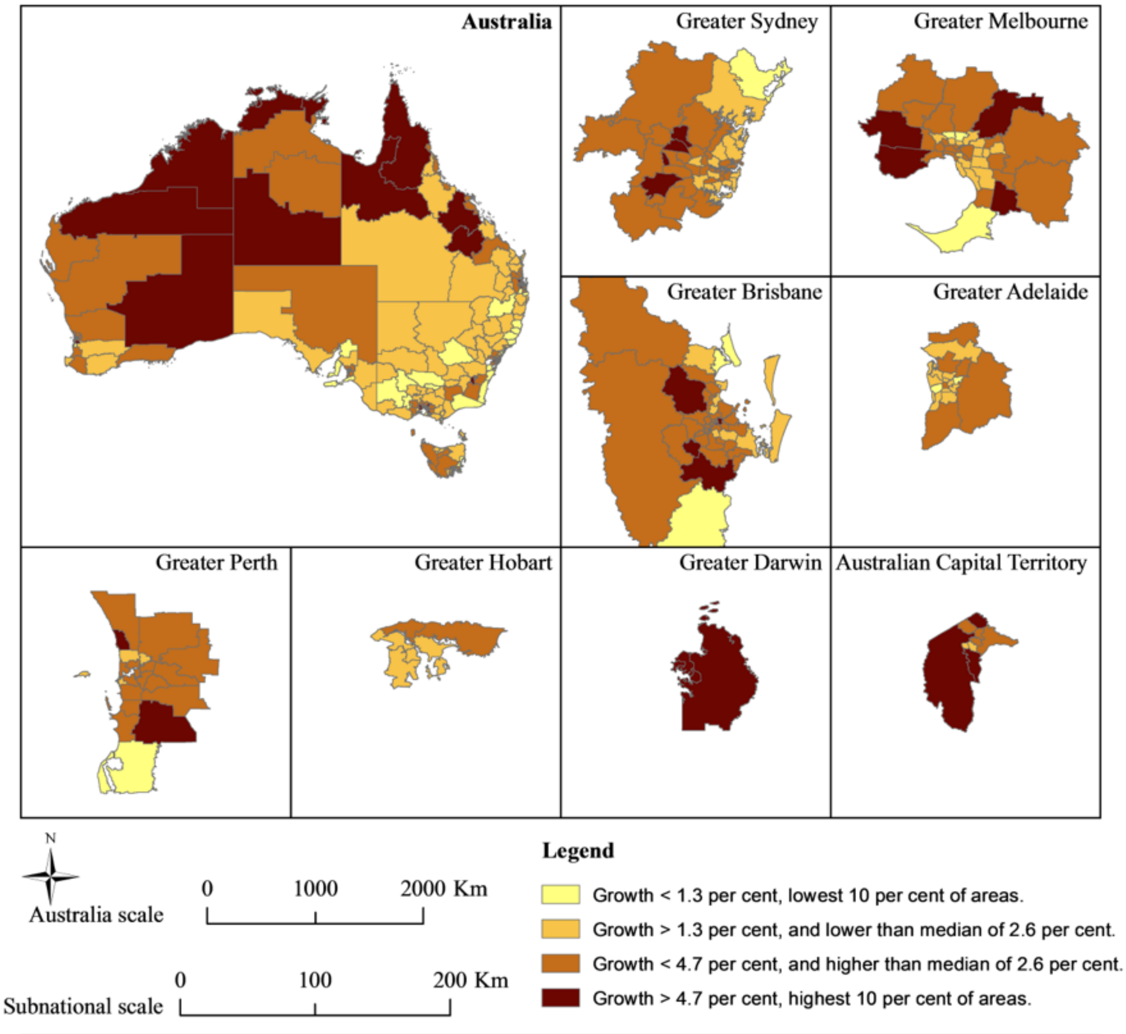
Survival into and through the aged years will be a key determinant of the size of Australia's aged population in the future. The ageing of the large baby boomer cohort into the aged years and survival through the aged years will be a key driver of growth in the aged population. This is known. What is not known is the subnational distribution of this growing aged population. I examine this using partial projection models closed to migration and ageing the population 45 and over. I compare three scenarios: current mortality conditions and the two improving mortality scenarios (the trend and slowing scenarios outlined in Section 7.3).

Growth in the aged population if mortality conditions are constant

The first projection scenario is survival of the current population based on constant mortality and no migration (Partial model 1). That mortality is constant is unlikely, so I discuss it only briefly to set a foundation from which to understand the impact of changing mortality conditions on the size of the aged population. The average per cent growth rate of the population aged 65 and over between 2011 and 2031 for the Australian regions if mortality conditions are constant is shown in Figure 29. For Australia, the size of the aged population increases to 5.2 million. The median growth is 2.6 per cent per year, and it can vary between -0.06 to a high of 11.5 per cent per year.

This is the lowest growth projection scenario included in this study. Even still growth in the aged population is near universal, indicating that simply the ageing-in-place is enough to produce growth in all but one region across Australia. This is also the only scenario where shrinkage in the aged population is observed over the forecast period; yet it only occurs in only one of the 327 regions examined—the Great Lakes region of New South Wales.

As a reference point for the subsequent figures, the average annual growth rates for the regions examined are shown in Figure 29. The highest growth regions are distributed around Australia. A number are outside of the capital cities, in particular in remote regions of Western Australia, Northern Territory and Queensland. Within the capital city regions, growth is typically above the median. The lowest growth regions are concentrated in the south and east of Australia, both within and outside of capital city regions.



Source: Author's calculations using ABS 2013c and ABS 2014c.
Notes: These estaimtes are from the Partial model 1 (see Table 8). See Chapter 7 for the calculations of the input variables. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 29 Average annual per cent growth in the aged population for Australian regions between 2011 and 2031: constant mortality and no migration scenario

Growth in the aged population if mortality conditions improve

If mortality conditions within the aged years improve the size of the aged population increases. Next, I examine the effect of slow improvement to mortality, also assuming the population is closed to migration (Partial model 3). At the aggregate level the size of the aged population increases by an additional 317,000 thousand people, compared with the constant mortality scenario above (Partial model 1). If mortality reductions continue with recent trends (Partial model 2), the aged population will be even larger by an additional 57,000 people in 2031, relative to the slowing mortality scenario (Partial model 3).

In Section 8.1.3 above, I outlined variation in the life expectancy at the subnational level in 2011. Here I pause to make a few remarks about how this changes during the projection horizon. Significantly, over the period 2011 to 2031, the gap between the high and low mortality regions increases, with the high mortality regions achieving relatively smaller gains. During the projection period, under the trend scenario, remaining life expectancy at age 65 reaches 27.9 years for females and 26.0 years for males and, at age 85, reaches 9.9 years for females and 8.8 years for males. Under the trend scenario there is also a change in the region with the longest lives. Under this scenario, the Gunghalin region of the Australian Capital Territory surpasses Manly as the region with the longest life expectancy.[66] The region with the worst mortality conditions is unchanged between 2011 and 2031. Although mortality conditions do improve, the gains are small: in the Daly-Tiwi-West Arnhem region, remaining life expectancy at age 65 reaches 14.5 for females and 12.0 for males and, at age 85, reaches 3.6 for females and 3.1 for females.

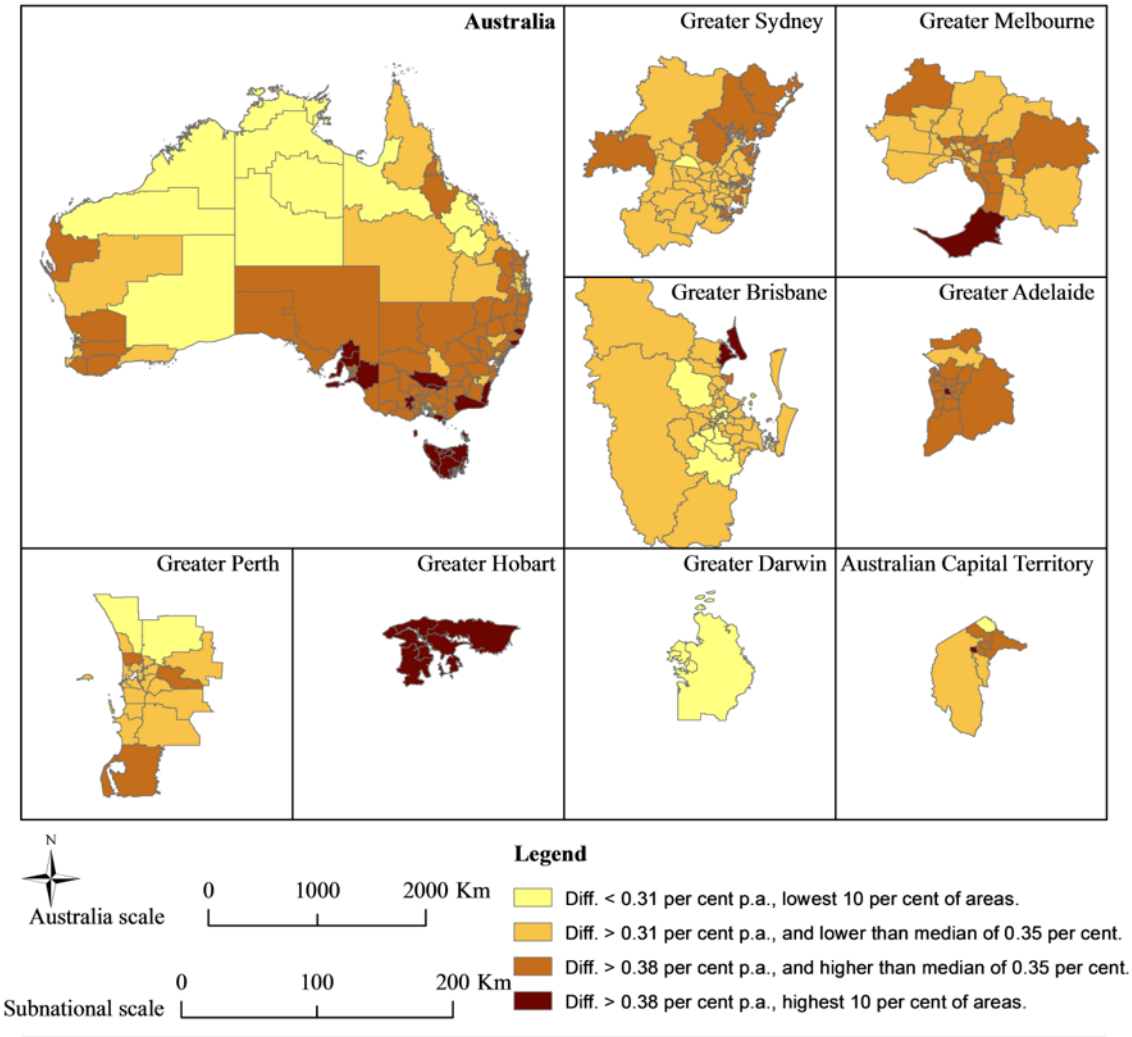
Based on the estimates developed for this study, inequality in survival to age 65 and within the aged years increases. By 2026, under the trend improving scenario and where the Gunghalin region has the highest survival, expected survival to age 65 is 96 per cent for males and 98 per cent for females and to age 85 is 77 per cent of males and 85 per cent of females. In contrast, in the Daly-Tiwi-West Arnhem region survival to age 65 is only 66 per cent of males and 78 per cent of females. The improvement in Daly-Tiwi-West Arnhem between 2011 and 2026 is an increase of just two per cent for males and one per cent for females compared with 2011. Survival through the early-aged years also remains very low—just 6 per cent of males and 18 per cent of females are expected to survive to age 85, meaning an improvement in the projection period of only one per cent.

The differences in life expectancy, combined with differences in the age structure, both affect growth in the aged population. To demonstrate this variation, I show in Figure 30 the differences in the average annual per cent growth in the aged population between constant mortality (Partial model 1) and trend mortality (Partial model 2) for each of the

[66] Note that as a newly established region in Australia morality conditions may have been artificially low in 2011.

Australian regions between 2011 and 2031. Improving mortality has the most significant effect on the growth of the aged populations in Tasmania and South Australia. The least affected regions are in the Northern Territory and Western Australia.

There are two key learnings from examining mortality using these partial projection models with improving mortality conditions. The first is that improving mortality conditions modelled in this study could add more than 300,000 people to the size of Australia's aged population relative to current mortality conditions by 2031. Relative to the effects of international migration (the medium scenario) and internal migration, improving mortality conditions has the largest effect on growth in the aged population for most regions. The differences between the trend and slowing scenario are relatively small, with the trend scenario adding an additional 57,000 people relative to the slowing scenario. This indicates slowing of mortality improvements will be unlikely to significantly change the growth trajectory of Australia's aged population. Thus, while a mortality shock—such a deadly pandemic influenza—is possible, the more likely scenarios is for survival to and through the aged years to continue to improve and enhance growth in the size of the aged population.



Source: Author's calculations using ABS 2013c and ABS 2014c.
Notes: These estimates are from Partial model 2 (see Table 8). See Chapter 7 for the calculations of the input variables. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 30 Change to the average annual per cent growth in the aged population between the constant mortality and trend mortality projection scenarios for Australian regions between 2011 and 2031

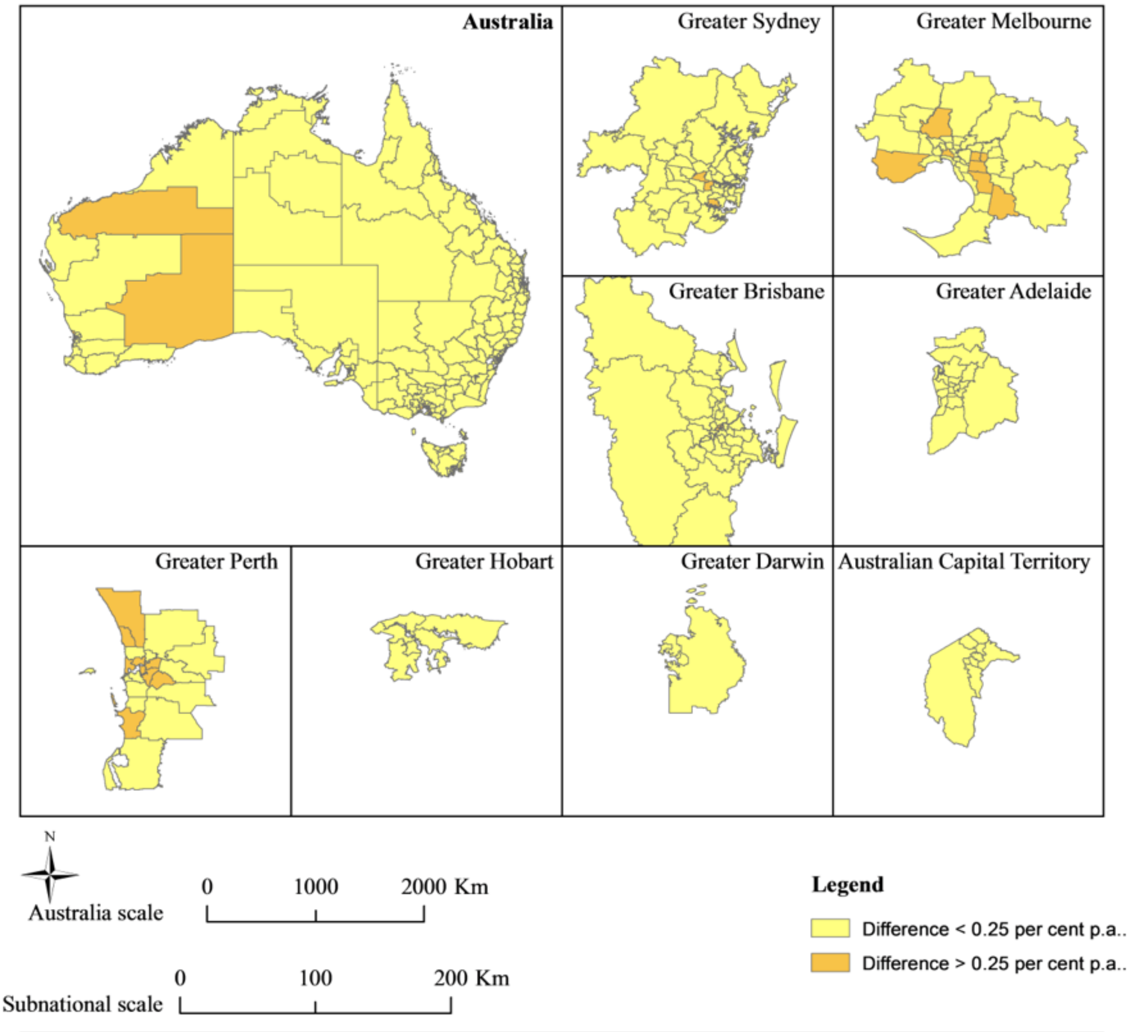
8.2.2.2 International migration

In theory, international migration can add or detract from the aged population. In practice, international migration is contributing to growth in the Australia population, and in recent years is contributing more to growth than natural increase. Less than 1.5 per cent of the international migrants are aged over 65 (ABS 2015c), yet younger immigrants age and contribute to the size of the aged population in the medium- and long-term.

Based on the trend mortality and medium overseas migration assumptions (with no internal migration, Partial model 11), Australia's aged population grows to 5.73 million in 2031. At the substate level, international migration enhances growth in the population aged 65 and over in all regions except one region in the Northern Territory, where a very small reduction in the growth of the aged population is observed. For most regions, as shown in Figure 31, the effect of international migration is small. In 305 of the 327 regions studied, the effect of international migration is less than 0.25 per cent per year. Of the regions where it is higher than 0.25 per cent per year, some caution should be exercised in interpreting the results for the remote regions in Western Australia. These results may be influenced by short-term factors such as larger numbers of overseas labour supporting the construction phase of the resource sector between 2006 and 2011. I would expect that the 2016 Census will show people flowing into these regions will return to their home countries or move elsewhere in Australia.

There are few differences between the projection scenarios. Substate projections incorporating international migration require assumptions about the level of international arrivals and departures for each region. I developed three scenarios based on high, medium and low international migration levels (see Chapter 7.4.1). Overall, net international migration adds at least 125,000 people to the aged population when compared with the scenario of constant mortality and no migration. However, in 2031, the difference between the high and low migration scenario is only around an additional 25,000 people by 2031. The impact of international migration is increased to up to 1000 additional aged people under the improving trend mortality scenario due to the improved survival of the migrant population. There is uncertainty about the actual level of migration and at least one authority argues that migration in Australia will be more uncertain in the future than the past (McDonald 2012). However, if fluctuations do occur, at least within this level of the scenarios considered in this study, the impact on the growth of the aged will be minimal.

International migrants are more likely to live in major urban areas, and the trend to settle in major urban areas has increased (Massey and Parr 2012). In the regions of Perth in Western Australia, and Wyndham and Melbourne City in Melbourne, international migration increases growth in the aged population more than growth from improvements in mortality (between the slowing and trend scenario). International migration enhances ageing in two regions in rest of Western Australia, Pilbara and Goldfields—which I expect are artificially inflated due to short-term labour market factors affecting these regions between 2006 and 20111. The remaining areas are in capital cities, particularly Sydney, Brisbane, Melbourne and Perth. In addition to the regions mention included Wanneroo, South Perth, Perth City, Canning, Brisbane Inner, Dandenong and Parramatta are the regions where international migration is projected to contribute the most significantly to growth in the aged population.



Source: Authors' calculations using ABS 2013c, ABS 2014c and ABS 2015c.
Notes: These estimates are from Partial model 11 (see Table 8). See Chapter 7 for the calculations of the input variables. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 31 Change to the average annual per cent growth in the aged population between the trend mortality projection scenario and international migration for Australian regions between 2011 and 2031

8.2.2.3 Internal migration

The level and spatial pattern of internal migration is a volatile component of the population process in the projection model (Smith 1986; Wilson and Rees 2005). How internal migration is incorporated into a projection model can have a significant effect on the projection results (Smith 1986, Wilson and Bell 2004b). Internal migration does not change the size of the aged population but redistributes the aged population at the subnational level. Thus, the goal is to identify the regions where the movement of people across regional boundaries has an impact on the growth of the aged population.

Recall from Section 7.4.2 that I estimated the level and spatial pattern of internal migration in Australia using origin-destination migration flow matrices. Each matrix is large (369 by 351 regions) so it not possible to demonstrate in this Chapter the level and spatial pattern of internal migration revealed in these matrices. They do show, consistent with earlier studies (Hugo 2005; Tobler 1970), that the level of internal migration falls with age and that most moves are within area moves, therefore residential mobility. I show an indicative version of this spatial pattern of internal migration in Figure 32 using the circular plot showing origins and designations of the residential moves of the population aged 65 and over (at the time of the 2011 Census) for the greater capital city and rest of state regions in each states and territory. For example, to assist in interpretation, the darker blue lines originating in the Greater Capital City (GCC) region of New South Wales represent residential movers in the Sydney region of New South Wales. Most move within New South Wales (represented by the u-shaped line) while a small proportion move within New South Wales but outside of Sydney (the u-shape line between GCC New South Wales and Rest of State New South Wales) and a small number migrate to Rest of State Queensland. There are flows from Sydney into the other regions, but these are much smaller.

Source: ABS 2011c
Note: Flows between origins and destinations are shown in this circular plot (see Sander et al 2014 for a description of the plots). The sending region determines the colour of the flow and the width of the flow line is proportional to the total moves. GCC is greater capital city, RoS is rest of state.

Figure 32 Spatial pattern of internal migration of the population 65 and over: Australian regions between 2006 and 2011

Turning now to the effect of internal migration on the growth of the aged population. The inclusion of net internal migration relative to trend mortality results in an aged population in 2031 of 5.57 million people (Partial model 5), a reduction in the size of aged population by 16,300 due to some migrants having left regions in the study for regions not included in the study (for example, to "other territories" see Section 5.2.)[67]

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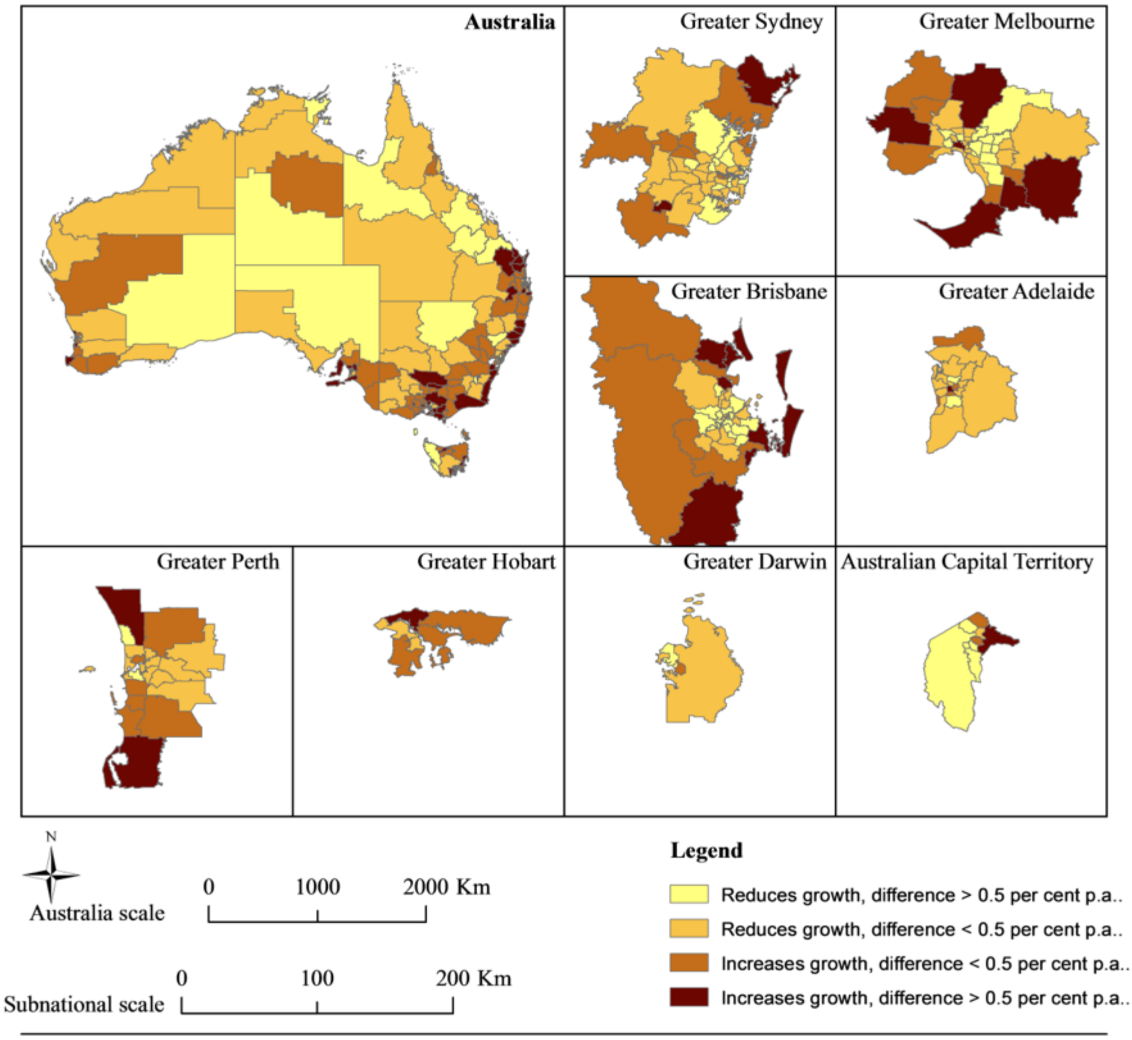
[67] The method of calculating internal migration is also likely to be a contributing factor, particularly rounding counts to the whole person (see Chapter 7.4.2).

These results show internal migration can enhance or supress the growth of the aged at the substate level. The spatial pattern of this variation is shown in Figure 33. Net internal migration is positive in 146 regions and negative in 181 regions. In no region does internal migration lead to negative growth in the aged population; the aged population continues to grow in all regions. For the large majority of regions, the effect is very small, a mean of around 1400 people aged over 65. However, the gains are uneven with the top 15 regions gaining 35 per cent of the internal migrants.

The regions where the gains are most significant are the high amenity regions often associated with retirement migration. Many are coastal regions including the regions of Fleurieu-Kangaroo Island and Yorke Peninsula in South Australia, the regions of Hervey Bay, Caloundra and Noosa in Queensland, the Surf Coast-Bellarine Peninsula in Victoria, and the South Coast and Port Stephens in New South Wales. Some regions are also inland regions reasonably accessible to Sydney and Melbourne including the Southern Highlands in New South Wales and Gippsland-East. In all regions, internal migration contributes more to the size of the early-aged population than the late-aged population, consistent with internal migration occurring more within the early-aged years and consistent with amenity-led migrations. However, where growth is supported by internal migration in the late-aged years, this tends to be regions in capital cities and larger urban centres outside of capital cities—Robina and Southport in Queensland are examples.

Wherever internal migration increases growth in one area, it must reduce growth in another. In fact, as mentioned, for the majority of the regions internal migration reduces growth. Among the regions most affected are the inner areas in Brisbane, regions such as Brisbane Inner (East and West), Nathan, Sunnybank and Straphine. A similar pattern is observed in all other capital city regions with the exception of Hobart. Outside of capital cities, internal migration mostly reduces growth in the aged population (Outback-North in Queensland, for example). Given this study uses geographically large spatial units for remote Australia, further analysis should be undertaken to examine the internal migration dynamics within these regions in the future.



Source: Author's calculations using ABS 2011d, ABS 2013c and ABS 2014c.
Note: See Chapter 7 for the calculations of the input variables. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 33 Change to the average annual per cent growth in the aged population between trend mortality scenario and internal migration for Australian regions between 2011 and 2031

It is likely that both the level and spatial pattern of migration will evolve differently to the assumptions in this projection model. I have already mentioned that net migration estimates can be biased, over estimating growth in fast growing regions. Over the projection horizon, socio-economic factors can also influence migration decisions (see, for example, Sander, Bell and Brown 2007). The current trends would suggest more downside than upside risk. Changes expected include falling level of internal migration as the aged population grows older; a postponement in retirement migration associated with the increased length of work and, similarly, a postponement in return migration if the length of life without disability increases. On the upside, if government was to remove the primary home from the asset test for the Age Pension (also discussed in Section 9.2), this could stimulate higher levels of residential mobility in the aged years and, some of these moves, may be internal migrations that would not otherwise have occurred.

The internal migration model is the last of the Partial models I outline to examine regional dynamics and partial projections. In the next subsection, I examine the full projection model incorporating trend mortality improvement, the medium international migration distributed by settlement proportion and constant net internal migration.

8.2.3 Subnational change in the size of the aged population 2011 to 2031 at the substate level

In the section above, I explored the common influences in contributions to growth of the aged population and identified where there are differences between regions. Ageing in place was a strong influence. In fact, across all regions there was a correlation of 0.93 between the average growth rate for the main projection (number 20) modelling mortality and migration processes and the average growth rate for the partial projection model (number 2), modelling only survival of the existing population. Improving mortality conditions and international migration enhanced growth in nearly all regions (as explained, there is one exception for international migration). Significantly, in more than 80 per cent of lowest growth regions (the bottom ten per cent), internal migration is reducing the growth rate of the aged population in the region. Interestingly, internal migration is also reducing growth in around nearly half of the highest growth regions. In this section, I focus on the main projection scenario (number 20) which assumes trend mortality, a medium level of international migration and constant net internal migration.

When applied to 2011 to 2031, the subnational projection model I developed performs well when compared with the official projection. If aggregated to the national level, this substate projection model produces estimates of the then aged population of between 5.32 and 5.73 million in 2031 (projection model 16 and projection model 23 respectively).[68] Based on the main projection model (projection model 20) the aged population is expected to grow to 5.72 million by 2031. These results are credible, with the most similar projection for the ABS projecting an aged population of 5.71 million in 2031 (ABS 2013g). In the following subsections, I examine the main projection model in more detail

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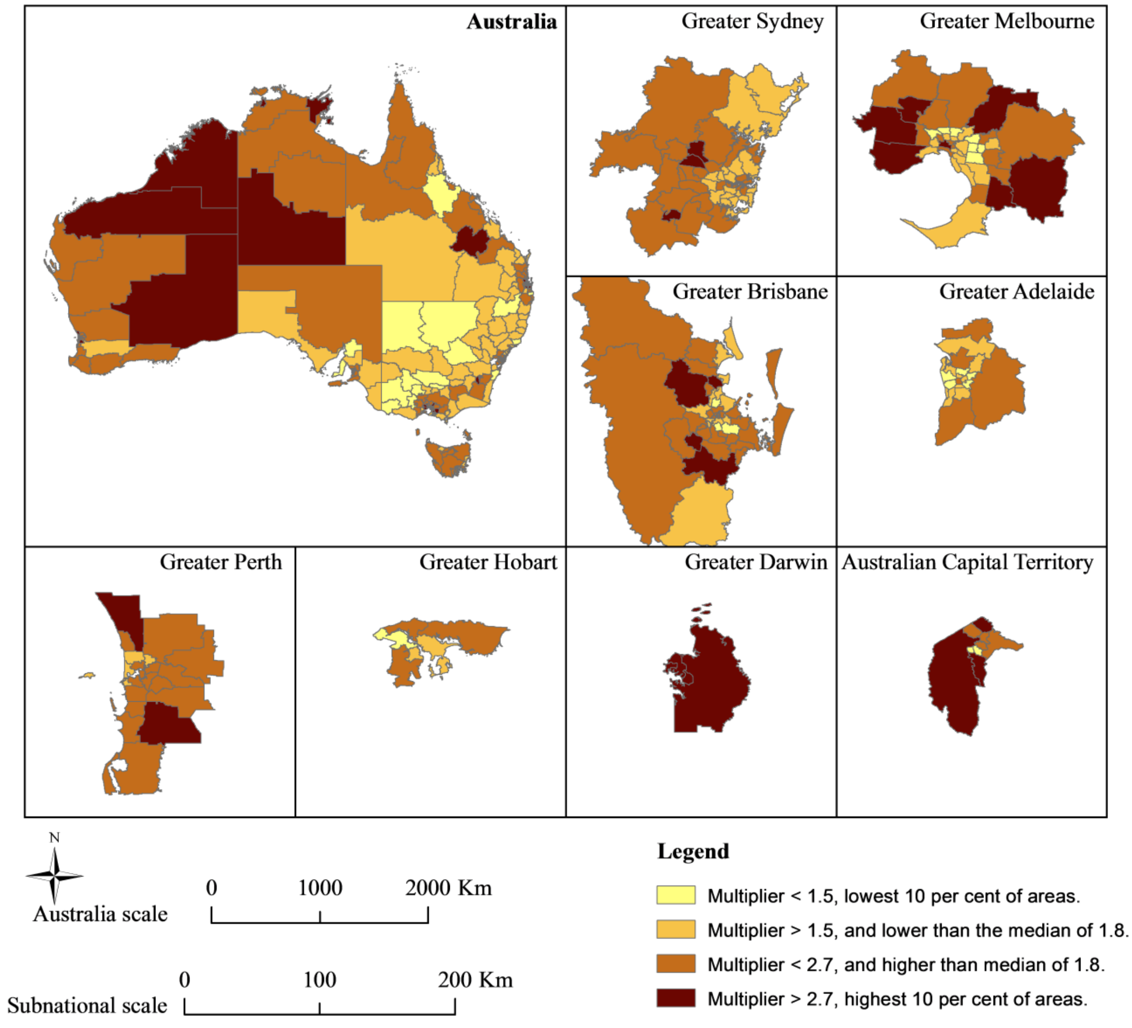
[68] Note: this is an aggregation from the substate projections, which should not be interpreted as directly comparable with national level projections.

focusing on regional growth in the aged population and compositional change in the aged population by age and sex.

Growth in aged population between 2011 and 2031 will be uneven

To begin I focus on the size of the population aged 65 and over. In Figure 34, for the 327 regions in the substate projection model, I show the relative change in size of the aged population in 2031 compared to 2011. While at the national level the aged population is expected to nearly double between 2011 and 2031, at the substate level there are substantial differences to the national average. The aged population increases in all regions, but the multiplier can be as low as 1.2 and as high as 11.0.



Source: Author's calculations using ABS 2011d, ABS 2013c, ABS 2014c and ABS 2015c.
Note: See Chapter 7 for the calculations of the input variables. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 34 Relative size of the aged population in 2031 compared with 2011: Australian regions

The regions where the largest expected change in the size of the aged population is expected are mostly within capital city areas. These include areas such as Gunghalin in the Australian Capital Territory, Blacktown-North in Sydney and the Melton-Bacchus Marsh region in Melbourne. While earlier studies have identified South Australia and Tasmania as at the frontier of population ageing (Jackson and Felmingham 2002b), in this study none of the regions in these states are among the regions with the largest relative increase over the next twenty years.

Outside of capital cities, the stand out regions are in remote locations of Western Australia and the Northern Territory (see Figure 34). The region with the largest multiplier is the Pilbara, which in this model increases from an aged population around 1200 to 13000 between 2011 and 2031. Applying judgement, growth in the aged population of this amount in the Pilbara is unlikely with the results more probably reflecting short-term demographic conditions associated with the construction phase of large resource projects. Similar factors may also be enhancing the projected growth in the aged population in other remote locations. Another region outside of capital cities worth highlighting is the Cairns-North region in the North of Queensland. The aged population in Cairns is expected to increase from around 4200 to 14,500 between 2011 and 2031, primarily a result of ageing-in-place but also with positive contributions from international and internal migration. These results are consistent with the private sector forecast for the Cairns Regional Council (Forecast.id 2016).

Growth in the aged population is occurring across all regions.[69] The regions with the lowest multipliers (the bottom ten per cent) are still within the range of 1.2 and 1.5. These regions are in the south and eastern states of Australia and evenly distributed within capital city areas and rest of state regions. Moreland-North in Melbourne has the lowest multiplier, with its aged population projected to increase from around 12,700 to 14,800 between 2011 and 2031. Other areas with only small changes in the size of the aged population are West Torrens in Adelaide, Keilor in Melbourne, Broken Hill and Far West in New South Wales. The regions with relatively low multipliers tend to also be regions losing aged population through internal migration. Growth from ageing-in-place in these

[69] While this is true for the aged population in aggregate, with the disaggregated results there are some signs of decline for some age-groups in some time periods. As the aged population grows, there will be more scope to disaggregate the aged population and more fully investigate the potential for decline in some areas for some ages.

regions is lower than the average across regions (3.2 per cent)—typically less than 2 per cent per year.

There is evidence of temporal hotspots, with the regional aged population growing more than 8 per cent per year.[70] Excluding regions with very small populations, from 2011 to 2021, there is potential for a hotspot of growth in the early-aged population in the Gunghalin region of the Australian Capital Territory. The potential for hotspots of growth in the aged 85 and over population between 2011 and 2021 is apparent also in Gunghalin, and in Jimboomba in Brisbane, Tullamarine-Broadmeadows in Melbourne and the Darwin Suburbs. While growth in the aged population is lower in the second half of the projection horizon, there are areas showing potential to be hotspots for growth. Interestingly, there are no hotspots for the early-aged population between 2021 and 2031 but for more than 25 regions there is potential for hotspots in the late-aged population. Not surprisingly the potential hotspot of growth in the early-aged population in Gunghalin translates into a potential hotspot of growth in the late-aged population between 2021 and 2031. Other potential hotspots include Cairns-North and the Gold Coast Hinterland in Queensland, Jimboomba in Brisbane, Rouse-Hill-McGraths Hill and the Hawkesbury in Sydney and the Macedon Ranges and Nillumbik-Kinglake in Melbourne.

A key insight from this analysis so far is that while growth is uneven, responding to growth in the aged population cannot be addressed through the redistribution of services. The aged population is growing in all regions and service levels will at least need to be maintained. The challenge will be responding to variation in growth and the composition of this growth. I explore the composition of this growth more in the following subsections.

For most regions, growth of the aged population is expected to be higher in the first half of the projection horizon

For the majority of regions growth in the aged population is higher in the first half of the projection period. This is expected given the baby boomer birth cohort begun ageing into their aged yeas in 2011. Stronger growth from 2011 to 2021 is particularly pronounced (more than 3 per cent relative to growth in 2021 to 2031) in the regions of the Northern Territory including the Pilbara, Darwin Suburbs, East Arnhem, Litchfield, in Springwood-Kingston in Brisbane and in Tuggeranong in the Australian Capital Territory. For twenty per cent of regions the opposite trend is observed and the growth

[70] This is not a formal definition of a 'hotspot'. The selection of 8 per cent per year is for illustrative purposes.

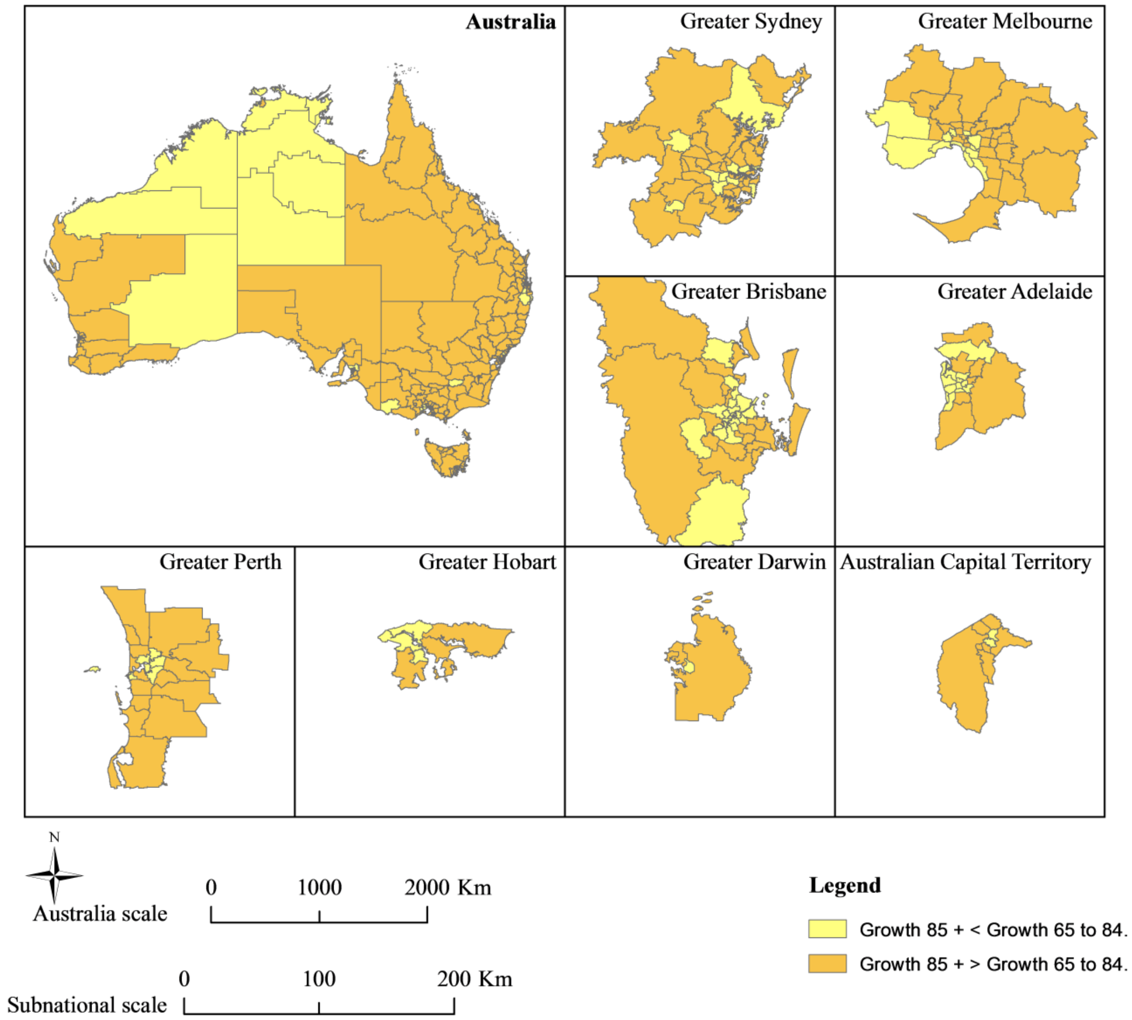
rate of the aged population is higher from 2021 to 2031 than 2011 to 2021. If growth is higher in the second part of the projection horizon, however, the differences in the growth rates between the first and second half of the projection horizon is not more than 1.9 per cent per year. In fact, it is only larger than 1 per cent in eight regions: Nathan, Brunswick-Coburg, Playford, Darebin-North, West Torrens, Darebin-South, Maribyrnong and Moreland –North. Thus, for the majority of the regions examined in this study, the response to ageing is a present concern with immediate implications for services.

Significant change in the composition of the aged population underway, but this too varies at the subnational level

The service needs of communities will differ depending on *age* of the aged population. The older the aged population, the more likely that services such as in home care or residential aged care will be needed (Jorm et al 2010). As outlined in Chapter 2, at the national level, the aged population is expected to grow and age with growth in the population aged 85 and over expected to be at least 0.5 per cent per year higher than the population aged 65 to 84 to 2031 (ABS 2013g). This is despite the baby boomers ageing in to the early-aged years during the projection horizon to 2031. At the substate level, in this model, the ageing of the aged population is uneven. For 241 of the 327 regions examined, the population aged 85 and over is expected to grow (on average) faster than the early-aged population. This can vary within the projection period. For example, in the first half of the projection horizon, growth in the late-aged population exceeds growth in the early-aged population in 136 of the 327 regions examined. In one region, Weston Creek in the Australian Capital Territory, there is negative growth in the early-aged years for the period 2021 to 2031.

The regions where growth in the late-aged population exceeds growth in the early-aged populations are identified in Figure 35. Differential growth rates such as these will reshape the early-aged proportions discussed in the opening analysis in this Chapter. Over the projection horizon, the age structure of most aged populations shifts towards the late-aged years. This does not mean, however, that there will not be sizeable early-aged populations. At the aggregate level in 2031, the early-aged is 86 per cent. At its lowest, the early-aged per cent is 77 per cent—three out of every four aged persons in the region are in the early-aged years. Consistent with the now familiar pattern of regional variation in the ageing processes, a number of regions are expected to become significantly younger between 2011 and 2031. These regions include Unley, Holdfast Bay and Port Adelaide-West and Prospect-Walkerville in Adelaide, South Canberra in the Australian Capital

Territory, South Perth and Perth City in Perth, Holland Park-Yeronga and Brisbane Inner in Brisbane; and Maribyrnong and Essendon in Melbourne. These are regions where there may be need to be shift in the focus of aged services to programs better targeted to the early-aged years.



Source: Author's calculations using ABS 2014c and ABS 2015c.
Notes: See Chapter 7 for the calculations of the input variables. Growth is the mean annualised growth rate for the period 2011 to 2031. The regions are Statistical Area 3 regions (see Section 5.2).

Figure 35 Average per annum growth of the 85 and over population relative to the 65 to 84 population: Australian regions between 2011 and 2031

While growth of the late-aged population relative to the early-aged population will not be strong enough in any region to position the late-aged age population as a majority of the aged population, the rebalancing between the early-aged and late-aged populations could be significant in some regions. For around 10 per cent of regions examined the reduction in population is more than a 5 per cent change. In the Gold Coast Hinterland and Bridie-Beachmere in Brisbane the rebalancing exceeds 8 per cent. This is true also of

Manningham-West, Keilor and Monash in Melbourne and in Woden and Weston Creek in the Australian Capital Territory. These regions may also warrant additional attention to ensure the service profile shifts with the service needs in these communities.

Sex differences are another key compositional characteristic of interest. I will show in Chapter 9 that the aged population is female dominated, particularly in the late-aged years. Variation in the growth rates—affected by differences in mortality and migration patterns—between males and females and survival through the aged years will affect the sex ratio. Based on this projection model, at the aggregate level (the sum of all regional projections), the sex ratio is expected to fall a small amount between 2011and 2031 from 116 to 114 for the aged population. However, the sex ratio is virtually unchanged in the early-aged years (at around 110) but the fall in the late-aged aged years is substantial (from 190 to 140) reflecting the assumption in the projection model of a more rapid improvement in life expectancy for males. At the substate level, there is evidence of both uniformity and variation. For the late-aged population, the fall in the sex ratio is nearly universal and affects more than 300 regions. For the early-aged population the change is more mixed, with the sex ratio expected to fall in only around 40 per cent of regions.

In small area analysis it is tempting to identify area types—to organise, categorise and take what is a complex pattern of demographic change and to synthetise into something manageable. In the next Chapter, I will organise regions into area types based on their characteristics. I developed this subnational projection model for the Australian aged population to remove the need to understand subnational demographic change through area types. Instead, with this approach, the unique ageing processes underway in each of Australia's regions can be examined. In this section I have identified key themes—universal growth oriented to the next ten years, an aged population growing older in most regions and a trends towards equalisation of the sex ratio as the life span disparity between males and females reduces. These are the broad trends identified using the main projection scenario in this analysis, but the projection model itself gives greater insight into the unique ageing processes across 327 regions of Australia.

8.3 CONCLUSION

To examine the size and age structure of the aged population I developed a subnational projection model uniquely calibrated for 327 regions examined. In this Chapter I set the scene, examining the size and age structure of the aged population as it was in 2011 and how it may change between 2011 and 2031.

Three features of the subnational projection model developed for this study make it unique in the Australian context. Firstly, it provides national coverage of the aged population but includes individual projections of more than 300 areas. Secondly, it is specifically designed to complement the official ABS national projections. Thirdly, it uses assumptions calibrated for each region using publicly available data so that the model is responsive to local level demographic conditions and can be replicated in the future to support regular monitoring of the aged and ageing processes in Australia. This model could be used to inform the policy response to ageing which is sensitive to local level demographic conditions.

The selected results reported in this Chapter demonstrate growth in the aged population is expected across all regions of Australia. Thus, ageing is not a redistribution challenge with service levels needing to be at least maintained across all areas. Growth in the aged population is uneven. Growth rates can vary significantly, from under one per cent per year, to up to 12 per cent per year. The contributions to growth can also vary by region, although ageing-in-place is the largest contributor to growth in nearly all regions. For the period 2011 to 2031, growth is typically stronger in the first half of the projection period, with the exception of the late-aged years, which are expected to grow more strongly in the second half of the projection horizon. With life span disparity between males and females reducing, more males survive into the aged years.

While I include specific results for each region in Appendix 1, I recommend some caution in interpreting the results for individual regions. Non-demographic factors such as the construction of a retirement village could influence the demographic conditions in a region, rendering the assumptions no longer credible for the local level demographic conditions. Monitoring the performance of this model would be a worthwhile extension to this study. There are a range of methods to evaluate errors which could be considered (Alho and Spencer 1997).

Finally, the actual population future of Australia's aged population may vary from the scenarios developed for this analysis. There is uncertainty in the growth of the aged population which varies by substate region depending on the size of the population and demographic conditions, with higher uncertainty in regions with small populations and where growth is enhanced or supressed by internal migration. Mortality change and the level and spatial pattern of internal migration are likely to be key sources of uncertainty affecting the growth in the aged population in Australia. So too could changes to policy settings affecting the definition of the aged be a trigger to redesign this projection model.

One of the benefits of having a multidimensional approach is to better understand the aged and ageing process is that not one single analysis is relied upon. While the size and age structure of the aged population at the substate level is of interest, so are the characteristics of the aged population. In the following chapters I examine the characteristics of the aged, beginning with their geodemographic characteristics.

Chapter 9

Geodemographic perspectives of the aged: characteristics of the aged population

Understanding the size and age structure of an aged population will not be enough to inform an efficient, effective or innovative response to a growing aged cohort in Australia. The characteristics of the aged and the communities they live in will affect both the demand for services and the capacity to provide them within the community. Already in Australia some population subgroups have attained priority access to Aged Care services (as legislated in the *Aged Care Act 1997 (Cth)*). This includes the population subgroups of Indigenous; culturally and linguistically diverse; rural and remote; and, the financially or socially disadvantaged (among others). The motivation of understanding the aged population goes beyond responding to the day-to-day service needs of the aged population; it also involves understanding the characteristics of the aged so that they can be shaped over time.

That there are differences in the aged population by region is already established. Typically, the more advantaged aged populations reside in capital cities (Tanton, Harding and McNamara 2010). On the outskirts of the capital cities are aged communities with fewer resources who benefit from the lower cost of living (Morrow 2000). Consistent with an amenity-led retirement migration pattern, in the accessible coastal communities there should be more early-aged aged populations with lower disability and higher resources (Argent et al 2011; Bell 1995). In the rural areas, there should be established an aged population who ages-in-place, has moderate resources and is possibly still economically active, but the regions they live in are not desirable to the youth (Argent and Walmsley 2008; Drozdzewski 2008). In the very remote areas there are likely to be higher proportions of the Indigenous aged population (Taylor 2011).

There are many studies of the characteristics of the aged. None, however, examine those characteristics across all of Australia. Where studies examine the aged by remoteness this means that areas not geographically adjacent are considered together. In this study I examine the individual, economic and social characteristics of the aged across 327 regions of Australia using three different approaches. My first approach is to examine the working-age and aged population together to identify regions with high or low dependency based on the traditional old age dependency ratio and the labour force based economic support ratio. My second approach is to examine each characteristic of the aged population separately looking at variation across the regions examined and between the early-aged and late-aged years. My third approach is to develop a geodemographic classification of the aged population. I identify six types of aged regions in Australia: foreign born (dissimilar) and relative disadvantage; foreign born (dissimilar) and relative advantage; active ageing and relative advantage; remote indigenous; typical aged; and, Australian born typical aged.

9.1 DEPENDENCY AT THE SUBNATIONAL LEVEL

In the introduction to this study I said that too often the aged are described in terms of summary demographic measures such as the old age dependency ratio. These measures can be too simplistic and at the national level can mask the extent of region variation. I show here just how significant that variation can be at the subnational level and, additionally, what dependency looks like if a labour market measure of dependency is used.

The old age dependency ratio is an influential measure used to highlight growth in a dependent aged population relative to the working-age population providing the support. While the measure is likely to be highly inaccurate—overestimating the support potential of the working-age and underestimating the capacity of the aged population to be independent—it is a powerful summary indicator of population characteristics. The old age dependency ratio compares the size of aged population to the working-age population and is calculated as follows:

$$Old\ Age\ Dependency\ Ratio = \frac{Population\ aged\ 65\ and\ over}{Population\ aged\ 20\ to\ 65} \cdot 100$$

The old age dependency ratio should not be the sole indicator of dependency as age alone is a poor indicator of the level of dependency in the population (or the burden of the aged).

The economic support ratio addresses the limitations of the old age dependency ratio by segmenting the population based on labour force participation. This method ensures the numerator in the dependency ratio is a better estimate of the dependent population (assuming dependency correlates with not being in the labour force). The denominator is the economically active population, measured as the population over the age of 20 in the labour force, expressed as follows:

$$Economic\ Support\ Ratio = \frac{Population\ out\ of\ the\ labour\ force}{Population\ aged\ 20\ and\ over\ in\ the\ labour\ force} \cdot 100$$

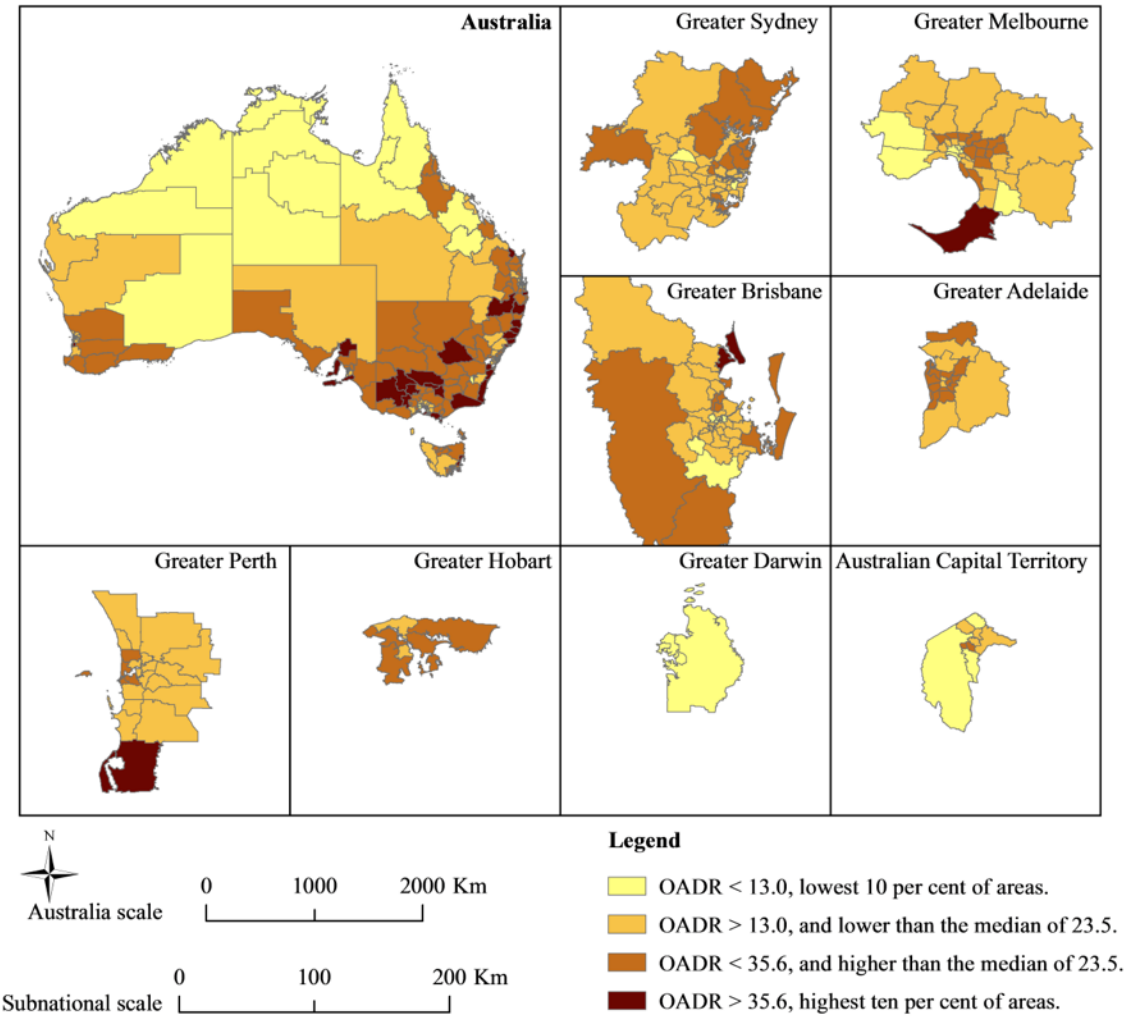
The economic support ratio will be sensitive to ageing because labour force participation is lower among the aged.

The regional variation in the old age dependency ratio is significant, with the minimum being an old age dependency ratio of 2.6 and the maximum being 59.0.[71] Fifty per cent of regions, however, have an old age dependency ratio between 17.3 and 29.2. The economic support ratio also varies substantially for the regions examined, and tend be higher than the old age dependency ratios. The minimum economic support ratio is 13.9 and the maximum is 124.2. Fifty per cent of regions have an economic support ratio between 40.8 and 62.1. There are six regions with more people out of the labour force than in the labour force (see Appendix 1). The spatial pattern of variation is shown in maps below, with the old age dependency ratios shown in Figure 36 and the economic support ratios shown in Figure 37.

Much of the transfers to the aged are not location specific, so local level dependency matters to local level issues such as the adequate supply to labour to care for the aged. High dependency in rural or remote locations, therefore, can be more of a concern if these regions cannot draw in adequate labour from adjacent areas. Strategies to boost the working age population are already in place in some rural and regional areas, including incentivising immigration into these areas (Massey and Parr 2012). A higher old age dependency ratio or economic support ratio should warrant further examination of a region's demographic conditions. In 2011, the regions with relatively high dependency (in the top ten per cent of regions) outside of capital city areas include a mix of rural and coastal areas including the Great Lakes, Port Macquarie, South Coast, Upper Murray (excluding Albury), Shoalhaven, Taree-Gloucester, Tweed Valley and the Southern Highlands in New South Wales. In Victoria, the regions include Gippsland-East and Moira. In South Australia, the regions include the Yorke Peninsula and Fleurieu-Kangaroo Island. In Tasmania and Queensland one region is identified: South East Coast in Tasmania and Hervey Bay in Queensland.

[71] Recall also that I outlined the old age dependency ratio for Australian states and territories by greater capital city and rest of state in Chapter 2.2.6.1.

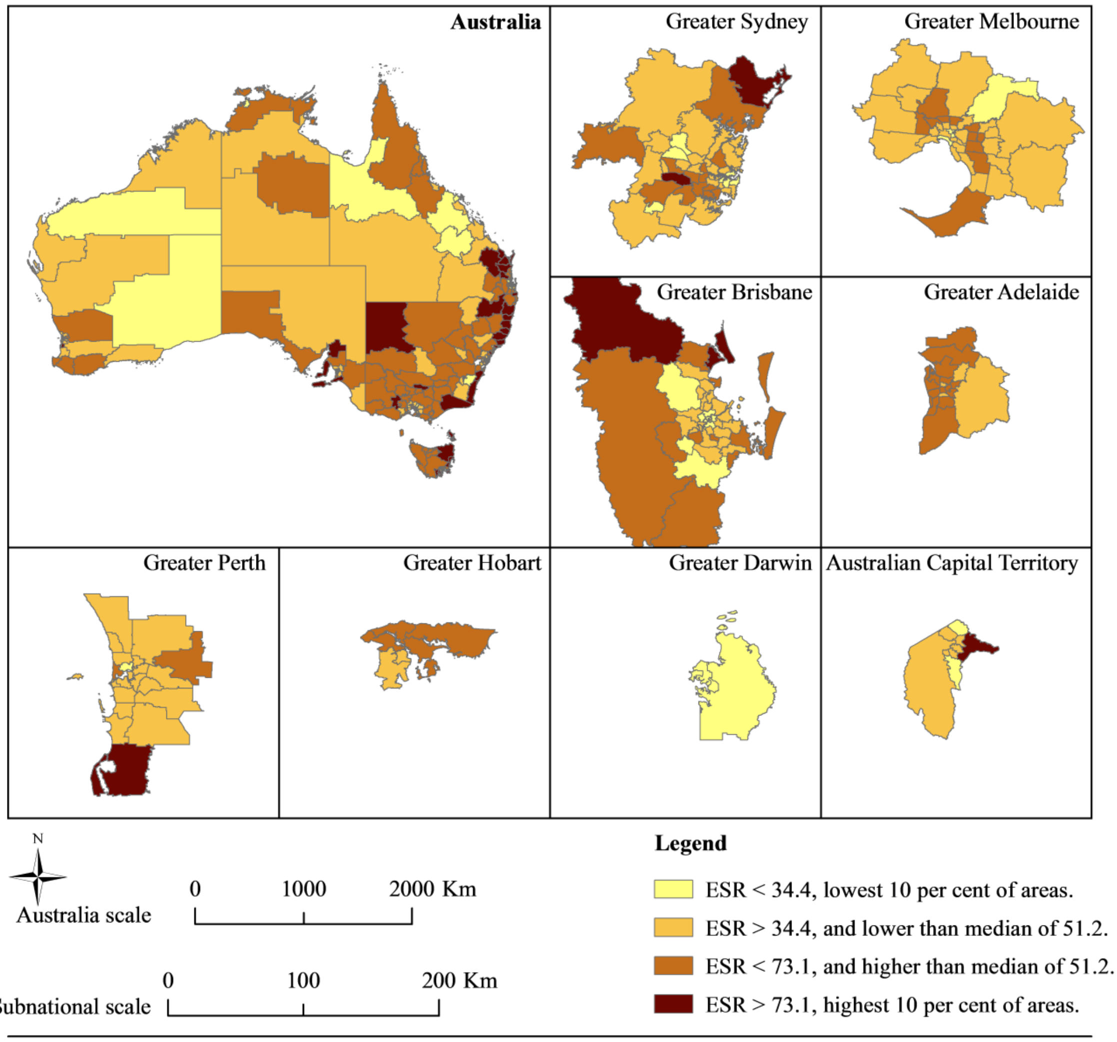
Regions with a high old age dependency ratio tend to also have a high economic support ratio. However, some of the agricultural regions are higher on the old age dependency ratio compared with the economic support ratio, such as Upper Murray (excluding Albury) and the Granite Belt in Queensland. In contrast, there are some regions where it is the economic support ratio and not the old age dependency ratio indicating the need for closer examination of the local demographic conditions. These regions include Burnett in Queensland and Broken Hill and Far West in New South Wales.



Source: Author's calculations using ABS 2014b.
Note: The regions are Statistical Area 3 regions (see Section 5.2).

Figure 36 Old age dependency ratio: Australian regions, 2011

Generally, however, both measures of dependency point to the higher dependency in the south-east of Australia, the coastal regions of the east coast and the retirement locations on the fringes of capital city regions. Just as growth in the aged population can be affecting these dependency ratios, demographic conditions in the pre-aged years will also be influential. In the inland areas, in particular, outward migration of youth from these rural locations is likely to be a significant factor driving up dependency ratios (Argent and Walmsley 2008; Hugo 2005).



Source: Author's calculations using ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2).

Figure 37 Economic support ratio: Australian regions, 2011

9.2 THE CHARACTERISTICS OF THE AGED POPULATION IN 2011

At the national level, according to the 2011 Census, the typical aged person in Australia was in their early-aged years, female, is Australian born and of non-Indigenous status (ABS 2011d). If foreign born, the typical Australian would be from a country with a dissimilar cultural background. If English is a second language, the typical aged person is likely to speak English well. If aged in their aged years, even the late-aged years, the typical aged person would not be disabled. They would most likely be living in a private dwelling owned outright and living with at least one other person. The typical aged person would have some social support usually through both marriage and children. Their income and capacity to generate additional resources are low, with the typical aged not in the labour force and reporting income of less than $22,000 per year (average earnings is around $74,000 (ABS 2016)). If they do work, they are likely to be working part-time. Interestingly, reflecting differences between the current aged cohort and pre-aged generations in Australia, the typical aged Australian has not completed the high school certificate.

The characteristics of the aged population are neither fixed over time or constant at the subnational level. I will deal with drivers of change in the first instance and then examine in more detail differences in the characteristics of the aged populations at the subnational level.

Recall from Section 2.2.3 that migration now contributes more than natural increase to population growth in Australia. The ethnic composition of this migration stream has shifted substantially from European migration to Asian migration. As these migrants age, so too will the composition of the foreign born population in the aged population. On a related issue, the language characteristic of the aged population is also expected to change. A key language characteristic, proficiency in English, is highly correlated with the length of time of arrival and the migration stream (Migration Council of Australia 2015). As the migration program has shifted towards skilled migration and education streams, the English language proficiency of the aged should increase. Thus, I expect that the average level of English language proficiency among the Australian aged population to increase.

Education levels are also continuing to increase (ABS 2011d). Already this is apparent in the aged population; with early school leavers more common among the aged than the pre-aged population. Given that ageing-in-place is the strongest source of growth (as established in Chapter 8), some insight into the future settlement pattern of the highest educated and highest earners in their forties and fifties is likely to be a good indicator of regions with advantaged aged populations in the future. The relationship between education level and disadvantage in the aged years will probably evolve given that being an early school leaver will go from the norm to the exception over the next few generations.

Future income levels are highly uncertain, affected by the strength of the economy, labour market conditions during the working life and the retirement income settings of government over several decades. The majority of aged Australians are low income and official projections of the Age Pension system show the proportion of the aged accessing the Age Pension will remain about two-thirds into the future, with growth in the proportion receiving part pension (Australian Government 2014c). Current investment returns, however, are lower now than returns achieved prior to the global financial crisis. If lower levels are sustained, it will be even harder to accumulate adequate resources for retirement.

There is a strong tradition in Australia to own a home and incentives exist for the aged to retain that home to *age-in-place*, including exempting the primary residence from the Age Pension assets test (Piggott and Sane 2007). While there is concerns about affordability of housing (Winter 2015), within the next several decades a continuing high degree of home ownership is likely. The other housing characteristics—residency in public housing or non-private dwellings—will largely be determined by governments (national and state and territory) to fund supply of these services.

Thus, there is momentum for change in the characteristics of the aged population. However, policy makers should also consider how to shape the characteristics of the aged through policy ‘nudge’. The characteristics most likely to be responsive to policy settings are income, housing and disability (or, at least, in relation to lifestyle related disabilities). For example, the Age Pension and Superannuation policy settings are key pillars of the retirement income system in Australia (see Section 2.3.3). By exempting the primary residence from the Age Pension asset tests the aged have an incentive to maintain assets within the family home thereby reducing access to disposable income and a disincentive to move to homes better designed to support independence through the aged years. Changing in retirement income settings is therefore not only about reducing fiscal exposure to an aged population, but could also influence housing and income characteristics and demand for residential care. A further area in need of a policy nudge is disability associated with lifestyle related factors (such as smoking, alcohol and obesity) to ensure the onset of severe or profound disability is prevented, or at least delayed deep into the aged years.

A further factor for policy makers to contend with is regional variation in the characteristics of the aged. For the remainder of this section I examine each characteristic of the aged separately looking at variation across the regions examined and between the early-aged and late-aged years.

This is a descriptive analysis of the individual, economic and social characteristics selected for this study (see Section 7.2). Given the vast dataset that was created by examining so many characteristics for 327 regions, I focus here on summary statistics, differences between the early-aged and late-aged population and key indicators of advantage and disadvantage. Where the spatial pattern of a characteristic is highlighted in this Chapter (i.e. for the maps in Figure 39 to Figure 44), I include the result for each region as a key indicator in Appendix 1.

The summary statistics are, for both counts and per cents, the minimum, maximum, median and mean values and the first and third quartiles for all regions. Also included is the Gini Ratio measuring spatial concentration of the population with each a specified characteristic. The Gini Ratio is a well-known measure of inequality between two cumulative frequency distributions, where one frequency simulates an equal frequency distribution and the other observed values. It is given by (Swanson and Tayman 2012, 74):

$$Gini\ Ratio\ = \left(\sum_{i=1}^{n} X_i Y_{i+1}\right) - \left(\sum_{i=1}^{n} X_{i+1} Y_i\right)$$

Where X_i and Y_i are cumulative frequency distributions and n is the number of regions. The Gini Ratio has a range of 0 to 1, with 0 indicating the population is evenly distributed across the regions. One weakness affecting the Gini Ratio is that the statistic is sensitive to the size of the region. Larger regions (either in geographic size or population) tend to be more heterogeneous and will therefore appear more similar to each other. Similarly, within regions there can be subregions where a population subgroup is highly concentrated which are not identified using the Gini Ratio.

The results for the single variate analysis are shown in Table 9. Of the individual characteristics, there are some key insights to highlight. There are sizeable aged populations with disabilities, Australian born and aged people who speak English only in each region. The characteristics that occur less frequently, such as poor proficiency in English and Indigenous aged, are more likely to be geographically concentrated in a small number of regions. Additionally, while the foreign born (dissimilar and similar) population is more spatially concentrated compared with the Australian born population, the foreign born (dissimilar) population is more spatially concentrated compared with the foreign born (similar) population.

There are a number of individual characteristics which are significantly different between the early-aged and late-aged population (as shown in Figure 39). Consistent with the health survival paradox (Vaupel 2009), the proportion of the aged population who are female and disabled is higher in the late-aged years. For the remaining individual characteristics, there is no notable difference between the early-aged and late-aged population. However, this does not mean that significant differences do not occur within individual regions.

In Figure 39, Figure 40 and Figure 41, I show the pattern of spatial variation in the sex ratio, counts of the disabled aged population and counts of the and foreign born (dissimilar) population respectively. The sex ratio is worth highlighting because for around 15 per cent of regions the male aged population exceeds the female aged population. These regions with the male-dominant populations are in the remote and regional locations. The male dominated regions include the Pilbara, Litchfield and Barkley in the Northern Territory and Western Australia. In contrast, the most female-dominant regions are within capital cities with the regions of Unley, Norwood-Payneham-St Peters and Holdfast Bay in Adelaide being the most female dominated regions in Australia.

In relation to the disabled and foreign born (dissimilar) aged population it is worth highlighting that even if a small share of the aged population has these characteristics, the presence of an aged population within a region with these characteristics can still be indicative of a service need. For Australia, in the 2011, the proportion of the early-aged population with disability is 13.2 per cent, much lower than the 47.7 per cent for the late-aged population (ABS 2011d). However, the size of the aged population in the early-aged years with a core activity disability is 345,000 compared with 192,000 in the late-aged years. For the subnational areas examined, the highest counts of the aged population with disability are in the capital cities of Melbourne and Sydney, and in the regions close to these cities such as Geelong and Newcastle (see Figure 40).

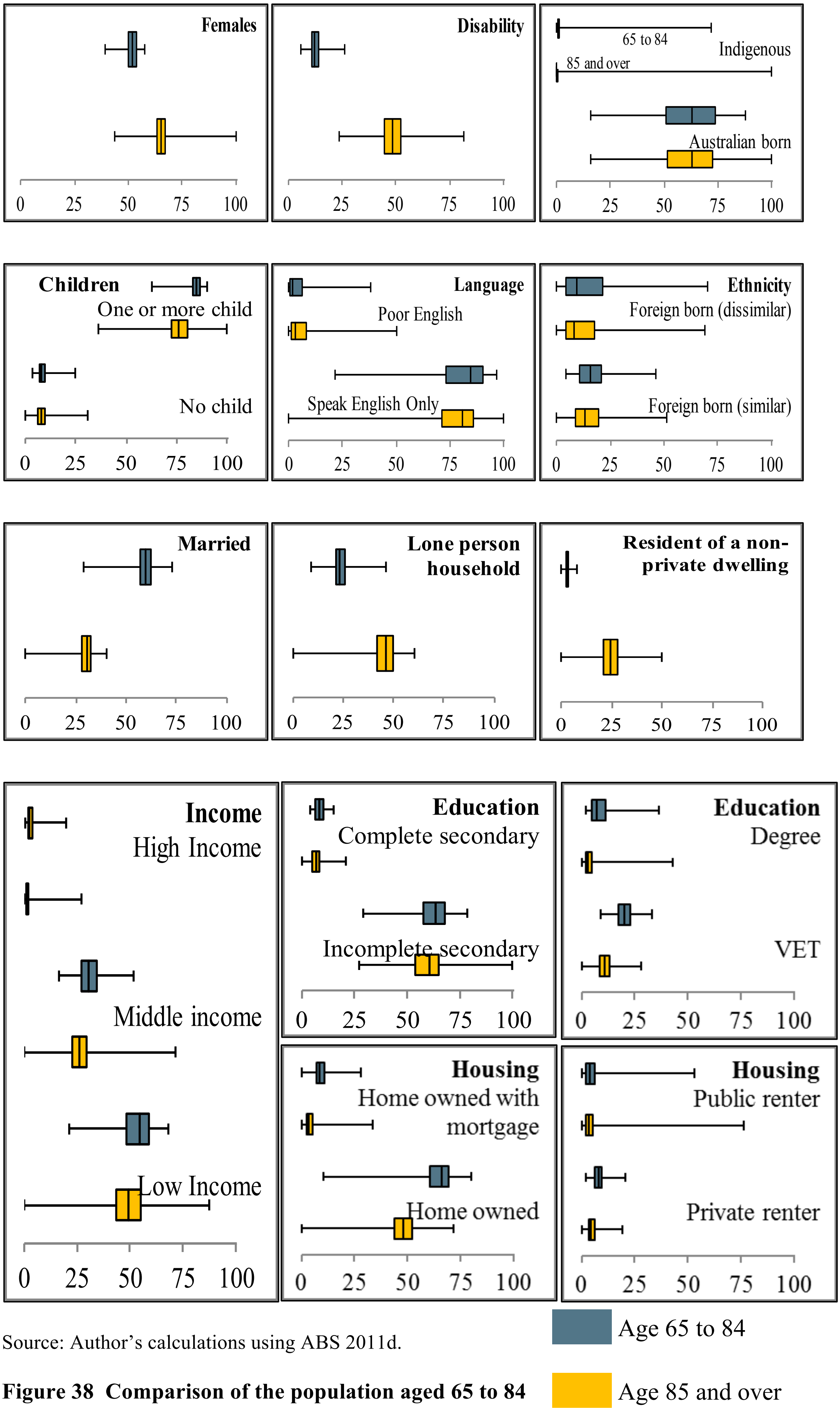
Table 9 Regional variation in the count and per cent of the population aged 65 and over by characteristic: Australian regions, 2011

Variable name	Min.	Max.	Med.	Mean	1st quantile	3rd quantile	Gini coeff.
Individual Domain							
Sex Ratio[a]	67.1	155.5	115.1	113.8	105.6	123.8	NA
Disabled	11	6353	1387	1641	862	2151	0.38
	9.8	*30.4*	*16.9*	*17.5*	*15.2*	*19.2*	*NA*
Indigenous	0	661	36	63	18	73	0.54
	0	*74.1*	*0.5*	*1.8*	*0.2*	*0.8*	*NA*
Foreign born: similar	7	7668	1184	1477	651	1946	0.41
	4	*46.8*	*15*	*16.4*	*10.8*	*20.6*	*NA*
Foreign born: dissimilar	0	14684	659	1586	267	1929	0.63
	0	*70.2*	*9.1*	*14.7*	*4.3*	*20.8*	*NA*
Australian born	61	21226	4754	5455	2771	7016	0.36
	16.5	*89.6*	*63.0*	*61.3*	*50.8*	*73.7*	*NA*
Speaks English only	61	27528	6354	7163	3674	9651	0.35
	20.5	*98.6*	*84.5*	*79.3*	*73.7*	*90.1*	*NA*
ESL Poor proficiency in English	0	8259	120	547	41	522	0.73
	0	*39.5*	*2.0*	*5.1*	*0.6*	*6.8*	*NA*
Social Domain							
Women without children	7	2103	364	437	212	566	0.39
	3.5	*21.2*	*8.1*	*8.7*	*6.9*	*9.8*	*NA*
Women with children[72]	27	13991	3533	4135	2239	5434	0.36
	63.5	*90.5*	*83.7*	*82.8*	*81.4*	*85.5*	*NA*
Married	33	16533	4285	4811	2520	6486	0.35
	27.7	*70.2*	*56.7*	*56.2*	*53.8*	*59.7*	*NA*
Lone person household	13	8561	1990	2200	1149	2937	0.36
	8.9	*44.3*	*25.9*	*25.8*	*23.0*	*28.6*	*NA*
Non-private dwelling	0	2020	437	526	242	718	0.41
	0.0	*18.0*	*5.3*	*5.4*	*4.3*	*6.5*	*NA*

[72] This is the proportion of the female aged population.

Variable name	Min.	Max.	Med.	Mean	1st quantile	3rd quantile	Gini coeff.
Economic domain							
Low income	40	16347	4258	4808	2384	6571	0.36
	22.2	*68.4*	*54.3*	*52.0*	*47.8*	*58.2*	*NA*
Middle income	23	10943	2433	2818	1469	3590	0.36
	16.1	*49.9*	*29.9*	*30.6*	*26.5*	*33.7*	*NA*
High income	5	2927	192	297	104	327	0.50
	0.6	*18.8*	*2.4*	*3.5*	*1.6*	*3.8*	*NA*
Incomplete secondary schooling	43	18744	5030	5616	2852	7726	0.35
	30.6	*78.5*	*63.4*	*61.1*	*57.3*	*67.4*	*NA*
Highest education of secondary schooling	7	2859	647	770	383	983	0.38
	3.7	*15.2*	*8.2*	*8.3*	*6.5*	*9.9*	*NA*
Highest education of vocational education training	22	7219	1505	1763	865	2384	0.37
	9.3	*30.1*	*19.0*	*19.0*	*16.6*	*21.6*	*NA*
Highest education of degree	10	6163	553	798	303	1044	0.47
	2.2	*31.9*	*6.6*	*8.7*	*4.7*	*10.5*	*NA*
Not in the labour force	45	25826	6585	7429	3966	9898	0.36
	48.8	*87.9*	*80.2*	*79.2*	*77.0*	*83.2*	*NA*
Working part-time or full-time	28	3827	899	997	549	1263	0.32
	4.4	*38.4*	*11.5*	*12.3*	*8.8*	*15.0*	*NA*
Home owner without mortgage	39	20014	5089	5830	3092	7655	0.35
	9.9	*78.3*	*63.9*	*61.7*	*58.5*	*67.1*	*NA*
Home owner with mortgage	0	2736	663	786	421	1007	0.35
	0	*28.3*	*7.7*	*8.8*	*6.4*	*10.3*	*NA*
Private renter	4	2268	638	686	351	922	0.34
	1.9	*19.7*	*7.7*	*7.7*	*6.1*	*9.0*	*NA*
Public renter	0	3185	324	418	159	526	0.46
	0	*53.9*	*3.6*	*4.8*	*2.2*	*6.0*	*NA*

Source: Author's calculations using ABS 2011d.
Notes: Counts are in standard text and the per cent of the aged population are in italics.
(s) The sex ratio is the number of females to every 100 males.



Source: Author's calculations using ABS 2011d.

Figure 38 Comparison of the population aged 65 to 84 and aged 85 and over by characteristic: Australian regions in 2011

It is evident from the Gini Ratio that the aged population who are foreign born (dissimilar) is among the most spatially concentrated population subgroup (exceeded only by the Indigenous aged population and aged population with poor proficiency in English). There are six regions where the size of the foreign born population exceeds 10,000 people: Fairfield, Canterbury and Strathfield-Burwood-Ashfield in Sydney, and Brimbank, Dandenong and Monash in Melbourne. Outside of Sydney and Melbourne, the largest foreign born (dissimilar) population is in Stirling in Perth. This reinforces a trend, highlighted in previous research and in this study, of the strong preference among the foreign born population to reside in capital city areas (see Section 8.2.2.2 and Massey and Parr 2012).

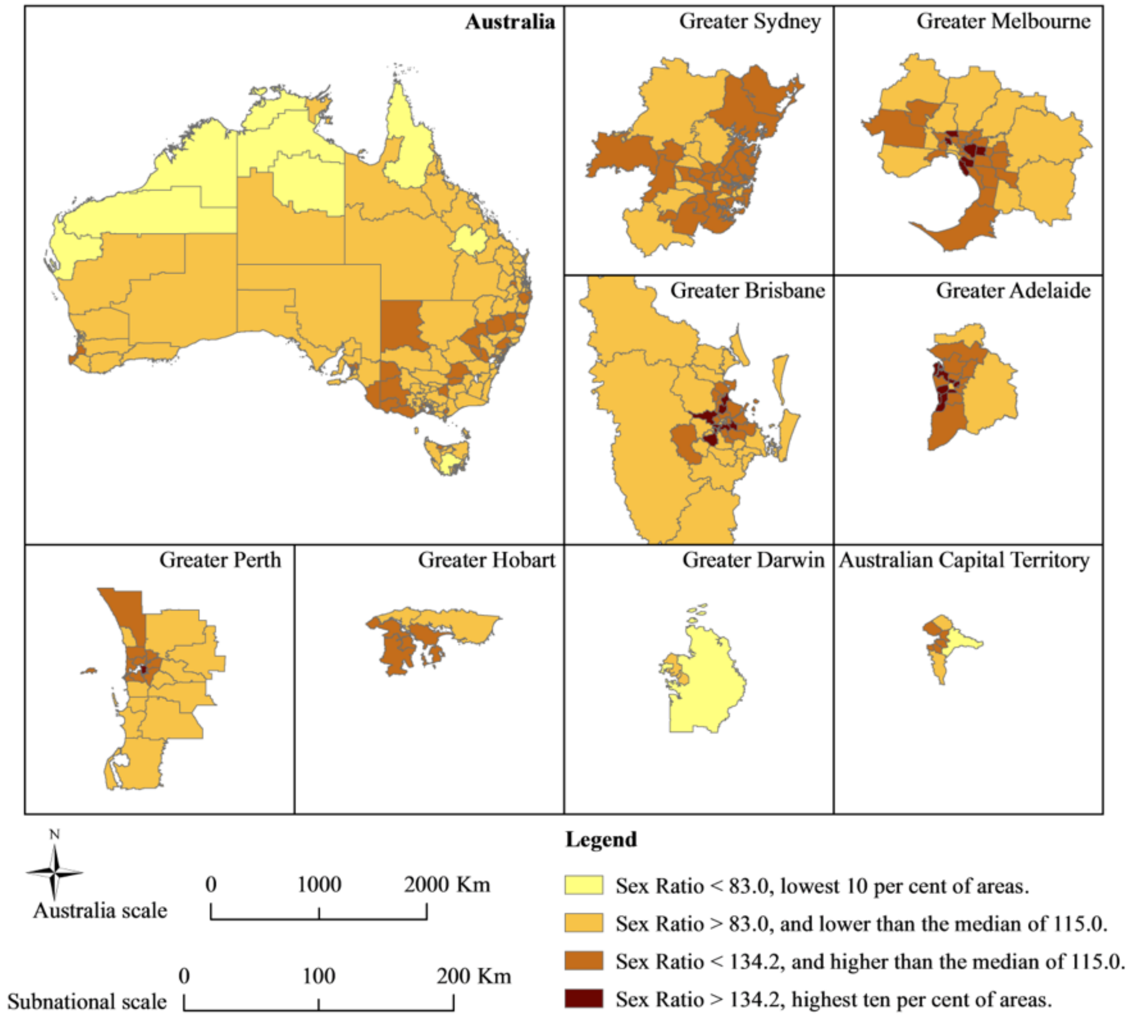
There are also several insights to highlight about the social characteristics of the aged population. For the majority of regions, the majority of aged population appear to have some support available either through marriage and/or living arrangements. A large majority of females in all regions also have children, thus further expanding their potential social support networks (recall from Section 7.2 that males are not asked to record the number of children they have in Census). Compared with the individual characteristics, the social characteristics are more evenly distributed across all regions when compared with the individual characteristics mentioned above.

For most social characteristics, there are differences between the early-aged and late-aged years. The differences, however, may reflect disparity in the length of life between partners (typically in favour of the female). In Figure 44 I show counts of the aged population living in lone households for Australian regions. The spatial pattern is similar to the regions with high counts of disabled with some additional areas identified as having high counts of lone person households. These are the regions of the Mornington Peninsula in Melbourne, Toowoomba in Queensland and Warringah in Sydney. These are regions where there could be relatively higher demand for domestic support.

The economic characteristics of the aged are among the most interesting. The lack of significant variation in proportion of the aged community with low income (for 50 per cent of regions the per cent is between 47.8 and 58.2 of the aged population) may be indicative of dependency on publicly funded income support in the aged years. The aged with high incomes are fewer in number and among the most spatially concentrated of the aged subgroups examined in this study. The aged population with the highest education qualification (i.e. a degree) are also fewer in number and the most spatially concentrated of the education qualifications examined. Education varies by region and also between the early-aged and late-age years; a pattern which could be indicative of both life span inequality by education level, increasing education levels by cohort and better access to education in some regions. For the majority of regions, more than 50 per cent of the aged population are home owners without a mortgage. Rental arrangements are less common, but are typically in the hundreds of aged people across a majority of regions.

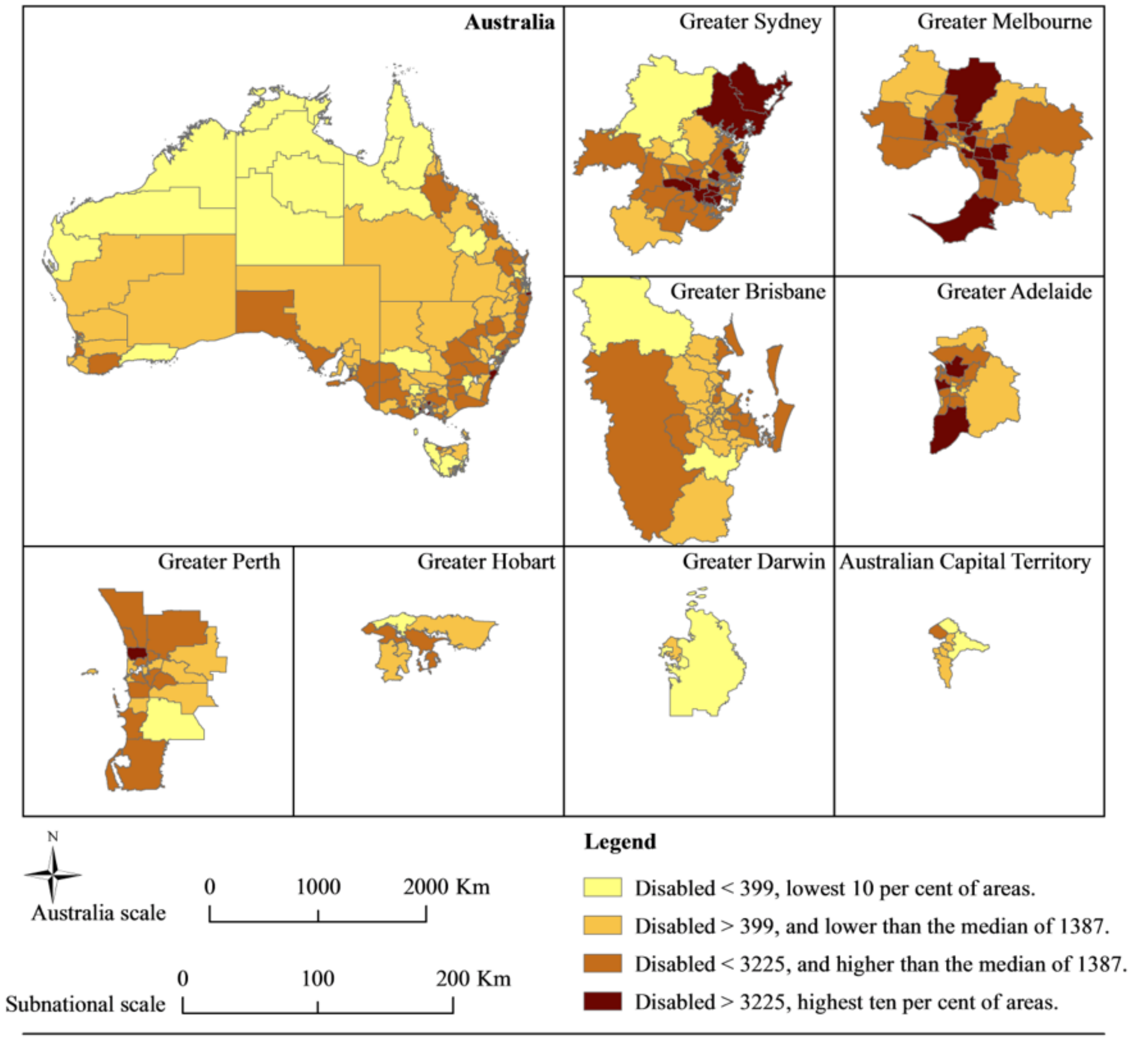
Overall the economic characteristics of the aged point to a higher degree of concentration of advantage and a dispersion of disadvantage. This is more clearly demonstrated in Figure 43 and Figure 44 which show the proportion of the aged population who are low and high income respectively. Previous studies suggest there are regional differences in income, with lower income in non-metropolitan areas (Lloyd, Harding and Hellwig 2000). In around two-thirds of the regions examined the low income population is more than 50 per cent of the aged population in the region. The regions with the highest proportion of the aged with low incomes are Fairfield and Mount Druitt in Sydney, Brimbank in Melbourne, Playford in Adelaide and in the remote Indigenous region of East Arnhem in the Northern Territory. In contrast the regions with the highest proportion of the aged population with high income are in North Sydney-Mosman in Sydney, Stonnington-West in Melbourne and South Canberra in the Australian Capital Territory.

This brief snapshot of the characteristics of the aged population show that there are regional variations in the characteristics of the aged. How much regional variation there is depends on the characteristic, and both high and low variation can be significant for policy makers. An analysis such as this can be used to identify populations with specific support needs, such as the disabled aged population. In the following section I examine the characteristics of the aged population by region using a multivariate approach.



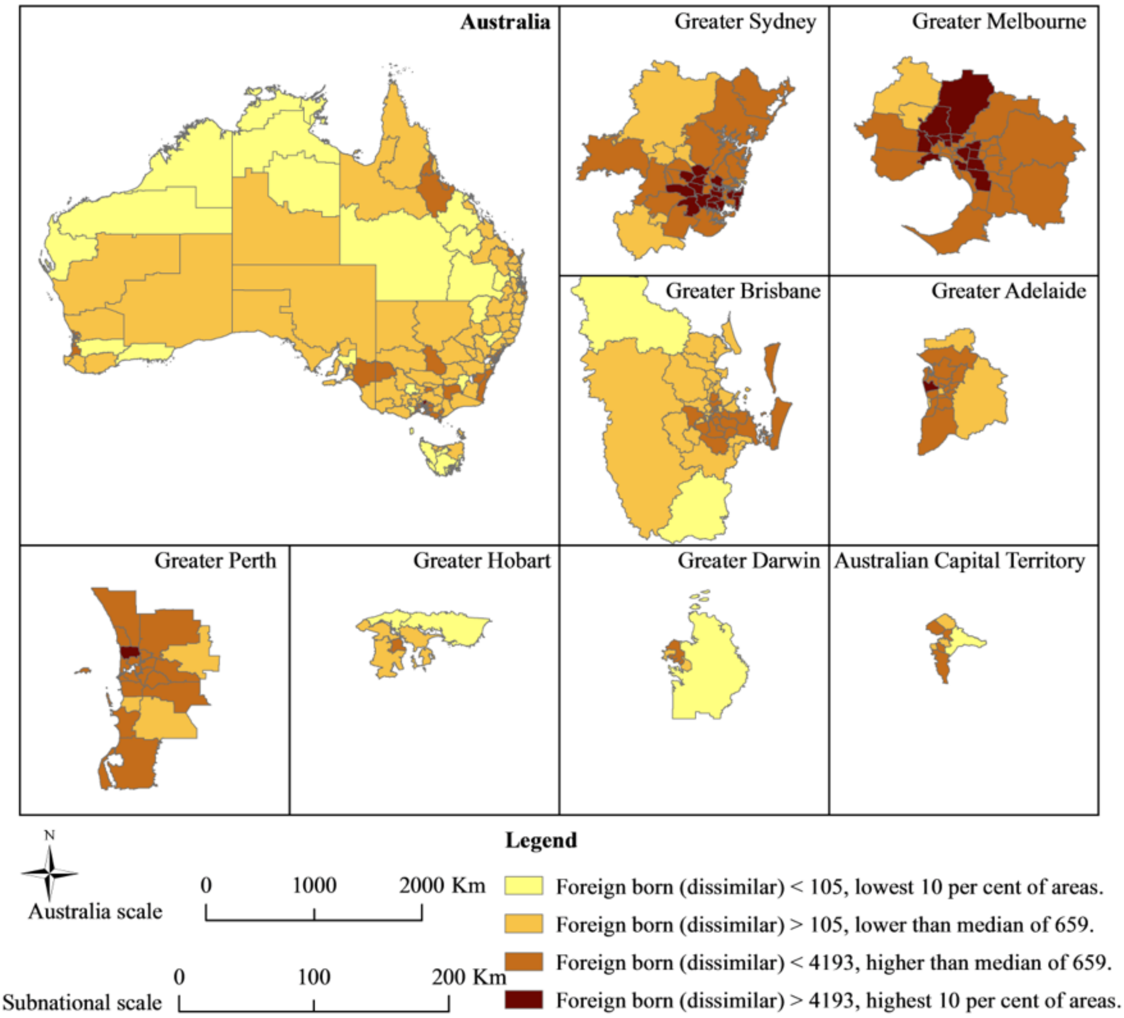
Source: Author's calculations using ABS 2011d.
Notes: The regions are Statistical Area 3 regions (see Section 5.2). The sex ratio is the number of females to males.

Figure 39 The sex ratio: Australian regions, 2011



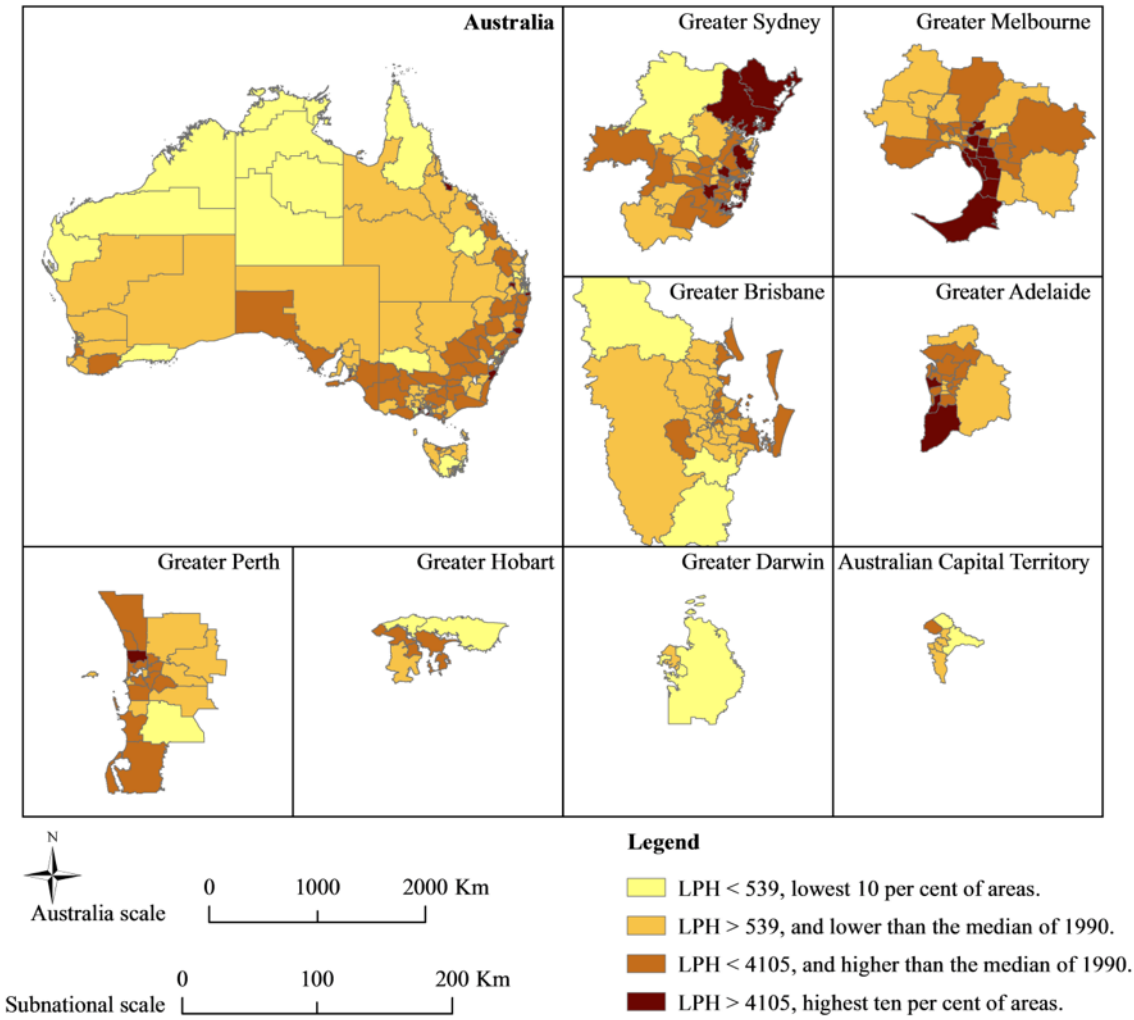
Source: Author's calculations using ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2). See Table 6 and Section 7.2.1 for the calculation of disabled.

Figure 40 Counts of the aged population who are disabled: Australian regions, 2011



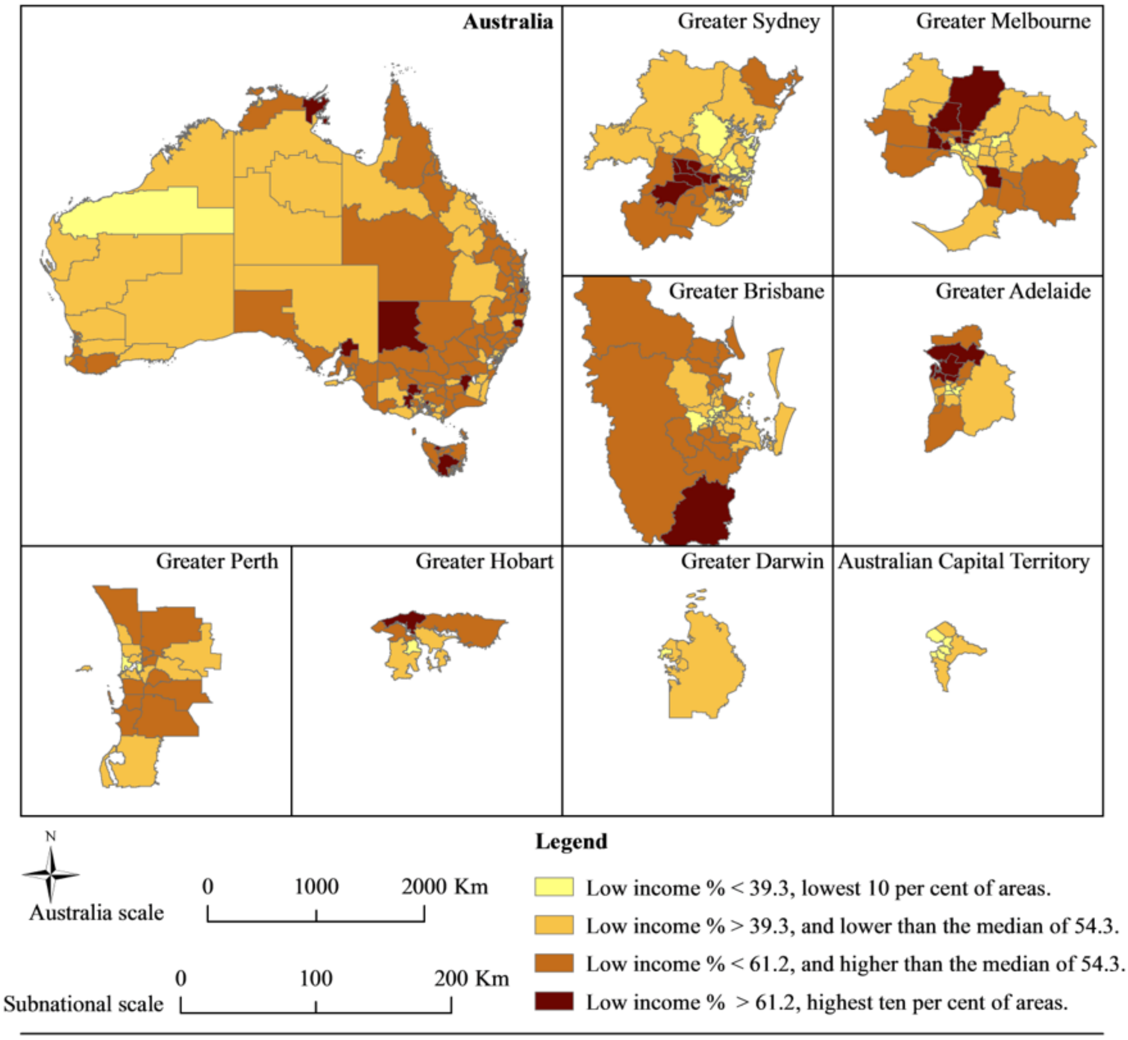
Source: Author's calculations using ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2). See Table 6 for the calculation of foreign born (dissimilar).

Figure 41 Counts of the aged population who are foreign born from a dissimilar background: Australian region, 2011



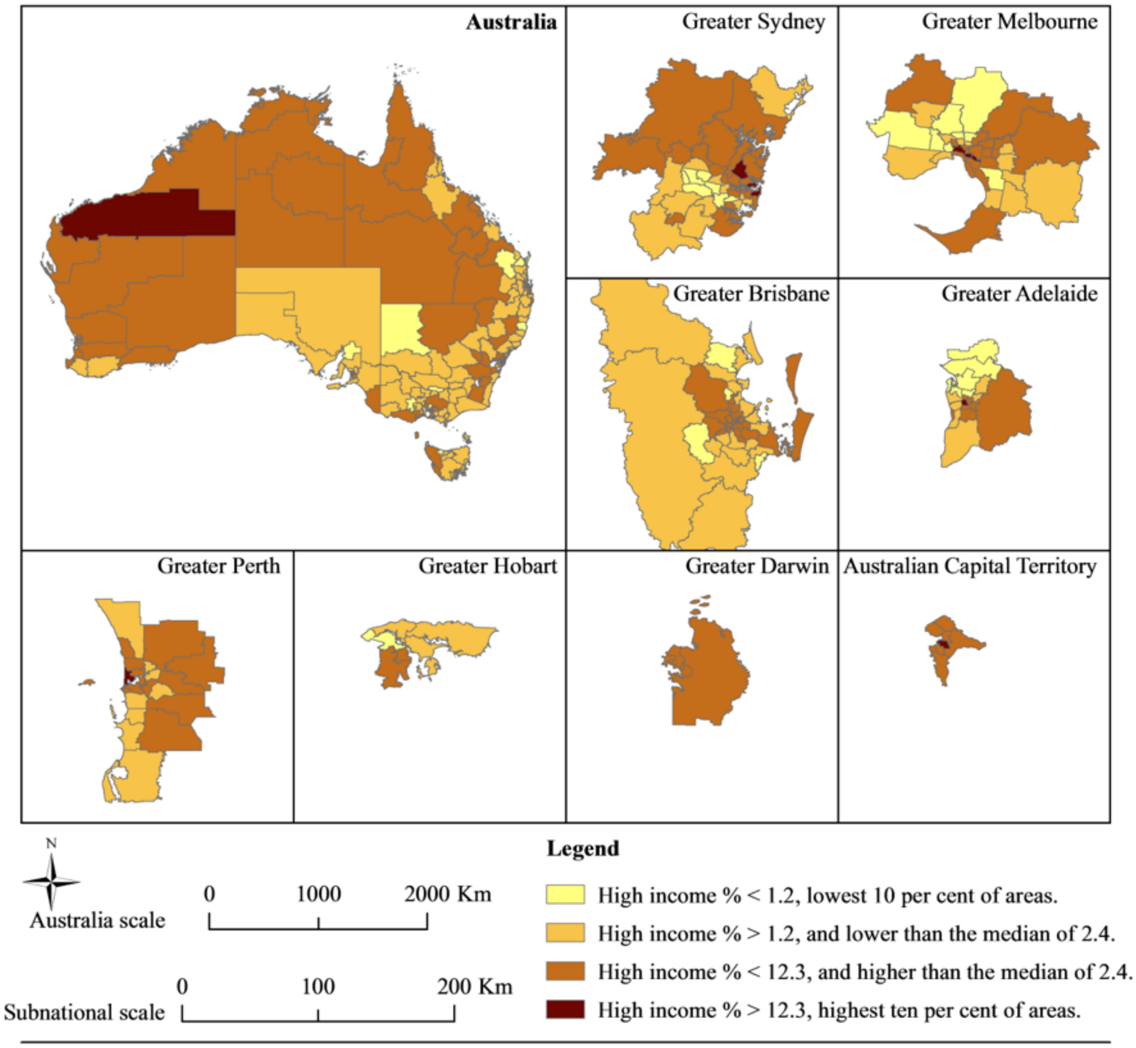
Source: Author's calculations using ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2). LPH is lone personal household as defined in Table 6.

Figure 42 Counts of the aged living in lone person households: Australian regions, 2011



Source: Author's calculations using ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2). See the definition of low income in Table 6.

Figure 43 per cent of aged with low income: Australian regions, 2011



Source: Author's calculations using ABS 2011d.
Note: The regions are Statistical Area 3 regions (see Section 5.2). See the definition of high income in Table 6.

Figure 44 Per cent of aged with high incomes: Australian regions, 2011

9.3 AN AREA TYPOLOGY FOR AUSTRALIA'S AGED POPULATION

Using a single variate analysis, as demonstrated in Section 9.2 above, becomes increasingly complex as the number of regions and characteristics studied increases. In contrast, multivariate methods support concurrent analysis of regions and characteristics. In this section I develop a geodemographic classification for Australian regions based on the aged population. This classification has near complete coverage of the Australian population aged 65 years and over residing in the 327 regions included in this study. A geodemographic classification offers several advantages to understand the regional variation in the characteristics of the aged. It is a multivariate approach meaning that it supports exploratory analysis of large numbers of variables and can be applied to a large number of areas simultaneously. A further advantage is that areas not geographically adjacent can be compared.

For this study, I use the k-means cluster methodology. Developed by MacQueen (1967), this is a widely used method in academic and commercial research.[73] I introduce the methodology in the following subsections. The k-means cluster is a non-hierarchical cluster method with the number of clusters determined before the algorithm is run. Thus, part of the challenge in performing a k-means cluster analysis is deciding if a credible area typology can be identified. To do this involves the selection of variables, experimentation with different clustering results and utilising visualisation tools such as the discriminant projection cluster plots to settle a final set of variables (see Section 9.3.1 for additional detail).

A stylised depiction of a k-means cluster result is shown in Figure 45. Briefly, at the outset of the analysis, regions are partitioned into k-clusters and through 1000 iterations the regions are moved between the clusters to identify an optimal clustering solution. The optimal clustering solution maximises the difference between regions in different clusters and similarities between regions within clusters, where distance is measured as deviation from the cluster means (Vickers and Rees 2006). Distance is measured as the squared Euclidean distance given by (Vickers and Rees 2006, 125):

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[73] Alternatives to the k-means cluster method were considered (see Vickers (2006) for a discussion of the different methods available). The k-means cluster method was selected because it has been used successfully for the official geodemographic classification developed for the United Kingdom with the 2001 and 2011 Census data (see Vickers (2006) and Office of National Statistics (2015)).

$$E_c = \sum_{i=1}^{n_c} \sum_{j=1}^{m} (Z_{ij} - Z_{cj})^2$$

"Where Z_{cj} is the mean value for cluster c of variable j and Z_{ij} is the value for object i of variable j and n_c is the number of objects in cluster c."

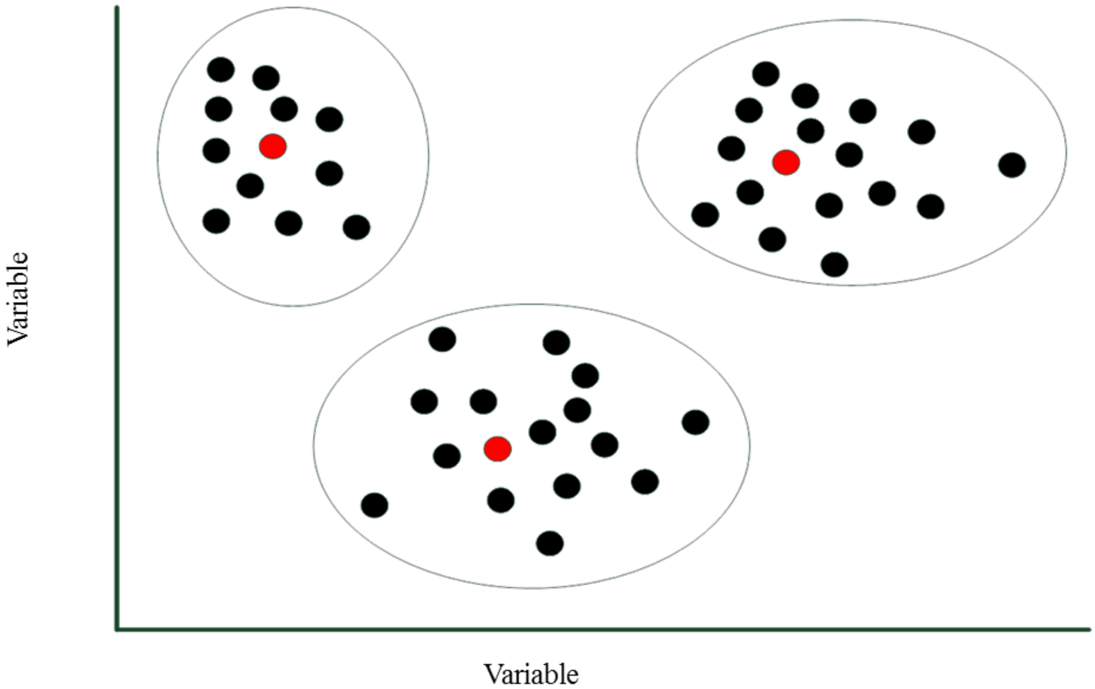

Figure 45 Stylised k-means cluster result

There are several stages involved in developing a geodemographic classification using the k-means cluster method. I outline these stages below, beginning with the approach and design, and after I introduce the six area types of the aged population for Australia and evaluate the geodemographic classification developed.

The classification developed is for the population aged 65 and over in 2011. It uses a flat structure and characteristics are not weighted. The result is a custom purpose classification. I considered developing separate classifications for the early-aged and late-aged subgroups but I recommend against this at this stage because of the small population size in the late-aged groups. Also, the result would have limited utility because it would not support direct comparisons between the groups.[74] The development of the clustering

[74] Classifications are calculated based on distance from the variable mean. The variable mean is different for the early-aged and late-aged group meaning the classification would be fundamentally different.

solution is consistent with the Milligan (1996) approach (and also the approach used by Vickers 2006 and the Office of National Statistics 2015).[75]

To perform this analysis, I use the R code developed by Dr Chris Gale for the United Kingdom 2011 Area Classification for Output Areas (Office National Statistics 2015). Dr Gale publicly released his coding using the R Software (Gale 2014).

9.3.1 Approach and design

The design of geodemographic classification is guided by theory but also requires the developer to exercise judgement based on their knowledge of the population subject to classification. In the following subsections I outline the design decisions covering the selection and transformation of the input variables, examining if area types are observed in the day and selecting the number of clusters.

This geodemographic classification is developed for the population aged 65 years and over residing in Statistical Area 3 regions.[76] The early-aged population dominates the classification because, on average, 88 per cent of the aged population is aged 65 to 84 years (and varies between 75 per cent and 97 per cent across all regions). The classification is developed using a selection of characteristics from the individual, social and economic domains (outlined in Section 6.2). Variables relating to the size or age structure of the aged population (i.e. the proportion in the early-aged years) are not considered for inclusion in the classification. This classification is designed as an adjunct to the size and age structure analysis and, therefore, is only influenced by characteristics of the aged population.

9.3.1.1 Selection and transformation of variables

The selection of characteristics is guided by Vickers (2006, 45) who recommends the input variables (the characteristics of the aged population in this study) should be included if they add definition to the clusters. He observes that some variables can mask significant patterns within clusters. Sometimes a principal component analysis is performed to remove redundant variables from the dataset; although, on this, Vickers (2006) says "clustering on principal components rather than the variables themselves is an outdated and unnecessary course of action" (Vickers 2006, 57).

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[75] The steps set out by Milligan (1996) include pre-cluster design decisions of selecting the clustering elements (or spatial unit), selection of variables and their standardisation. The clustering itself requires decision about the measure of association, clustering method and number of clusters.

[76] With some modifications, as outlined in Section 5.2.

Importantly, this classification is a custom purpose classification designed to support a range of policy initiatives. Therefore, I select variables that could indicate the presence of a service need or relative advantage or disadvantage. The final geodemographic classification uses 18 population characteristics selected through repeated testing of the classification with different combinations of characteristics. The testing involves evaluating the suitability of the population characteristics for inclusion in a k-means cluster analysis and their performance in the k-means cluster.

These variables selected for the classification are included in Table 10. The individual domain includes four variables representing sex, health, Indigenous status and country of birth, language. The economic domain includes nine variables representing income, education, work and housing tenure. The social domain includes four variables representing family and domestic support.

Ideally, variables in a geodemographic classification would not correlate. This is not achieved in this classification. Correlation is common in Census variables and can arise from different sources: variables can be causally linked, for example, a person in a lone household is more likely to be a person who is single; the presence of one variable can be indicative of another, for example, a foreign born person for whom English is a second language; and variables can be interdependent, for example, a male person cannot also be a female person (see Vickers 2006 for discussion). Through testing different combinations of variables, it is possible to reduce correlations but not remove them entirely. The significant correlations between the final 18 variables are shown in Table 10. Highly correlated variables were typically retained when their inclusion did not negatively impact on the performance of the classification and their presence aided interpretation of the classification. To prepare the variables for inclusion in the k-means cluster they are transformed to reduce skewness. Census variables are typically more positively skewed and this analysis is no exception. A box-cox transformation was used to reduce skewness.

The geodemographic classification was run with alternative iterations of variables. Specifically, the classification was run without the poor English variable as it can be associated with both Indigenous and foreign born (dissimilar) communities. The public rental and non-private dwelling variables were also excluded in one of the trials because they are characteristics associated with the supply of services or housing. Different variations of education and work were also considered (among others). Overall, the 18 variables selected provided the best performance of the clustering algorithm and the insights into the characteristics of the aged population by region.

Table 10 Final variables used in the geodemographic classification

Variable Number	Variable Name	Domain	Subdomain	Significant positive correlations (p<0.05) (Variable numbers)	Significant negative correlations (p<0.05) (Variable numbers)
s001	Female	Individual	Sex	2,4,5,9,11,15,16,17	6,8,13
s002	Disabled	Individual	Health	1,6,8,18	7,9,11,16
s003	Indigenous	Individual	Indigenous	6,8,10,13,14,	5,9,12,17,18
s004	Poor English	Individual	Language	1,9,14,15,18	8,10,11,13,16,17
s005	Foreign born dissimilar	Individual	Country of Birth	1,7,9,12,14,15,18	3,6,8,10,13
s006	Low income	Economic	Income	2,3,13,14	1,5,17
s007	High income	Economic	Income	5,17	2,11,13,16
s008	Incomplete secondary schooling	Economic	Education	2,3,11,13	1,4,5,10,17
s009	Degree	Economic	Education	1,4,5,10,17	2,3,13,14
s010	Working (part-time or full-time)	Economic	Work	3,15	4,5,8,11,16,18
s011	Home owner without mortgage	Economic	Housing tenure	1,8	2,4,7,10,13,15
s012	Home owner with mortgage	Economic	Housing tenure	5	3,14,15
s013	Private renter	Economic	Housing tenure	3,6,8	1,4,5,7,9,11,16,18
s014	Public renter	Economic	Housing tenure	3,4,5,6,17,18	9,12
s015	Women without children	Social	Family	1,4,5,10,17,18	11,12,16
s016	Married	Social	Family	1	2,4,7,10,13,15
s017	Lone person household	Social	Domestic Support	1,7,9,14,15,17	3,4,6,8
s018	Non-private dwelling	Social	Domestic Support	2,4,5,14,15,17	3,10,13

Note: See Section 7.2 for the description of these variables.

9.3.1.2 Design of the final geodemographic classification

With the variables selected, the k-means cluster algorithm is run and further evaluations of the clustering solutions are performed. Four indicators are examined: visual evidence of area types in the cluster solution; difference between clusters; coherence within the cluster; and the distribution of regions between the clusters. In practice, the selection of variables and these evaluations are performed concurrently and iteratively until the classification is finalised.

Consistent with Hennig's (2005) advice, I examined the clusters for evidence of separation between regions in different clusters and homogeneity within the cluster. To evaluate the visual evidence of area types I used discriminant projection plots. These projection plots project the multidimensional data on a two dimensional plane.[77] The discriminant projection plots for the four to seven cluster solutions are shown in Figure 46. Each cluster is differentiated by colour, and it is clear there are relatively discrete clusters. However, these discriminant projection plots give the first indication that not all clusters are equally differentiated from the others; an insight I return to in the evaluation of the classification in Section 9.3.2 below.

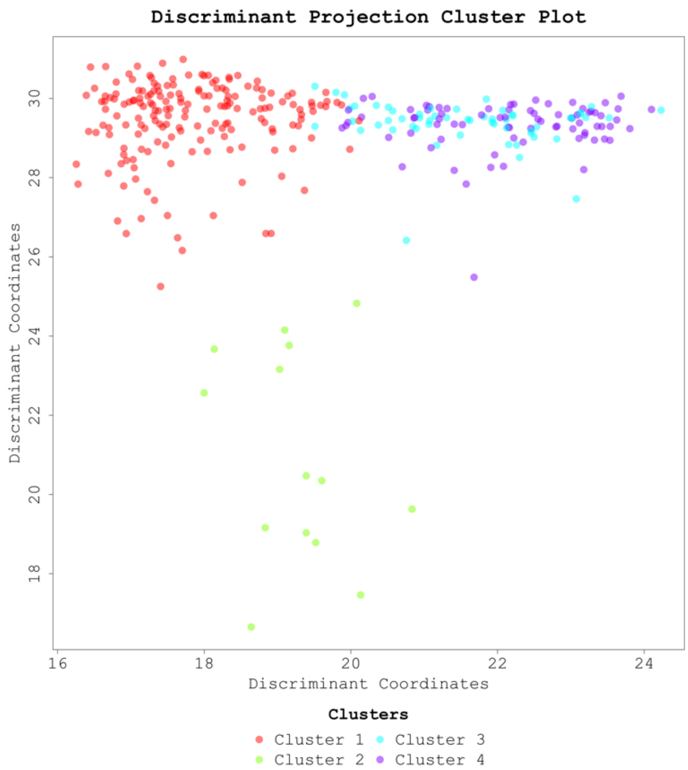
Coherence within clusters is measured by the total within cluster sum of squares. As the number of clusters increases, so does coherence within the clusters. While it is important to maximise coherence, too many clusters will make the classification complex to use. Vickers (2006, 68) offers a rule of thumb to "select the cluster which shows the greatest reduction in the average distance from the solution with one fewer clusters." For the final characteristics selected, the four cluster solution has a total within sum of squares of 519.3, reducing to 461.3 for the five cluster solution and 416.9 for the six cluster solution. Vickers' rule of thumb supports the five cluster solution.

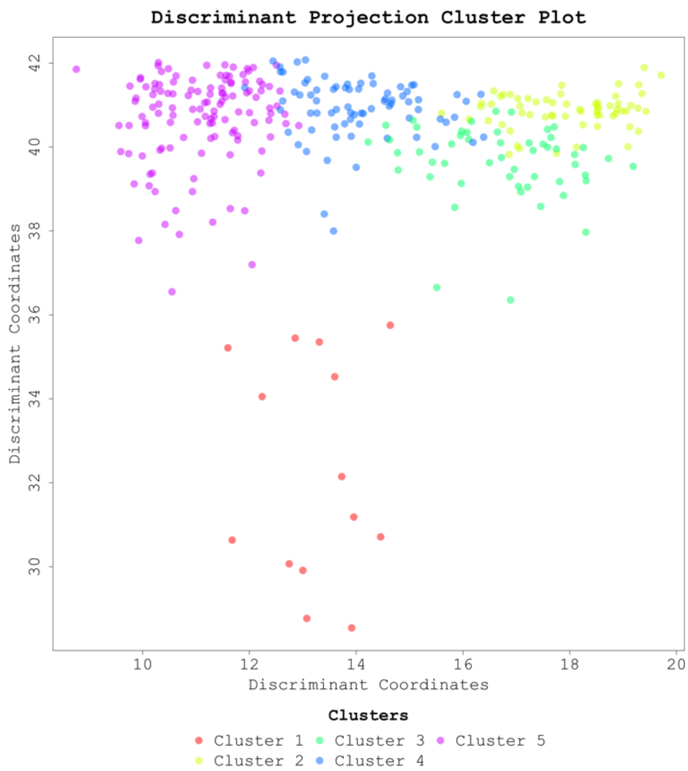
However, once the distribution of clusters is examined, I consider a six cluster solution to be the best alternative. Ideally the clusters are evenly distributed across the number of regions. The distribution of regions to the clusters for cluster solutions from four to seven is shown in

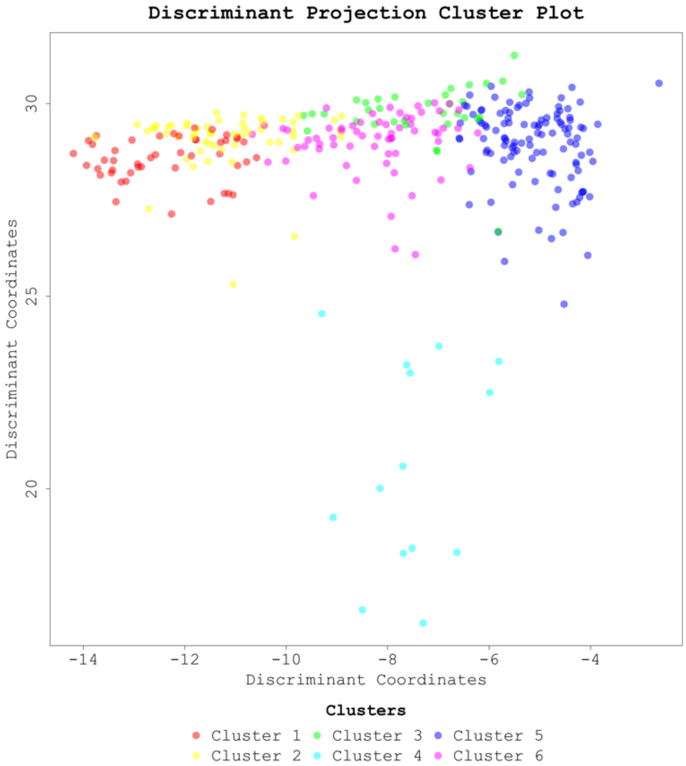
Table 11. In all the solutions there is one cluster which attracts a larger number of regions. In the four cluster solution, more than 50 per cent of regions are in one cluster. In the five

[77] The discriminant coordinate is linear projection technique (see Hennig 2005).

cluster solution more than a third of regions are in one cluster. Even in the five and six cluster solutions this remains a problem, with around one-third of the regions allocated to just one cluster. Different selection of characteristics (such as the variable combinations mentioned above) did not remove this problem. I decided the six cluster solution is the best and could provide the most meaningful clustering solution.







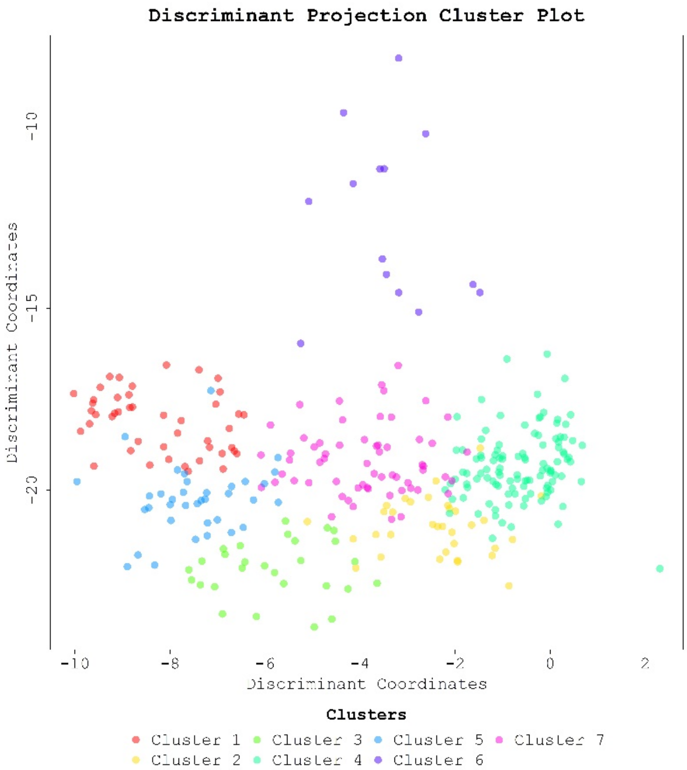


Figure 46 Discriminant projection plots for selected cluster solutions of the Australian aged population: Australian regions, 2011

Table 11 Number of Australian regions allocated to each cluster for the 4 to 7 cluster solutions

Cluster No.	No. of regions (Total 327)	WCSS (Total 519.3)
1	178	240.2
2	14	40.7
3	57	105.6
4	78	132.8

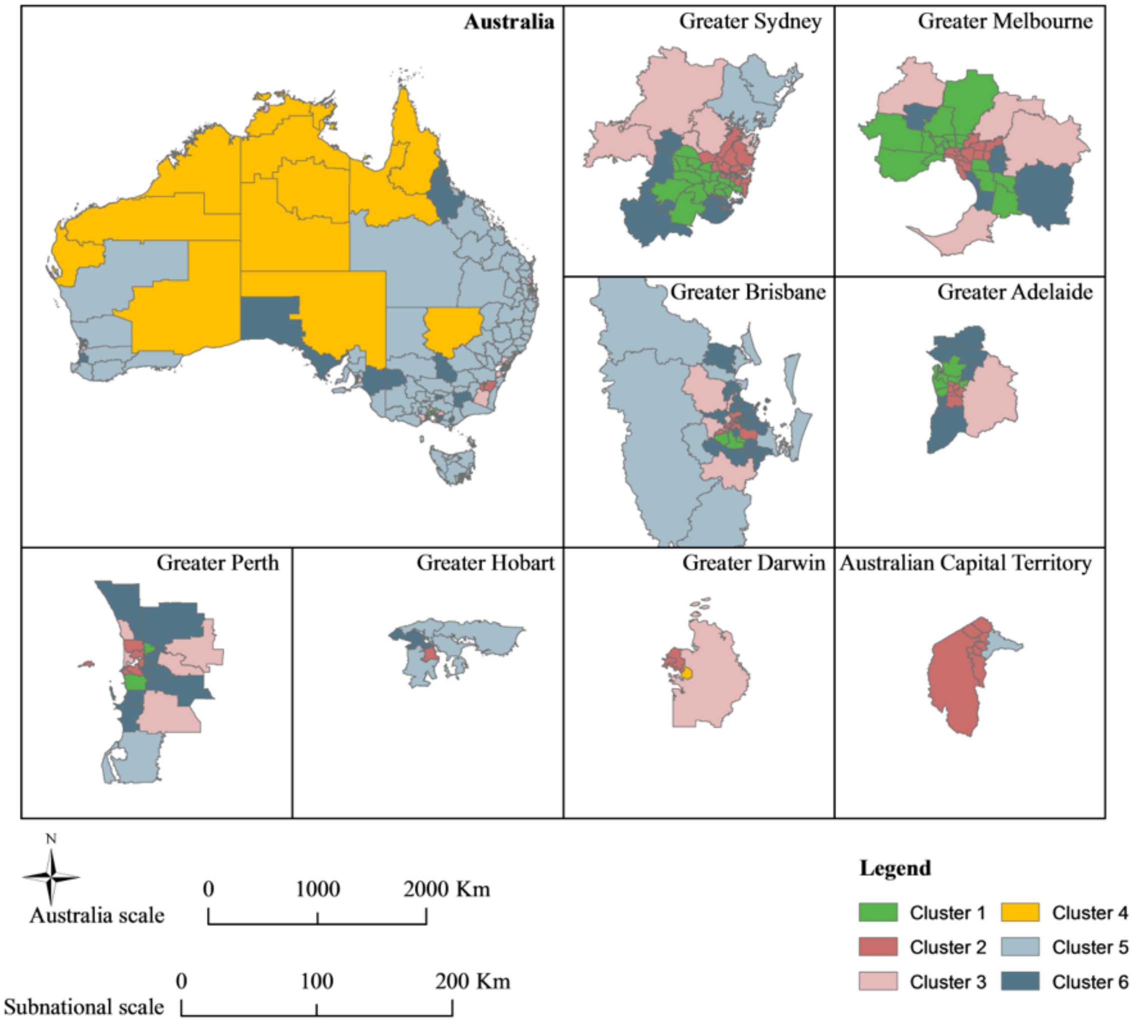
Cluster No.	No. of regions (Total 327)	WCSS (Total 461.3)
1	14	40.7
2	62	93.2
3	52	93.8
4	76	99.2
5	123	134.3

Cluster No.	No. of regions (Total 327)	WCSS (Total 416.9)
1	47	61.7
2	55	93.9
3	34	47.0
4	14	40.7
5	113	108.5
6	64	65.1

Cluster No.	No. of regions (Total 327)	WCSS (Total 390.3)
1	45	58.0
2	33	38.6
3	28	34.1
4	110	103.7
5	36	53.3
6	14	40.7
7	61	61.8

9.3.1.3 The six types of regions for Australian aged population

The geodemographic classification outlined in the following subsections is the final classification, the best performing distribution of regions from 1000 runs of the clustering algorithm. The final model uses a one level structure of 18 characteristics and allocates 327 regions to one of six area types. The first four area types have aged populations with features differentiating them from the typical aged. The final two area types reflect typical aged communities, differentiated only by country of birth with the areas in cluster five being typical of the total aged population and the areas in cluster six being typical of the aged population but with fewer foreign born aged relative to the typical aged communities. The six area types are outlined in the following subsections and figures, beginning with the spatial pattern of the areas types which is shown in Figure 47.



Source: Author's calculations using ABS 2011d.
Notes: The regions are Statistical Area 3 regions (see Section 5.2)
Cluster 1 are the foreign born (dissimilar) and relative disadvantage areas.
Cluster 2 are the foreign born (dissimilar) and relative advantage areas.
Cluster 3 are the active ageing and relative advantage areas.
Cluster 4 are the remote indigenous areas.
Cluster 5 are the typical aged areas.
Cluster 6 are the Australian born typical aged areas.

Figure 47 The geodemographic classification of the aged in Australia

The first area type is characterised by above average foreign born population (of dissimilar background) as well as indicators of relative disadvantage. Forty-seven regions are included in this cluster, and approximately 19 per cent of the aged population reside in these areas of this type. These regions occur nearly exclusively within capital city regions (only Dapto-Port Kembla in New South Wales is in this cluster). The indicators of relative disadvantage include above average levels of disability, poor English, low income, public renters and below average levels of work. However, it is worth keeping in mind that not all of these characteristics are as influential on the clustering solution. This can be easily seen in the radial plots in Figure 48, which, for this area type, show the foreign born population (of dissimilar background) and poor English skills are highly influential on clustering these regions together.

The second area type is characterised by above average foreign born population (of dissimilar background) as well as indicators of relative advantage. Fifty-five regions are including in this cluster. The foreign born population (of dissimilar background) is not as pronounced in this area type as the first, but it is still a defining characteristic. The indicators of advantage include high income, degree educated and working. There are also relatively fewer aged with indicators of disadvantage including Indigenous, low incomes, incomplete secondary education, private renters and lone person households. Approximately 18 per cent of the aged population reside in these regions of this area type. These regions also occur nearly exclusively within the capital city regions, with Queanbeyan in New South Wales (but geographically adjacent to the Australian Capital Territory) being the only non-capital city region included in this area. Within capital cities regions with this area type tend to be regions close to the central business district.

There is evidence, however, that the aged population in the second area type is more heterogeneous. In the regions included in this area type there is relatively high proportion of the aged population who have poor English skills, are women without children and reside in public rental housing or non-private dwellings. The area type represents the characteristics of the region but does not represent all the aged population within these regions. There could be sizeable aged populations requiring service support in this region even though the overall region has indicators of advantage relative to other regions.[78] That there are public rental and non-private dwelling facilities in these regions could be a response to an aged population requiring support and care. An alternative explanation, however, is that because these services are present in these regions an aged population requiring these services is attracted to these regions—a question to resolve in a future study.[79]

The third area type is characterised by active ageing and relative advantage. Thirty-four regions are included in this cluster and approximately 8 per cent of the aged population reside in regions of this area type. The third area type includes a mix of capital city and rest of state regions. As is clear from Figure 47, where this area type occurs within capital

[78] This is referred to as ecological fallacy where the aggregate analysis may not represent the individual (see Gehlke and Biehl 1934 and Robinson 1950).

[79] Similarly, in the third area type there are relatively fewer aged residing in public rental or non-private dwellings and it is also not known whether this feature of these regions is due to demand or supply factors.

cities, these regions tend to be towards the outer boundary. A number of the regions outside of capital cities would be associated with high amenity locations such as the Yarra Ranges, Mornington Peninsula and Surf Coast-Bellarine Peninsula in Victoria, the Adelaide Hills in Adelaide, Cairns-North in Queensland and the Blue Mountains in Sydney (among others). These regions have characteristics in common with regions in the second area type, but there are fewer signals of heterogeneity within the aged population and fewer signals of relative disadvantage in these regions.

The characteristics of the aged in the third area type point to relatively higher potential for active ageing. With the exception of remote Indigenous communities (discussed below), the proportion of the aged population working in the areas classified as active ageing and relative advantage is the highest of all the area types identified. Significantly, these are also the regions with the highest proportion of the aged who own a home with a mortgage. While these may be working-aged populations they are working from a position of advantage, as they are more likely to high incomes, be degree educated and married. The aged in these regions are relatively less likely to be disabled, Indigenous, have poor English skills or living in lone person household. The aged females in these regions are less likely to have children, which can be a signal of lower social resources for their own care but also lower responsibilities to care for others. These are all signals for the potential for these regions to demonstrate active ageing and successful ageing objectives of work, independence and social support.

The fourth area type includes 14 remote regions with relatively higher proportions of Indigenous aged. While the physical area covered by these regions is large, less than 1 per cent of the aged population reside in these regions. Two characteristics are particularly strong, Indigenous and public renter. Other characteristics may seem peculiar on face value. While these are regions with relatively high Indigenous aged, the Indigenous aged population is a minority in each of these regions. It is the non-Indigenous population in these regions which are driving some of the regional characteristics and bringing these areas together in a cluster, such as the relative high levels of employment.

The fifth and sixth area types closely reflect typical aged regions and include around half the aged population in Australia. The fifth cluster includes 113 regions and approximately one-third of the aged population. The sixth cluster includes 64 regions and 21 per cent of the aged population. The fifth area type is a truer representation of the typical aged regions. It is called typical aged regions. The sixth area type is very similar except for these being near exclusively Australian born aged populations. It is called Australian born typical aged area.

As shown in Figure 47, these regions cover large parts of the regions within and outside capital cities. Examples include the inland areas of Orange, Dubbo and Albury in New South Wales, Wellington and Ballarat in Victoria and the Central Highlands in Queensland. These area types show that even though large aged populations resident in capital city regions, inland areas can be among the most representative of the aged population in Australia. As typical aged regions, these regions are expected to have similar characteristics to the national average as outlined in Section 9.2).

Looking at the aged typology through the state and territory lens highlights variation in in the aged regions at this level. Of particular interest is that no region in the Northern Territory is allocated to either the typical aged or Australian born typical aged area types. Based on this analysis the aged population in the Northern Territory is particularly distinct among the states and territories. The regions in the Australian Capital Territory are also mostly not of the typical aged area type. However, the regions within the Australian Capital Territory are fairly homogenous, with nearly all regions in the Australian Capital Territory being of the type foreign born (dissimilar) and relative advantage. In New South Wales, Victoria, Queensland and Western Australia there is more heterogeneity and a mix of the area types. Tasmania is also homogenous with most regions being typical aged communities.

One of the motivations for performing the k-means classification is to compare regions independently of geography. A particular goal was to examine the characteristics of the aged at a subnational level without using the remoteness classification. Surprisingly, however, the analysis shows (as is clear in Figure 47) that the distribution of regions by area type is far from being heterogeneous. In fact, there is clear differentiation by rural, remote and capital city regions.

9.3.2 Evaluating the geodemographic classification for Australia

The geodemographic classification reveals several insights into the characteristics of the aged population in Australia. The first is that the classification is strongly influenced by small number of characteristics. These characteristics include country of birth, specifically the characteristics of foreign born (dissimilar) and Australian born. The Indigenous aged population also influences the area types. A remote area type with a relatively high proportion of Indigenous age occurred in all iterations of the classification.

This occurs because of the geographic concentration of the population with these characteristics in some regions. In contrast, the characteristics which occur more commonly and are relatively less spatially concentrated are less likely to be a differentiating feature using the k-means algorithm where the goal is to maximise differences between regions. Where there are few differences between regions it is difficult for these characteristics to be used to define a cluster. An example in this classification is the low income characteristic, as can seen in the radial plots in Figure 48 it is simply too common to assist much with differentiation between regions.

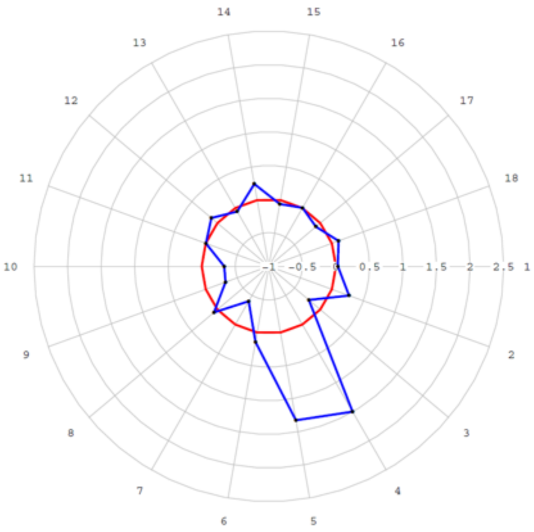
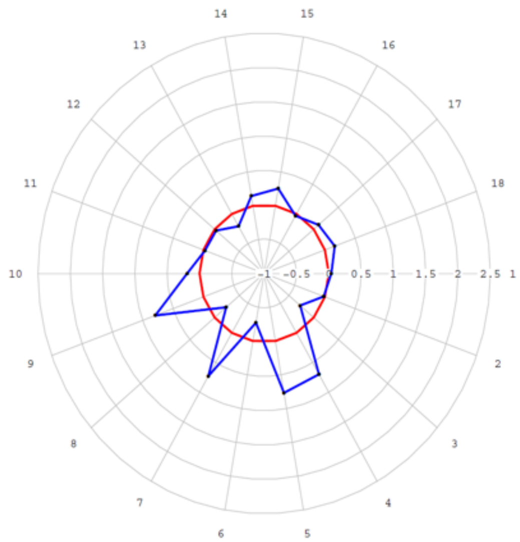
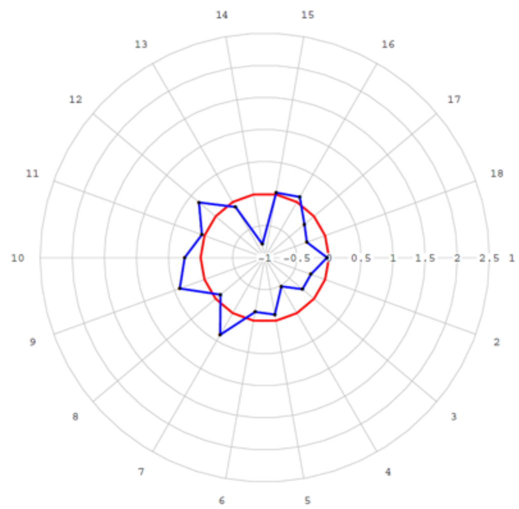
The k-means clustering methodology requires all regions to be allocated to a cluster. This means regions will be allocated even if they are a poor fit. The inclusion of regions with a poor fit will increase the within cluster sum of squares. As shown in Table 11, the within cluster sum of squares is highest for the fifth cluster (the typical aged). This is not unexpected given it is also the typical aged area type includes the largest number of regions. The within cluster sum of squares is next highest for the second cluster (foreign born (dissimilar) and relative advantage). As I mentioned, there is evidence of heterogeneity within the aged populations in this area type and that this region has one of the higher within cluster sum of squares score is further evidence of this being the case.

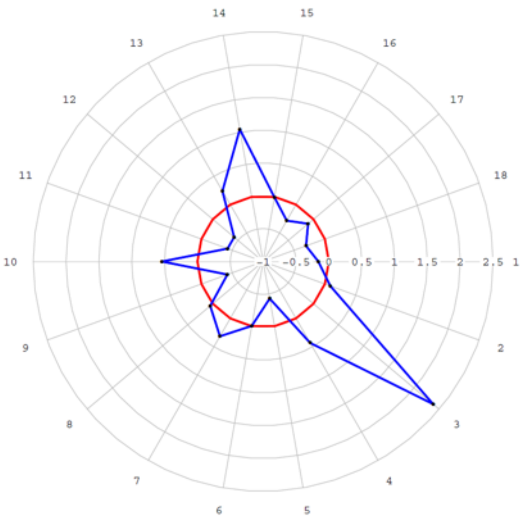
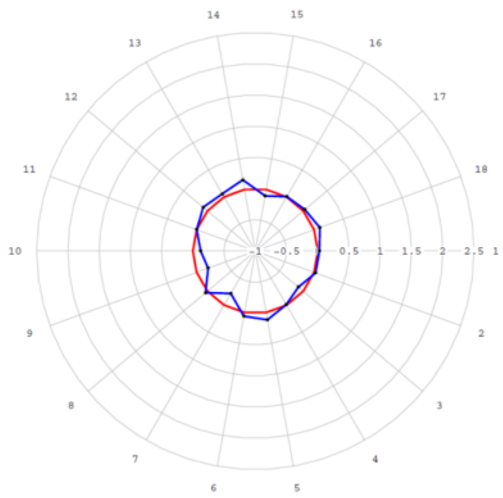
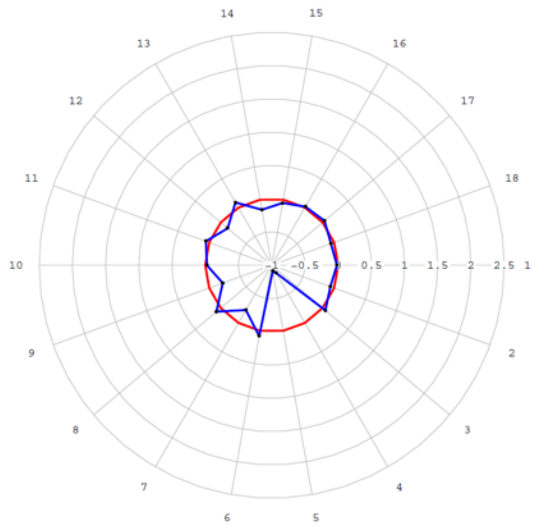
In addition to examining the allocation of regions to the cluster with the best fit, I also examined which clusters were the worst fit for each region. For 29 of the 327 regions, the best fit cluster is also the worse fit cluster. These regions were close to evenly split between the fourth area type (remote Indigenous) and the sixth area type (Australian born typical aged). The regions in the Northern Territory were particularly affected by this, with 5 out of the 9 regions in the Northern Territory being allocated to clusters of best and worst fit. This signals, once again, that the aged population in the regions in the Northern Territory are complex and heterogeneous so that they do not fit easily into an area type.

The best and worst cluster analysis is a useful reminder that there is no guarantee that the k-means cluster method will produce a meaningful result. This needs to be assessed once the classification is developed. While the classification developed, and outlined above is meaningful, it is important that the results do not directly inform aged care planning. As mentioned, the k-means method will allocate all regions to a cluster using the number of clusters fixed at the beginning of the analysis. There is also the modifiable areal unit problem to consider (introduced in Section 5.2), which means the classification will be influenced by the spatial unit selected for the classification. Particularly, it is worth keeping in mind that small populations (with high service needs) can be present within any of these regions, even if the region is classified as having indicators of relative advantage. A key example is the Indigenous aged population which are few in number relative to the non-Indigenous population but are a population subgroup with distinct service needs. When these small populations live among larger population groups, their presence in these regions will not be directly obvious in the classification.

Finally, the geodemographic classification developed in this study will change over time as the characteristics of the aged population changes over time. Change can happen for multiple reasons, including: cohort effects; age effects; differential survival rates by individual, economic and social characteristics; and, unevenness in internal migration patterns across population subgroups. Locational effects may also be important, and the increased supply of certain services (such as non-private dwellings) could lead to a higher proportion of the aged moving or staying in particular locations.

Despite some limitations, the classification produced is a contribution to better understanding the aged in Australia. Consistent with my aim, it is a custom purpose classification of the aged population which can be replicated over time. The development of a classification is "part art and part science", with multiple solutions available depending on the design decisions made. However, while alternative classifications could be designed, this classification demonstrates the best fit the Australian aged population as it was in 2011. It shows there are distinct area types which can be used to classify regions in Australia based on the characteristics of their aged population.

Cluster One: Foreign born (dissimilar) and relative disadvantage (47 Regions)	Cluster Two: Foreign born (dissimilar) and relative advantage (55 Regions)	Cluster Three: Active ageing and relative advantage (34 Regions)
		
Characteristics *Near average*: 1,8,11,12,13,15,16,17,18 *Above average:* 2,4, 5,6, 14, *Below average: 3, 7, 9,10*	Characteristics *Near average*: 1,2,11,12,17 *Above average*: 4,5,7,9,10,14,15,18 *Below average*: 3, 6,8,13,16,17	Characteristics *Near average*: 1, 5, 6,8,11,13 *Above average*: 7, 9,10,12,15,16 *Below average*: 2, 3,4,14,17,18

Cluster Four: Remote indigenous (14 Regions)	**Cluster Five: Typical aged (113 Regions)**	**Cluster Six: Australian born typical aged (64 Regions)**
		
Characteristics *Near average*: 2, 6,8,15,17 *Above average*: 3,4,7,10,13,14 *Below average*: 1,5,9,11,12,16,18	Characteristics *Near average*: 1,2,3,5,6,10,12,13,14,15,16,17,18 *Above average*: Nil. *Below average*:7,8,9	Characteristics *Near average*: 1,2,3,6,8,10,11,12,13,14,15, 16,17,18 *Above average*: Nil. *Below average*: 4,5,7,9

Notes: See Table 10 to cross-reference the variable numbers with the variable names.

Figure 48 Radial plots showing relative variation in the characteristics of the aged population to the average for each area type

9.4 CONCLUSION

Building on my analysis in Chapter 8 where I examined the size and age structure of the aged population in Australia, in this Chapter I added to analysis of the geodemographic perspectives of the aged population focusing on the characteristics of the aged population in Australia. While there is regional variation in the characteristics of the aged, there is also evidence of common characteristics across a number of regions. Significantly, in a country where the largest aged population resides in capital city regions, this study shows that regions outside of capital cities can be more representative of the typical aged region in Australia.

To be responsive to the aged population and its subnational variation policy makers need to understand the aged population at the local level. Furthermore, in addition to growth in the size of the aged population, the characteristics of the aged can shape demand for services. The geodemographic classification of the aged population makes it clear that there are distinct area types for the aged population. The classification developed differentiates regions into six types: foreign born (dissimilar) and relative disadvantage; foreign born (dissimilar) and relative advantage; active ageing and relative advantage; remote indigenous; typical aged; and, Australian born typical aged. The classification is relatively robust, with experimentation with different variables producing only minimal changes to the overall classification. Another strength of the classification is that it allows comparisons of regions that are not geographically adjacent. These results for 2011, however, show a high proportion of adjacent regions allocated to the same area type.

For several reasons the geodemographic classification developed is not designed to be a service delivery planning tool. Due to low population density in some areas, some of the regions examined are too large geographically to be used as a local level planning area. As the population grows, it may be possible to further subdivide these regions and repeat the classification exercise. Through further subdivision of the substate regions, it would also be possible to investigate the effects of the modifiable areal unit problem on the results and to examine the potential for heterogeneity of the aged population within the regions examined. As discussed in the Chapter, there are at least some signals that the modifiable areal unit problem affects this analysis.

The insights about the aged presented here are based on point in time analysis, although I did discuss some drivers of change in the characteristics of the aged population at present. Both cohort flow and migration effects could change the area typologies developed in study. So too can effective policy interventions be shaping the characteristics of the aged.

Chapter 10

Life course perspectives of the aged in Australia

While geodemographic perspectives of the aged are necessary to plan for growth in the aged population, to design programs responsive to their characteristics and to deliver services in the locations the aged reside, additional perspectives are required. I have already argued for life course perspectives of the aged in Australia to complement geodemographic perspectives of the aged. Life course analysis offers more potential to shift perspectives of the aged as a homogenous group with the key entry criteria being retrospective chronological age of 65 years.

The focus of this Chapter is population level transitions, specifically transitions into the aged years, between work and retirement, between health and disability and life and death. While these will be complex and often non-linear transitions at the individual level, population level analysis looks at broader issues about the threshold of the aged, the ages where additional years of life are lived (or lost) as mortality conditions change, the quality of the years lived and inequality within a population in the length of life, work or health.

Life course analyses can inform current policy concerns and to lay a foundation to build momentum for the policy directions set out in Chapter 4. In the past policy makers have not been sufficiently alert to these perspectives and this has contributed to a divergence of policy settings with demographic conditions. Bloom, Canning and Fink (2011), for example, studied 43 countries between 1965 and 2005 finding that male life expectancy rose nine years on average and mean legal retirement age rose less than half a year. Policy makers are being confronted with difficult questions: can this imbalance between demographic conditions and policy settings continue and will our current suite of policy responses be effective in the future? The findings in this analysis support technical improvements in policy settings, such as quantifying the age at which deaths need to be averted to reduce lifespan inequality. However, responding to population ageing is also an adaptive challenge. Life course perspectives can be used to open up debate about the more fundamental questions I outlined Chapter 4, particularly how to distribute the benefits of increased life span across the life course.

This being said, the methods I use in this analysis are quantitative approaches providing data to inform the policy response. It is not my aim to resolve the adaptive challenge of population ageing, but rather to provide a foundation for a more nuanced discussion. There are three sections in this Chapter. In the first section I examine change in the threshold of the aged using the Sanderson and Scherbov (2013) age-transitions method for Australia over the period 1901 to 2031. In the second section I examine the life span dimension using the Arriaga (1984) method to decompose life expectancy change for Australia over the period 1901 to 2011 and the life span disparity measure, $e^{\dagger}$, to quantify the average years of life lost to death at key ages (van Raalte and Caswell 2013). In the third section I examine life course markers of ageing using the Sullivan method to calculate working-life expectancies between 2006 and 2031 and disability-free life expectancies at the national and subnational level (Sullivan 1971). Information about the data and variables for this analysis is set out in Chapter 6 and Chapter 7.

10.1 CHANGE IN THE THRESHOLD OF THE AGED

In Australia age 65 is the typical threshold to the aged years. There are signs of change, with the eligibility age for the Age Pension soon to increase and the Australian Government's National Committee of Audit recommending a dynamic approach to set the eligibility age of the Age Pension to 77 per cent of life expectancy at age 65 (Australian Government 2014c). While I have already stated my support for an individually defined threshold of the aged (see Chapter 4) any move in this direction will first require a more robust examination of how a more traditionally defined threshold of the aged is changing.

Consistent with an overall theme in this study, this analysis uses multiple perspectives of the threshold of the aged using a method proposed by Sanderson and Scherbov (2013) to develop age-transition trajectories. I am forward-looking in this analysis to ask what the threshold of the age would look like in the future if these trajectories continued and I also look back to ask what would the threshold of the aged be in 2011 if these approaches were already in place.

In their paper, Sanderson and Scherbov (2013) introduce their age-transition trajectories as a way to examine change in characteristics-based measures of the aged. Similarly, to their study, I use life table based measures of the aged: remaining life expectancy (RLE_x) to represent a prospective age approach to defining the threshold of the aged; the mortality rate (m_x) to represent frailty based approach to defining the threshold of the aged; and a life course ratio (T_x/T_{20}) to represent a stable proportion of life dedicated for the aged years.[80] An age-transition trajectory is given by (Sanderson and Scherbov 2013, 675):

$$\alpha_{k,t} = C_t^{-1}(k_t)$$

"Where $\alpha_{k,t}$ is the chronological age at which the level of a specified characteristic and C_t^{-1} is the inverse of the characteristics schedule at time *t*."

Using this method, I identify changes in the threshold of the aged years for Australian males and females since 1901. While any of the historical life tables can be used as the reference year for an age-transition trajectory, in this analysis I focus on six reference life tables of *1901-10*, *1960-62*, *1970-72*, *1980-82*, *1990-92* and *2000-02*.[81] The age-transition trajectory beginning in the reference year of 1905 closely represents change since the Age Pension was introduced in 1909, while the age-transition trajectory beginning in 1961 most closely represents change in the working life of the baby boomers. The age-transition trajectories are calculated for males and females separately using all life tables available between the reference year and 2011. I also include two projected life tables for 2021 and 2031 using both the trend and slowing mortality scenarios to examine future scenarios for the threshold of the aged (see Section 7.3.3 for the calculation of these scenarios).

In total, 36 age-transition trajectories were calculated. While three distinct characteristics are examined over time, there are common elements in the approach. Each age-transition trajectory begins at age 65, the typical threshold demarcating the commencement of the aged years. In these calculations time (*t*) is discrete and I assume any change to the threshold of the aged occurs evenly between each period. This means some caution should be exercised when interpreting the age-transition trajectories up until 1990 given that, due to the availability of data, the gaps between estimates points can be more than ten years. Selected results are shown in Figure 49 where I chart the historical age-transitions trajectories for the reference years 1901 and 1961. I include more detailed results in Table 12 with the historical age-transition trajectories for the all the reference years examined

[80] More specifically, Sanderson and Scherbov (2013) refer to this life course quantity as a life course ratio representing a demographically index pension scheme. This description has less relevance to the Australian policy context and therefore this description is not used in this study. More generally, Sanderson and Scherbov (2013) refer to three families of characteristics-based measures including elder proportions, elder ratios and elder relationships. These descriptors are not used in this analysis, but could be useful to frame a public narrative about changing aged.

[81] Recall from Section 7.3.2, these are the range of year for which the period life table applies. I use these references when referring to the life tables, but to pinpoint the year these life tables cover I refer to the mid-point of the life table.

(the rows) and the chronological age at which the level of a specified characteristic occurred in subsequent years and for the projected scenarios in 2021 and 2031.

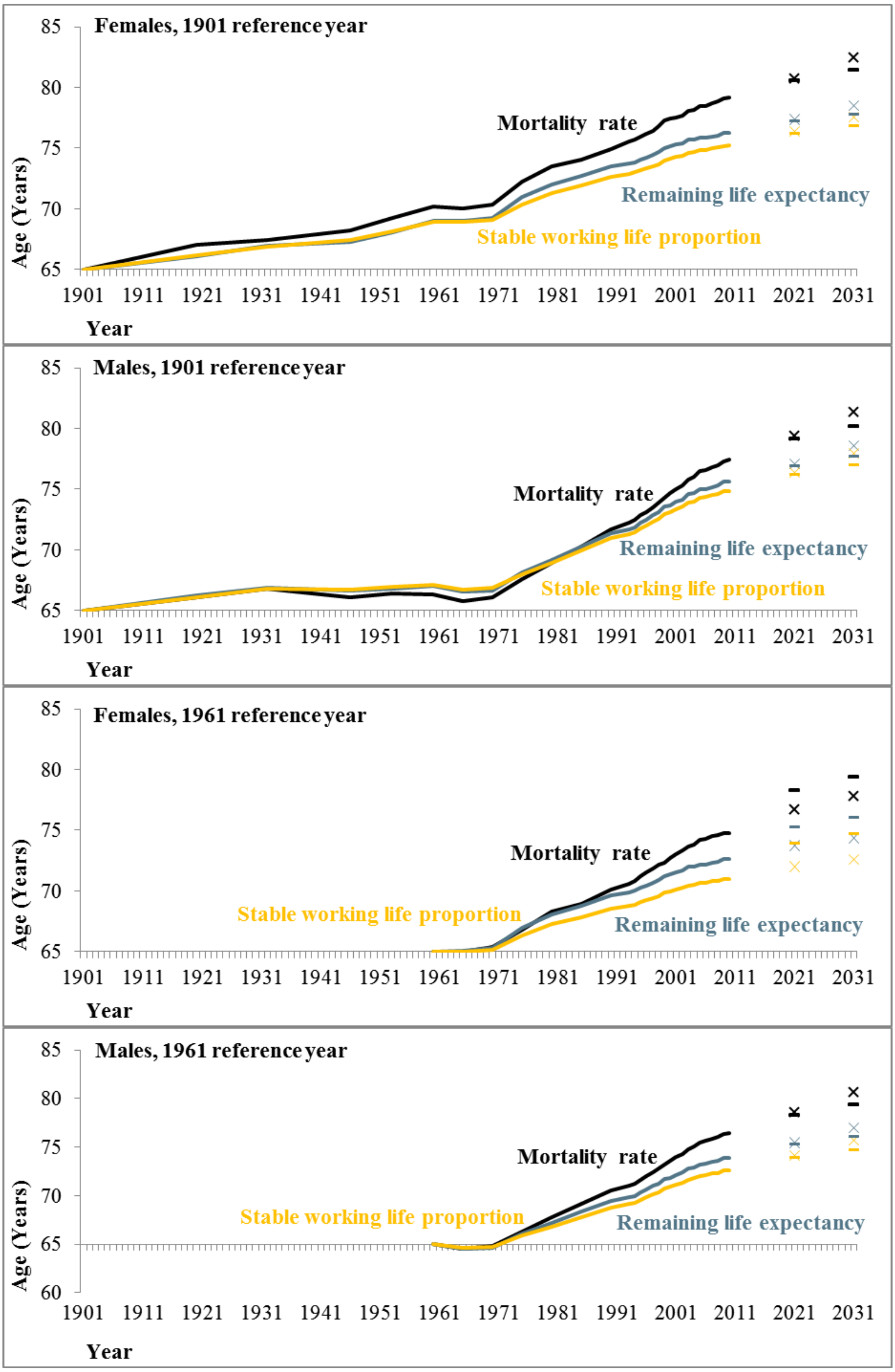
The age-transition trajectories are all positive through to 2011 supporting the established view that the threshold of the aged is increasing (Australian Government 2014c). Depending on the reference year and characteristic, by 2011 the threshold age for the aged could have shifted from age 65 to be between age 66.6 and 77.4 for males and between age 66.0 and 79.1 for females. Only one period of de-ageing was observed, and affected males between 1961 and 1971 when the threshold of the aged fell for each characteristic examined by up to half a year. Overall, the increase in the threshold of the aged is noticeably slower before 1971 than subsequently, which suggests that it has been during the working life of the baby boomer cohort where changes to the threshold of the aged have been the most significant.

With the exception of the 1901 reference year, the age-transition trajectories are steeper for males compared with females leading to increases in the threshold of the aged being larger for males than females. As a consequence, the threshold of the aged for males is older than for females at the end of the analysis in 2011 for all reference years and characteristics after 1901, even though life expectancy is lower for males relative to females in 2011. This demonstrates one of the challenges in using dynamic models for age-based policy settings; models which rely on change in the life table characteristics (as this one does) will reflect current patterns of life table change rather than a combination of historical and current conditions. Thus, while female life expectancy may be higher than male life expectancy, if male life expectancy is converging with female life expectancy then dynamic models will increase age-based policy settings for males more rapidly. While in practice policy settings are unlikely to differentiate by sex, it is critical that our interpretation of the demographic evidence enables more accurate prediction and planning for the needs of the aged.

There are also differences in the pace of change between the three variable characteristics examined. The age-transition trajectories for the mortality characteristic (m_x) show the largest increase over the period 1905 to 2011; however, most of the increase has occurred since 1971. For males, the change between 1905 and 1961 was minimal, rising from age 65 to 66.3 years and then falling by 0.2 years between 1961 and 1971. For females, the change was more significant over this period; increasing from age 65 to 70.2 years between 1905 and 1961 and a further 0.2 years from 1961 to 1971. From 1971, the increases were significant for both males and females, rising a further 11.3 years for males and 8.7 years for females. The peak rise for males occurred between 1991 and 2001 and occurred earlier for females during the years 1971 to 1981.

If the threshold of the aged was based on the life course ratio (T_x/T_{20}) or remaining life expectancy (RLE_x) increases to 2011 would still have been significant. For males (but not females), increases in these characteristics to measure the threshold of the aged initially exceeded increases observed in the mortality characteristic (m_x). However, the higher increases for life course ratio (T_x/T_{20}) and remaining life expectancy (RLE_x) relative to the mortality characteristic (m_x) were not sustained past 1991. Between 1905 and 2011, the age-transition trajectory for the characteristic remaining life expectancy (RLE_x) increased from age 65 to age 75.6 for males and to age 76.3 for females. The life course characteristic (T_x/T_{20}) showed the least increase over the period 1905 to 2011, but still increased to age 74.9 for males and age 75.2 for females.

The application of the characteristics-based method to more recent reference years shows a similar pattern. Overall, the average pace of change for the mortality characteristic, (m_x), was the highest, followed by the remaining life expectancy characteristic (RLE_x) and the life course characteristic (T_x/T_{20}). The pace of change, however, peaks at different times for different characteristics. For females, with 1971 being the reference year, the average pace of change was highest for the remaining life expectancy characteristic (RLE_x) and the life course characteristic (T_x/T_{20}) with 1971 (increasing 0.18 and 0.15 years per year respectively) and is highest for the mortality characteristic (m_x) in the reference year 1991 (increasing 0.25 years per year). For males, the average pace of change was highest for remaining life expectancy (RLE_x) and the mortality characteristic (m_x) when 1991 was the reference year (increasing 0.24 and 0.34 years per year respectively) and the life course characteristic (T_x/T_{20}) peaked in the 1971 reference year (increasing 0.20 years per year). A small reduction in the pace of change was observed between 1991 and 2001 reference years for males and females, but should be interpreted cautiously as it may be an effect of the methodological change in the 2011 life table used (see Section 7.3.2).



Source: Authors' calculations using ABS 2014c.

Figure 49 Age-transition trajectories: Australia by sex, multiple reference years and the trend and slowing mortality scenario for 2021 and 2031.

Stepping back from the results it is possible to consider, briefly, the implications for public policy of this analysis using the example of the eligibility age for the Age Pension. When introduced in 1909, the eligibility age for the Age Pension was age 65 for males and 60 for females (ABS 1988). While male and female children born at this time had an average life span lower than these ages, remaining life expectancy exceeded 11 years for males and 16 years for females who survived to age 65 and age 60 respectively (and nearly 13 years for females who survived to age 65). To preserve the simplicity of the point, assuming that both males and females accessed the Age Pension at age 65 in 1909 (so that female remaining life expectancy was 13 years) and this remaining life expectancy characteristic was used to determine the age of access to the Age Pension into the future, by the time the baby boomers were entering the work force, males would be accessing the Age Pension at around 67 and females at around 69, and by the time the baby boomers reached age 65, the age of access to Age Pension would exceed age 75 for males and females. However, in reality, over this period female access to the Age Pension increased to 65 and did not change for males.

The current Australian Government policy is to increase the age of eligibility for the Age Pension to 67 by 2023. Compared with the characteristics examined above, this would account for increases in the threshold of the aged covering the last ten to twenty years. A proposal has been put to Government, which, if accepted, would see the Age Pension increase to age 70 by 2053 (Australian Government 2014c). When considered in the context of this analysis, this approach would not be large enough to compensate for the increases in the threshold of the aged which occurred during the life of the current aged population or the working life of the baby boomer cohort.

The Sanderson and Scherbov (2013) method provides, in principle, a foundation for a dynamic model of change in the threshold of the aged. The method can be readily applied; the challenge is the selection of an appropriate reference year and characteristic. Each of the life table characteristics examined in this section are reasonable measures for the threshold of the aged. They are better measures of the threshold of the aged compared with life expectancy at birth, which can rise quickly and without impact on the aged years. Thus, an advantage of the characteristics-based approach is that it provides a dynamic model of change that is more sophisticated than life expectancy change at birth.

Table 12 Age-transition trajectories using the individual characteristics-based approach: Australia

Reference year (the mid-point of the reference life table year)		1961		1971		1981		1991		2001		2011		2031[a]	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
1905	RLE_x	67.1	69.0	66.6	69.3	69.1	72.0	71.4	73.5	73.7	75.1	75.6	76.3	77.7 - 78.6	77.8 - 78.5
	m_x	66.3	70.2	66.1	70.4	68.9	73.5	71.7	74.9	74.7	77.4	77.4	79.1	80.2 - 81.4	81.4 - 82.4
	T_x/T_{20}	67.1	68.9	66.9	69.1	68.9	71.3	70.9	72.6	73.1	74.1	74.9	75.2	77.0 - 78.0	76.8 - 77.6
1961	RLE_x	65.0	65.0	64.6	65.3	67.1	68.1	69.5	69.6	71.9	71.4	73.9	72.6	76.1 - 73.9	74.4 – 75.1
	m_x	65.0	65.0	64.8	65.4	67.7	68.3	70.5	70.1	73.6	72.7	76.5	74.8	79.4 - 76.5	77.8 - 79.1
	T_x/T_{20}	65.0	65.0	64.8	65.2	66.8	67.3	68.8	68.5	70.9	70.0	72.6	71.0	74.8 - 72.6	72.6 - 73.3
1971	RLE_x			65.0	65.0	67.6	67.8	69.9	69.3	72.3	71.1	74.3	72.3	76.4 - 77.3	74.1 - 74.9
	m_x			65.0	65.0	67.9	67.8	70.7	69.7	73.8	72.3	76.6	74.4	79.5 - 80.7	74.5 - 78.8
	T_x/T_{20}			65.0	65.0	67.0	67.1	69.0	68.3	71.2	69.8	72.9	70.8	75.0 - 76.0	72.4 - 73.1
1981	RLE_x					65.0	65.0	67.4	66.6	69.9	68.4	72.0	69.7	74.3 - 75.3	71.6 - 72.5
	m_x					65.0	65.0	67.7	67.0	71.2	69.7	74.2	71.7	77.5 - 78.9	75.4 - 76.9
	T_x/T_{20}					65.0	65.0	66.9	66.2	69.0	67.6	70.7	68.6	72.8 - 73.8	70.2 - 70.9
1991	RLE_x							65.0	65.0	67.6	66.9	69.8	68.2	72.2 - 73.3	70.2 - 71.0
	m_x							65.0	65.0	68.7	67.8	71.7	69.9	75.5 - 77.1	73.8 - 75.4
	T_x/T_{20}							65.0	65.0	67.1	66.4	68.7	67.4	70.8 - 71.7	68.9 - 69.6
2001	RLE_x									65.0	65.0	67.2	66.4	69.8 - 70.9	68.4- 69.3
	m_x									65.0	65.0	67.9	67.4	72.1- 74.2	71.2- 73.2
	T_x/T_{20}									65.0	65.0	66.6	66.0	68.6- 69.5	67.5 - 68.2

Note: (a) This gives the range between the slowing scenario and the trend projection scenario (see Section 7.3.3).

10.2 INCREASING LIFE WITHIN THE AGED YEARS AND PERSISTENT INEQUALITY IN THE LENGTH OF LIFE

As mentioned, in the early 20th Century males and females in Australia had a life expectancy at birth of around 55 years and 59 years respectively. By 1961 life expectancy at birth had increased to 68 years for males and 74 years for females and then continued to rise to 79 years for males and 84 years for females in 2011. There are inequalities in the length of life, and these inequalities have a spatial dimension (AIHW 2007b)

In the above section I examined how these demographic conditions could have affected the threshold of the aged if a dynamic approach was in place to shift the threshold of the aged as demographic conditions changed. One reason dynamic approaches appeal is that they ensure policy and demographic conditions remain aligned. However, some caution is required. If demographic conditions are changing within the aged years or if there is a high degree of variation in demographic conditions simply focusing on the threshold of the aged may not result in a successful policy response to population ageing. For example, an increase in eligibility age for the Age Pension may reduce fiscal pressures on government in the short-term, but the overall years spent on the Age Pension per person could continue to increase if survival through the aged years is increasing. Similarly, if inequality is present in the population (in length or life or even the capacity to maintain a connection to the labour market) then those short-term savings on the Age Pensions may be eroded by expenditure on the individuals whose lives are poorly represented by the population average.

In the following sections I undertake an analysis of the life span in Australia as part of the multidimensional approach to examining the aged and population ageing in Australia. This is essential for supporting policy development that accurately reflects contemporary trends in ageing. I use two types of analysis: firstly, a decomposition of the length of life to quantify at what ages the additional years of life are lived and; secondly, a measure of the average years of life lost to death to examine inequality in the length of life. The insights gained from this type of analysis can support technical responses to a growing aged cohort, but also act as a genesis of an adaptive response to population ageing involving more fundamental change to policy settings and the life course.

10.2.1 Life span change

In Australia, like other developed countries, death is increasingly becoming concentrated within the aged years (Cheung et al 2005; Wilmoth 2000). Using a decomposition analysis, it is possible to quantify the specific ages where the additional years of life are gained (or lost) as a result of changing mortality conditions. A decomposition analysis compares two life tables to estimate the contribution of mortality reductions by age to the total life expectancy gain (Preston, Heuveline and Guillot 2001). A mortality reduction between ages x and $x + n$ contributes to increased life expectancy in two ways: directly, through increasing the person-years lived between x and $x + n$; and indirectly through increasing the person-years lived at subsequent ages (Arriaga 1984; Nusselder and Looman 2004). In other words, additional average years lived within the aged years can be the result of improving mortality conditions within the aged years or in the pre-aged years.

Different methods are available to decompose mortality change, although the results do not vary significantly depending on the method used (Ponnapalli 2005). I use the method developed by Arriaga (1984). It is suitable for the discrete data available for Australia, widely accepted by demographic researchers and can also be used to decompose the Sullivan life tables developed in the next section (see European Health Expectancy Monitoring Unit 2010). In addition to the direct and indirect effect, the Arriaga (1984) method decomposes life expectancy gains into an interaction effect identifying the change in years lived as a result of mortality changes after age $x + n$. In this analysis, I report the interaction and indirect effect as a single unit. The decomposition can be performed with life table quantities (see Table 7) as follows (Arriaga cited in Preston, Heuveline and Guillot (2001)):

Closed-age interval:

$$n\Delta_x = \frac{l_x^1}{l_0^1} \cdot \left(\frac{{}_nL_x^2}{l_x^2} - \frac{{}_nL_x^1}{l_x^1} \right) + \frac{T_{x+n}^2}{l_0^1} \cdot \left(\frac{l_x^1}{l_x^2} - \frac{l_{x+n}^1}{l_{x+n}^2} \right)$$

Open-age interval:

$$\infty\Delta_x = \frac{l_x^1}{l_0^1} \cdot \left(\frac{T_x^2}{l_x^2} - \frac{T_x^1}{l_x^1} \right)$$

The decomposition analysis performed is single sex.[82] The time periods examined are 1905 to 1961, 1961 to 2011, 1961 to 1981, 1981 to 2001 and 2001 to 2011. All decompositions are calculated using the national level population using the life tables

[82] A complementary analysis which could be included in future studies would be compare male and female life spans.

calculated for this study (see Section 7.3.2). To simplify the results, I use five broad age groups consistent with life stages used in this study, 0 to 19 representing the youth, 20 to 44 and 45 to 64 representing the working-aged years, 65 to 84 representing the early-aged years and 85 and over representing the late-aged years.

An initial insight from the decomposition of analysis, consistent with existing research for Australia, is the significant change over time in the age groups contributing to life expectancy gains (AIHW 2006; Booth and Tickle 2004). For selected life table pairings, the per cent contribution of each age group to the total life expectancy gain is shown in Figure 50. Over the 20th Century, the age groups contributing the most to life expectancy gains shifted from youth to older ages. Over the period 1901 to 1961, a reduction in mortality between birth and age 10 contributed more than 50 per cent of the life expectancy gains for males and 42.2 per cent for females. Between 2001 and 2011, changes in mortality in this age group contributed 4.2 per cent of the gains for males and 7.8 per cent of the gains for females. In contrast, mortality changes at ages older than age 65 contributed 5.3 per cent and 12.5 per cent of life expectancy gain for males and females respectively over the period 1901 to 1961 and 61.8 per cent and 65.8 per cent of life expectancy gain for males and females respectively over the period 2001 and 2011.

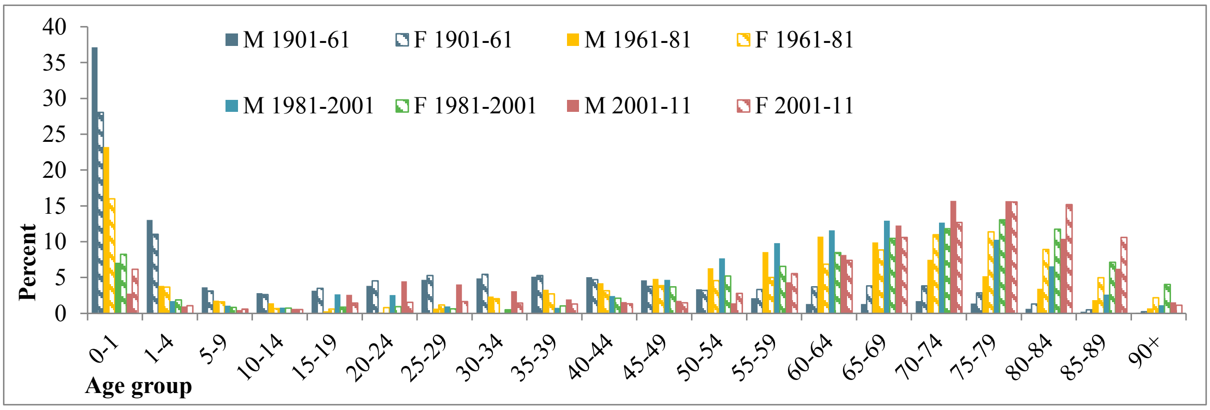


Figure 50 Contributions to life expectancy gain over the period by sex: Australia, selected years from 1901 to 2011

The life expectancy gains disaggregated by direct and indirect effects, again for selected life table pairings, are shown in Table 14. The pattern is consistent with the analysis of the per cent contribution of each age group to life expectancy gains. For the earliest time period, 1905 to 1961, the majority of the additional years of life lived were in the pre-aged years. However, since 1961 the majority of the additional years gained have been years lived over the age of 65, and particularly in the early-aged years between age 65 and 84.

The relationship between direct and indirect contributions of mortality change to life expectancy gains by age changes from 1901 to 2011. In the context of falling mortality across the life span, as occurred in Australia over this period, years gained through indirect effects favour older ages because of the accumulation of life expectancy gains as a result of falling mortality in the pre-aged years. As expected, over the period 1901 to 1961, the majority of the additional years lived after the age of 65 were the result of mortality improvements in the pre-aged years. This shift from 1961 and more of the gains in the aged years are attributable to direct effects of mortality change within the aged years. For females in their early-aged years, direct effects exceed the indirect effects between 1961 and 2011. For males in their early-aged years, the direct effects exceed the indirect effect in the early-aged years since 1981. However, gains in the late-aged years are still more likely to be the result of indirect effects relative to direct effects.

Overall, the decomposition analysis shows that additional years of life are lived within the early-aged years. The results show, relative to 1961, a male surviving to age 65 in 2011 could expect an additional 6.2 years of life between the ages 65 and 84. A female surviving to age 65 in 2011 could expect an additional 4.7 years of life between the ages 65 to 84 years. The changes over the age of 85 were smaller, but still significant: on average 2.1 years for males and 3.0 years for females.

Stepping back to consider the life course implications, this decomposition analysis supports the idea that the lengthening life span is having the most significant impact during the early-aged years. Consistent with Laslett's (1989) theory of the third-age, the demographic evidence supports the potential for a new life stage to be established during these additional years of life (see Section 3.1.4 for an introduction to this theory). There are complicating factors. While it is true that majority of the gains in additional life are in the early-aged years (defined here using the retrospectively chronological measure of age 65 to 84), it is also true that sizeable gains have also occurred in the late-age years (85 and over) and during working life.

As a final comment, this analysis confirms that current demographic conditions warrant a policy response to population ageing extending beyond shifting the threshold age of the aged from 65 to older ages. I have already argued in Chapter 4 that responding to ageing is an adaptive challenge with the policy response increasingly differentiating between the early-aged and late-aged years. Given the changing demographic conditions within the aged years, such an approach would give policy makers better leverage to keep policy settings aligned to demographic conditions through the aged years.

Table 13 Partial life span and life course expectancies by sex: Australia, selected years from 1901 to 2011

Partial life expectancies by sex: Australia, selected years from 1901 to 2011

	1905		1961		2011	
Age Group	M	F	M	F	M	F
0-19	17.4	17.7	19.4	19.5	19.9	19.9
20-44	23.5	23.6	24.5	24.7	24.7	24.9
45-59	13.5	14.0	14.1	14.5	14.7	14.8
60-64	4.7	4.7	4.7	4.8	4.9	4.9
65-70	4.5	4.6	4.5	4.7	4.8	4.9
70-74	4.2	4.4	4.3	4.6	4.8	4.8
75-79	3.8	4.0	4.0	4.3	4.6	4.7
80-84	3.4	3.7	3.6	3.9	4.3	4.5
85-89	2.9	3.2	3.1	3.4	3.8	4.1
90-94	2.4	2.6	2.6	2.8	3.2	3.5
95 and over	1.9	2.1	2.3	2.6	3.1	3.4

Partial working-life expectancies at older ages by sex: Australia, 2006 and 2011.[a]

	2006				2011			
	Work		Not working		Work		Not working	
Age Group	M	F	M	F	M	F	M	F
50-54	4.3	3.7	0.66	1.3	4.3	3.8	0.65	1.1
55-59	3.8	2.9	1.2	2.1	3.9	3.2	1.0	1.7
60-64	2.8	1.7	2.1	3.3	3.0	2.1	1.9	2.8
65-69	1.3	0.63	3.6	4.3	1.6	0.90	3.3	4.0
70-74	0.6	0.3	4.2	4.6	0.71	0.34	4.0	4.5
75-79	0.30	0.11	4.3	4.6	0.34	0.14	4.3	4.6
80+	0.31	0.12	8.0	9.9	0.27	0.10	8.3	10.4

Partial disability-free life expectancies at older ages by sex: Australia, selected years from 1901 to 2011.

	2006				2011			
	Disabled		Not Disabled		Disabled		Not Disabled	
Age Group	M	F	M	F	M	F	M	F
50-54	0.16	0.16	4.8	4.8	0.18	0.19	4.8	4.8
55-59	0.23	0.20	4.7	4.7	0.24	0.24	4.7	4.7
60-64	0.32	0.24	4.6	4.7	0.30	0.35	4.6	4.6
65-69	0.32	0.30	4.5	4.6	0.41	0.35	4.4	4.6
70-74	0.42	0.48	4.3	4.4	0.50	0.54	4.3	4.3
75-79	0.62	0.79	3.9	3.9	0.7	0.89	3.9	3.9
80-84	0.99	1.3	3.2	3.2	1.0	1.4	3.1	3.2
85-89	1.3	1.8	2.2	2.5	1.5	2.0	2.3	2.1
90-95	1.5	2.1	1.6	1.3	1.8	2.4	1.4	1.1
95+	1.8	2.8	1.3	0.95	2.2	2.8	0.92	0.55

[(a)] This model uses the labour force participation model (see Section 7.2.2.1).

Table 14 Life expectancy gained within each age group as a result of direct and indirect mortality change by sex: Australia, 1901 to 2011

	Males							Females						
	Total years gained		Age groups					Total years gained		Age groups				
			0-19	20-44	45-64	65-84	85+			0-19	20-44	45-64	65-84	85+
1905-1961	12.7	D	2.0	0.83	0.67	0.44	0.03	15.3	D	1.8	1.0	0.75	1.18	0.06
		I	0	2.9	3.4	2.3	0.24		I	0	2.7	3.6	3.5	0.69
1961-2011	12.0	D	0.46	0.28	1.1	3.0	0.23	10.1	D	0.37	0.15	0.60	2.6	0.59
		I	0	0.72	1.1	3.2	1.9		I	0	0.53	0.74	2.0	2.43
1961-1981	3.3	D	0.27	0.07	0.36	0.66	0.07	4.1	D	0.22	0.08	0.26	1.1	0.24
		I	0	0.35	0.44	0.85	0.25		I	0	0.30	0.41	0.82	0.69
1981-2001	6.2	D	0.16	0.11	0.67	1.8	0.15	4.3	D	0.16	0.04	0.28	1.2	0.40
		I	0	0.29	0.41	1.6	0.95		I	0	0.17	0.23	0.84	1.0
2001-2011	2.5	D	0.03	0.11	0.09	0.87	0.17	1.7	D	0.03	0.03	0.06	0.50	0.18
		I	0	0.07	0.19	0.41	0.55		I	0	0.05	0.09	0.25	0.48

Source: Author's calculations using ABS 2014c.
Notes:
Where D is the direct effect and I is the indirect effect and interaction effect (see Section 9.2).
Discrepancy between the age groups and the total years gained are due to rounding errors.
The life expectancy gain in the table is the average gain for individuals who survive to age *x*, where *x* is the age at the beginning of the age interval.

10.2.2 Life span inequality[83]

Variation in the length of life, particularly when it is systematically associated with differences in individual, social or economic characteristics, signals the presence of inequality. Not only is reducing inequality a standalone objective, it is also likely to increase life expectancy. Vaupel, Zhang and van Raalte (2011) have shown that countries with lower life inequality tend to have higher life expectancy.

As part of setting the scene for this study, in Section 2.2.2, I highlighted that there has been a reduction in life span variation from 1901 to 2011. There is inequality still present in Australia. In this subsection, I examine life span inequality using three approaches offering increasingly specific insight into the phenomenon. I start by looking at partial life expectancies, then I use a measure of life span disparity quantifying the average years of life lost to death and, finally, I pinpoint the age separating early-aged and late-age deaths based on the age above which any death averted increases life span disparity.

Recall from Section 7.3.1 that partial life expectancy is the years expected to live within an age group by a randomly selected person in the age group. This is a not a traditional approach to examining inequality but I include it to illustrate a significant point. The partial life expectancies for selected age groups are shown in Table 13 for selected years. Clearly there is inequality with not everyone surviving through the age interval. However, survival through each five-year age group has improved and is reasonably high well into the 90s. Individuals, at least, should plan for a long life. Policy makers, on the other hand, need to ensure policy settings are appropriate for the inequality present in each age group as well as supporting its reduction over time.

In Section 2.2.2 I referred to a measure on inequality which is the interquartile range of deaths in the life table. Here I use a more sophisticated measure of inequality called lifespan disparity to measure “the average remaining life expectancy at death, or alternatively the average years of life lost in a population due to death” (van Raalte and Caswell 2013, 4). This is a life table based index denoted by the symbol ($e^{\dagger}$) and formula is given by (van Raalte and Zarulli 2013):

[83] This calculation was performed using R-code provided by the Max Planck Institute for Demographic Research.

$$e^{\dagger} = \frac{1}{l_x}\sum_{x=0}^{\omega} d_x \bar{e}_x$$

Where ω is the maximum life span and $\bar{e}_x = a_x(e_x + e_{x+1})$. The quantities a_x and d_x are the standard life table quantities (see Table 7). It is possible to extend life span disparity analysis to include confidence intervals and a decomposition analysis. This would be a worthwhile addition to this analysis in the future.

A life span disparity analysis was performed on all the national life tables included in this study. I tested the analysis on the substate life tables but ultimately decided not to report the results given the degree of indirect estimation required to produce the substate life tables. I do, however, calculate this life span disparity measure for projected life tables for 2021 and 2031 using the trend and slowing scenarios (see Section 7.3.3). In discussing the results, I focus on the life tables: 1901-10, 1960-62, 1970-72, 1980-82, 1990-92, 2000-02, 2010-12 and life span disparity at birth, age 65 and age 85. Life span disparity is calculated separately for males and females.

At birth, the results of the life span disparity analysis ($e^{\dagger}$) show falling life span disparity between 1901 and 2011. During the life of the population alive today, mortality conditions have improved such that the average years of life lost in the population due to death (from all causes) at birth fell from close to 20 years to near to 10 years for males and females (see Table 15 for the precise results). This is a significant achievement, signalling success in reducing life span inequality in the population.

However, the results for older ages (conditional on surviving to older ages) show a different pattern. In their cross-country analysis, Engelman, Canudus-Romo and Agree (2010) found different patterns of change over time in life span disparity ($e^{\dagger}$) by age, including an increase in life span disparity at older ages. This study confirms this finding. In contrast with life span disparity at birth, life span disparities at age 65 and age 85 have increased. Several mortality patterns could produce this result, including persistent mortality in the early-aged years coupled with lengthening life spans for at least some in the population. That life span disparity has increased more at age 85 than age 65 supports the explanation that long lives for some individuals is contributing to this trend.

There is some complexity in the results with temporal variation observed within the overall trend. Life span disparity at birth has fallen for all time periods. Life span disparity at age 65 increased until 1991 and has then fallen for females and fallen, or at least stabilised, for males. These are small changes and should be interpreted cautiously. At age 85, life span disparity appears to increase for males throughout the period and for females there has been some stabilisation in life span disparity since 1991.

Turning now to the future scenarios of life span disparity for the trend and slowing mortality scenarios. Under both scenarios, life span disparity at birth continues to fall and falls more rapidly for the trend mortality scenario (in other words, life span disparity at birth reduces more when life expectancy gains are more rapid). For males at age 65 there is a small reduction in life span disparity to 2031 (by 0.2 years under the slowing scenario and 0.4 years under the trend scenario). For females at age 65 the reduction in life span disparity is marginally larger than for males (0.3 years under the slowing scenario and 0.5 years under the trend scenario). This means the differential between male and female life span disparity at age 65, which was close to zero from 1981 to 2001, may increase in the future. For males and females at age 85, life span disparity increases under both scenarios to 2021 (to 4.4 years for males and 4.5 years for females) and remains relatively stable at that level to 2031.

Table 15 Average years of life lost for death ($e^{\dagger}$) by sex and selected ages: Australia, selected years from 1901 to 2011

	At birth		At age 65		At age 85	
	Males	Females	Males	Females	Males	Females
1905	19.9	19.5	6.5	6.9	3.0	3.3
1961	13.1	11.8	6.9	7.1	3.3	3.7
1971	12.8	11.7	6.9	7.2	3.4	3.8
1981	12.2	10.9	7.3	7.4	3.7	4.1
1991	11.7	10.5	7.5	7.6	4.0	4.4
2001	11.0	9.8	7.4	7.4	4.1	4.4
2011	10.5	9.2	7.3	7.0	4.2	4.3
Change 2011-1961	-2.6	-2.6	0.37	0.05	0.84	0.67
Change 2011-1905	-9.3	-10.3	0.79	0.12	1.2	1.1

Source: Author's calculations using ABS 2014c.

A complementary analysis to the life span disparity analysis above is to calculate the age differentiating early and late deaths. In this study, this is the age above which any death averted increases life span disparity and below which any death averted decreases life span disparity. The life span disparity analysis gives policy makers a way to track life span disparity within the population and thus target interventions to decrease inequity. The threshold age separating early and late deaths analysis is based on the work of Zhang and Vaupel (2009) who prove that when life table entropy is greater than one (such that $\frac{e^{\dagger}}{e(0)} < 1$, as is the case for the Australian life tables in this analysis) there is a threshold age ($a^{\dagger}$) which distinguishes between early and late deaths. Currently, this is not a widely used analysis, but for another applied example, interested readers should see Rabbi (2012). I calculate this threshold at the national level, again for males and females separately, using the life tables 1901-10, 1960-61, 1970-72, 1980-82, 1990-92, 2000-02 and 2010-12.

As expected, the threshold age for premature death ($a^{\dagger}$) increases for both males and females between 1905 and 2011. By 2011 it reached 78.7 years for males and 83.3 years for females. This is close to life expectancy of 79.9 years for males and 84.3 years for females, and represents a convergence of this threshold age for premature death and life expectancy.

This threshold age for premature death should be interpreted as an input to assist in understanding how changing mortality conditions affect life span disparity. Also it would add value, in particular, to an analysis of the causes of death within the population and as part of the tools to evaluate public health interventions by assisting policy makers to be more accurate and strategic in their development of health services. Public health interventions at ages below the threshold age for premature death may have the additional benefit of reducing life span disparity as well as increasing life expectancy. The magnitude of mortality improvements over the 20^{st} Century are unprecedented in history and may not be as easily achieved in the future, particularly in developed countries. Additionally, with pressures on public financing in the health care sector, it will be increasingly important to direct health expenditure to give maximum benefit.

Table 16 Threshold age for premature death (a[†]): Australia, selected years from 1901 to 2011

	1901	1961	1971	1981	1991	2001	2011
Males	59.0	66.2	65.9	69.0	72.1	75.8	78.7
Females	62.0	73.3	73.4	76.9	78.6	81.2	83.3

Source: Author's calculations using ABS 2014c.

10.3 LIFE COURSE MARKERS OF AGEING

There remaining analysis in this multidimensional approach is the life course markers of ageing. As the length of life has increased so too has interest in how these additional years of life are lived. Are these healthy and active working years of life? How does disability and work expectations change within the aged years? I focus in this section on working-life expectancies and disability-free life expectancy using Sullivan (1971) method, widely used by governments and researchers since it was first published. With the exception of the dependency ratios in Section 8.1, the other analysis in this study focuses on the aged. This final analysis situates the aged within the life course. The characteristics of the aged will to some extent be influenced by the lives lived in the pre-aged years. Similarly, policy directions to distribute the benefits of increased life span across the life course will require insights into the complete life course conditions.

The Sullivan (1971) method has the advantage of being able to both examine the complete life course and to isolate age specific insights (in this case focusing on the aged years). It is a method requiring a life table and a prevalence estimate measuring the proportion of a population with a specific characteristic (which in this analysis is either a work or a disability characteristic). Recall from Section 7.3.1 that the life table includes the person-years lived within each age group (L_x). The Sullivan method uses prevalence to decompose person-years (L_x) where the characteristic is present and absent (i.e. persons-years lived with disability and person-years lived without disability). When these person-years are accumulated and divided by survivors (l_x) the result is remaining years expected to be lived with the characteristic present. The formula is given by:

$$e_x\ (j) = \frac{T_x(j)}{l_x}$$

Where $e_x\ (j)$ is life expectancy in state (j) and $T_x(j)$ is the total person-years lived in state (j) and l_x is the survivors to age x (Eurostat 2012). A key strength of the Sullivan method is the results are independent of the size and age structure of the population and thus is a good analysis to evaluate changes over time and between regions.

The Sullivan life table can be decomposed to examine the contribution of mortality change (the mortality effect) relative to changes in the prevalence of the state (*j*) expectancy with (or without) that characteristic. The decomposition method in this study uses the Arriaga method introduced above with the amendments developed by the European Healthy Expectancy Monitoring Unit (2010) to decompose both the life span and life course changes simultaneously (see also Nusselder and Looman 2004 for additional explanation).

Some caution should be exercised when using the Sullivan method. The Sullivan method does not capture transitions either from a disability-free to disabled, or from work to retirement. In reality, these can be complex pathways characterised by partial and two-way transitions. The results are averages, based on synthetic period measures and will only reflect future conditions if the mortality and prevalence conditions are stable over time. In-principle, when used in substate analysis, it is also possible for internal migration to change the results where there is spatial variation in either mortality or the prevalence indicator. This stability assumption is more problematic if the underlying mortality and prevalence conditions are changing rapidly or vulnerable to short-term conditions (such as an economic shock affecting work prevalence at the time of data collection). To understand trends, therefore, these calculations should be performed at frequent intervals (Nurminen 2014), and with a decomposition to analyse the contribution of changing mortality or prevalence to the estimates.

Alternative methods to examine the life course markers of ageing were considered for this study, including using multi-state modelling. Such approaches are more effective in capturing the complexity of the individual experience, particularly when transitions to disability (or out of the labour market) are not linear (Fong, Shao and Sherris 2013; Nurmimen 2014, Willekens 2014). However, the data requirements to develop these models are significant and typically derived from longitudinal surveys which are not used in this study (see Chapter 6).

In the following subsections, I outline key findings from the working-life expectancy and disability-free expectancy analyses using the Sullivan (1971) method. While these are distinct analyses, in several ways the approaches are similar. In both analyses the prevalence estimates are matched with the life table for the relevant year (for example, the 2011 prevalence estimates use the 2010-2012 life table) and future scenarios are developed.

10.3.1 Working-life expectancy

As the average life span increases, the proportion of life spent in the labour market is of interest. The working-age years are the time of life to accumulate assets for retirement. If the time spent in work falls relative to retirement then the individuals need to accumulate more during their working-life or risk relying on Government income safety-net through their aged years. Working-life expectancies give insights into the average length of labour market connection based on current conditions, the current working years of the population, the average length of the labour market connection within the population. This is an important analysis given the current demographic conditions in Australia yet it is not regularly calculated.

Working-life expectancy measures the expectation of years lived in the labour market. In this section I present the results of the two models of working-life expectancy, labour force participation and full-time equivalent hours for Australia. The labour participation model focuses on the length of labour market connection and the full-time equivalent model focuses on the depth of labour market connection by measuring the expectations of full-time equivalent working hours. Temporal variation is examined at the national level for the period 2006 and 2011 and for the forward projection scenarios of 2021 and 2031.

There are several advocates for studying working-life. The Employment Committee of the European Union concluded that "working life expectancy will replace the average age of withdrawal from the labour force indicator" (Nurminen 2014, 3). Further, Hytti and Nio 2004, 4) advocated using the Sullivan prevalence-based method to develop a life cycle perspective on labour force participation. However, defining the concept of working life is complex and a range of approaches can be used.

In this analysis, I use two indicators of working life: a measure of labour participation to indicate the length of labour market attachment (including period of work and unemployment) and a measure of full-time equivalent work years to indicate the accumulation potential across the life course. The calculation of these prevalence variables, referred to as the labour participation and full-time equivalent work prevalence variables respectively, were set out in Section 7.2.2.1. Both prevalence variables are calculated at the national level in 2011 and, in addition, the labour participation prevalence variable is calculated for 2006 and, using forward looking scenarios, for 2021 and 2031. For the forward-looking analysis, there are three labour market scenarios of constant labour market prevalence, trend extrapolation and reduced rate of exit. I calculate complete Sullivan life tables and partial working-life expectancies for the labour participation model for the ages 50 to 79 using five-year age with an open-age interval from age 80. I experimented with the calculation of working-life expectancies at the substate level but labour market indicators can be unstable at small area based on short-term conditions and I did not consider the results produced were sufficiently reliable for inclusion in the results from this analysis.

The estimate of work prevalence by age and sex used to calculate working-life expectancy based on labour force participation model is shown in Figure 5 (of Chapter 2). Labour participation is higher for males compared with females. For males, labour participation increases rapidly from age 15 to a peak in the mid-30s. The pace of the subsequent decline is slow initially and then increases, peaking between ages 60 and 65. For females, their labour participation also increases rapidly after the age of 15 but begins to differentiate from male labour participation around the age of 20. For females, there are two peaks in labour participation occurring in the mid-20s and late 40s. The peak pace of decline for female labour participation occurs around the age of 60. Labour participation is very similar in 2011 and 2006; there is, however, an observable increase in work prevalence at older ages in 2011 compared with 2006 for both males and females.

The results for working-life expectancies are shown in Figure 51. Based on the labour participation model, at age 15, in 2011, males had a remaining expectation of work of 41.7 years and females had a remaining working-life expectancy of 35.6 years. Compared with 2006, this is an increase of 0.57 years for males and 1.4 years for females. Over the same period mortality conditions improved, with life expectancy increasing by 0.81 years for males and 0.47 for years for females. This means, in 2011 at age 15, males and females could expect to participate in the labour force for 63.8 per cent and 51.1 per cent respectively of their expected remaining life. While this is an increase relative to 2006, for males the result is small and should be re-examined following the 2016 Census before being confirmed. For females, the trend is clearer, increasing from 49.4 per cent of life to 51.1 per cent over the period 2006 to 2011.

While I do not examine working-life expectancies prior to 2006, Ruzicka (1986) provides some insights into what they were. Using a similar approach of decomposing the life table (but with less disaggregated data than what is available in this study), Ruzicka (1986) found working-life expectancies to be relatively stable compare to life expectancy for the period 1947 to 1981. His results show for a boy aged 15 the active duration of working life was 45.4 years in 1947, 44.3 years in 1966 and 41.2 years in 1981. Even though the two analyses are not directly comparable, both point to stagnant conditions in working life.

Returning to current conditions, also using the labour participation model, at age 60 remaining working-life expectancy for males was 4.9 years in 2006 and 5.6 years in 2011 and for females at the same points in time was 2.7 years and 3.5 years respectively. Gains in work expectancy exceeded gains in life expectancy of 0.66 years for males and 0.44 years for females at age 60 between 2006 and 2011. As a result, the proportion of life spent in work at age 60 also increased—by 2.3 per cent for males and 2.8 per cent for females. This shows work expectancy rising with the additional working years gained typically in the early-aged years.

As shown in Table 13, using the partial working-life expectancy approach it is clear that work expectancies falls significantly from age 50. In 2011, the expectation of work in the five-years after surviving to age 65 is 1.4 years for males and less than one year for females (0.90 years). Using economic and social analysis, an increase in labour force participation among the aged is expected (McDonald 2012). These results support this prediction, showing an increase in partial working-life expectancies between 2006 and 2011. While female working-life expectancy is lower than male working-life expectancy at all ages, the gain for females exceed the gain for males in the near-aged years. The gap between males and females is largest between the ages of 60 to 64 indicating a potential age group of focus in the response to population ageing.

While the labour participation model described above is a reasonable proxy for the length of labour market attachment, the full-time equivalent model is a better proxy of the depth of the labour market connection. It is these results which show even more clearly the inequality between males and females with regards to formal working lives. At age 15 in 2011 males had a full-time working-life expectancy at age 15 of 35.7 years and for females it was 26.3 years. Expressed as a proportion of remaining life expectancy, work free life is 62.2 per cent for females and 45.3 for males at age 15.[84] In these results, females have lower working-life expectancies for several reasons—they live longer, have lower workforce participation and a higher prevalence of part-time employment.

[84] Note that age 15 is used at the beginning of the working life expectancies to be consistent with the collection of labour force participation data in the Census (ABS 2011d).

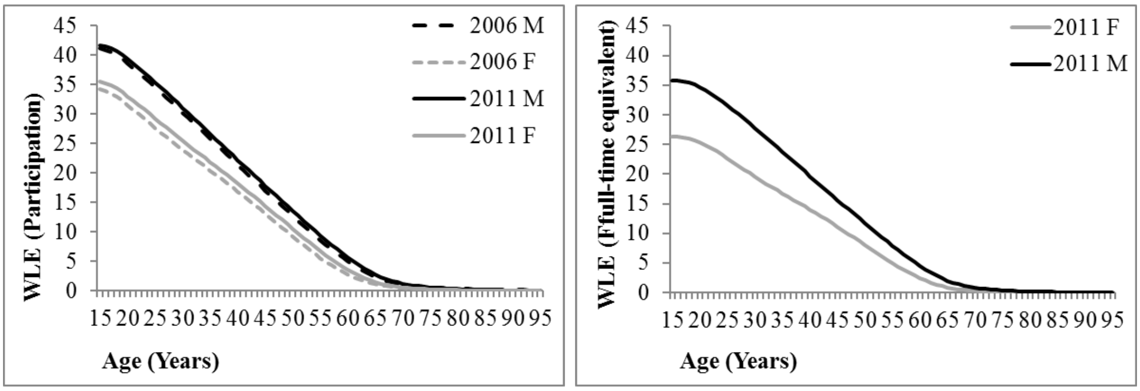


Figure 51 Working-life expectancies by sex: Australia, 2006 and 2011

(a) WLE Participation **(b) WLE full-time equivalent**

These findings can inform retirement income policy settings. Put simplistically males have only 35.7 years full-time in the labour market to generate sufficient income for retirement. At the current average age of retirement of 63 for females and 65 for males this would be to support 19.2 years for males and 23.8 years for females. Retirement income planners should also keep in mind that with mortality conditions improving within the aged years the risks are weighted to the downside with the potential for fewer years in work to support the life lived outside the labour force.

However, there are some positive trends. Particularly evident among females between 2006 and 2011 is the increase of 1.4 years in working-life expectancy at age 15 (based on the labour force participation model). This increase may be associated with broader social changes. Significantly, over this period, the age of eligibility for the Age Pension increased for females but not for males (Productivity Commission 2015). Alternatively, the lengthening working-life could be associated with a range of socio-demographic factors including a need for females affected by family breakdown to accumulate additional assets for retirement, increasing levels of education for females supporting labour force participation and changing age of caring responsibilities associated with later child birth affecting the age associated with the grand parenting years or a reduction in mortality in the older ages affecting the age of caring for elderly parents. As women's retirement decisions are strongly influenced by the labour market attachment of their partner (Productivity Commission 2015), increased age homogamy between partners would mean females exit the labour market closer to the age of male exit from the labour market—although this is not easily assessable with publicly available data. Testing these hypotheses could be the subject of future research.

Turning now to the future scenarios of working-life expectancy, what happens if labour participation is constant, the trend continues or if there is a reduced rate of exit by age from the labour force and mortality conditions improve with trend or the slowing scenario (see sections 7.2.2.1 and 7.3.3 for details). All models of future working-life expectancy show improvements. For the trend extrapolation scenario (with constant mortality), a further 3.1 years of working life are gained for males and a further 5.2 years of working life are gained for females to 2031. For the reduced rate of exit scenario, a further 4.2 years are gained for males and a further 4.9 years for females to 2031. These gains are due entirely to labour participation increases. Given mortality does not improve in these scenarios, the proportion of life spent in the labour market increases.

If mortality changes, but labour participation remains constant, there would still be an increase in working-life expectancy. Under the slowing scenario, the increase to 2031 for males would be just over half a year and for females around 0.2 years. Under the trend scenario, the increase for males would be 0.8 years and for females would be 0.3 years to 2031. These gains, however, would not offset increases in life expectancy and therefore the proportion of life lived outside of the labour force would increase. This is a key point informing the policy response to population ageing; if the proportion of life spent in the workforce is to stay constant, labour force participation would need to increase to offset gains in life expectancy. In the absence of increases in labour force participation across the life span, individuals and/or governments will be under increased pressure to fund retirement incomes with fewer years in the labour market (relative to life).

When mortality and labour participation are both changing, as current conditions suggest, there is heightened uncertainty about how working-life expectancy will evolve. For the trend extrapolation and trend mortality scenario, both the years with and without work increase for males and females and the proportion of life not in work falls. This pattern is true also for the reduced rate of exit scenarios and slowing mortality scenarios. Compared with the mortality effect, the labour participation effect is more significant. Using decomposition analysis, it is possible to identify the ages where the additional years are worked and to disaggregate these between the mortality effect and labour participation effect. This analysis shows that while changes are occurring at all ages, as expected, much of the change is occurring from the middle-aged years onwards and is particularly concentrated in the early-aged years.

Overall, this analysis shows that while male and female life expectancy is converging, for working-life expectancy females are closing the gap with males. While it is too early to be definitive about the future trajectories, recent history has demonstrated that working-life expectancies can change significantly in the short-term. Additionally, while working-life expectancies are enhanced by falling mortality, most of the change is likely to be associated with increased labour force participation given that mortality change is increasingly concentrated in the years not traditionally associated with work. While this is a positive indication of the potential for working-life expectancies to change, labour market conditions will also be a key component supporting increased labour force participation in the future.

Finally, are there any insights from these working-life expectancies for the threshold of the aged? I suggest that there are. Transitions from working life to non-working life is a marker of entry into the aged years (Ayalon et al 2014). The results of this analysis of working-life expectancies point to a threshold of the aged around age 60 to 65 if we assume withdrawal from the labour market marks the entry into the aged years. However, in the real world, transitions into retirement are not always easy to demarcate as these working-life expectancies would imply. Perhaps more importantly then, this analysis can inform policy directions in the area of a comprehensive approach to longevity risk (see Chapter 4). It supports a focus on continuous improvement in labour force participation encompassing both the length and depth of the labour market connection.

10.3.2 Disability-free life expectancy

The increase in the average life span has also generated interest in the quality of extra years lived. So too has interest in the need for care across the life course, the length of period in care and the age at which care needs emerge. In addition, in Australia, there is interest in healthy life expectancy given a commitment of the Prime Minister's Science, Engineering, and Innovations Council (2003) to achieve an additional ten years of healthy and productive life expectancy by 2050.

While there are many methods to define life expectancy, in this analysis the focus is on disability-free life expectancy using a measure of core activity limitation.[85] In other words, disability in this analysis is not simply the presence of disability but disability so severe it causes daily limitations. I chose disability-free life expectancy because it is the best descriptor of the data available from the Australian Census. This is not a measure of dependency within the population. Disability, health and dependence are distinct

[85] There are many related calculations to disability-free life expectancy, including healthy life expectancy and frailty-free life expectancy. The name of the metric should be informed by the data available.

concepts. Disability can occur without dependence but dependence cannot occur without disability. Dependence is "the need for frequent human help or care beyond that habitually required by a healthy adult" (Harwood, Sayer and Hirschfeld 2004). Disability and health are also distinct concepts. People with disability can be healthy, just as those in poor health can be fully independent.

In this analysis, I calculate disability-free life expectancy at the national level for 2006 and 2011 and perform a decomposition analysis to understand the nature of the intercensal change. I calculate partial Sullivan life tables five-year age groups from 50 to 94 in addition to the complete Sullivan life tables. Significantly, I extend the existing analysis to calculate disability-free life expectancy at the substate level for more than 300 regions across Australia in 2011 using the Statistical Area 3 regions (see Section 5.2). There is some complexity in calculating the required disability prevalence variables at the substate level and the methods are set in Section 10.3.2. I considered a projection of disability rates, but due to recent instability in the trend estimates, projecting forward from the current base was not advisable.

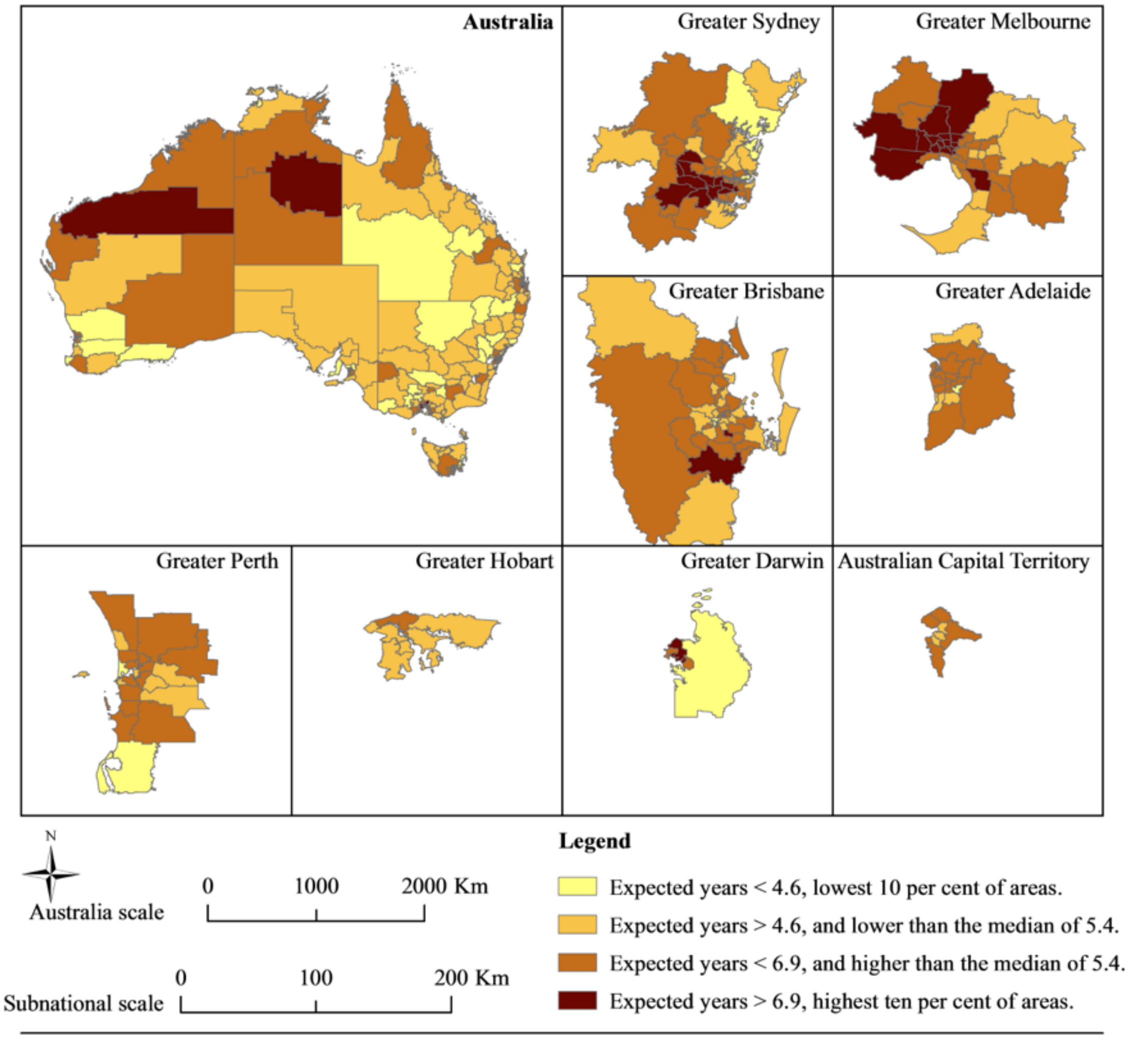
Recalling from Chapter 3, previous research has found conflicting results in relation to change in disability-free life expectancy. There are the pessimists, such as Kramer (1980) who argue that morbidity is increasing because the old and frail are being kept alive; the optimists, such as Fries (1980) and Fries, Bonnie and Chakravarty (2011) who argue that the onset of disability and progress of chronic illness is being delayed; and those, such as Manton, Corder and Stallard (1997), advocating for a dynamic equilibrium where there is more disability but it is less severe. One reason the empirical evidence is unclear may be that all these processes are occurring concurrently (Howse 2006; Jagger et al 2008 for discussion of examples).

Turning now to the results in this study, it is important to keep in mind that not all disability is bad—when it occurs instead of death it can be a sign of improved wellbeing. As I outline the results, the prevalence of disability by age and sex in 2006 and 2011 is shown in Figure 4 (in Chapter 2). The prevalence of disability increases at older ages, with females experiencing higher levels of severe and profound disability compared with males. According to the Census, the prevalence of disability has not changed substantially between 2006 and 2011.

Based on the Sullivan method, the disability-free life expectancy in 2011 was 74.9 years for males and 77.6 years for females. This was an increase of 0.4 years for males and 0.1 years for females compared with 2006. In 2011 93.7 per cent of life is disability-free for males compared with 92.0 per cent for females. These results are consistent with the AIHW (2014a) finding that expected years free of severe or profound core activity limitation of around 93 per cent for males and 91 per cent for females. The 2011 result shows a reduction in the proportion of life lived disability-free for males and females relative to 2006, where 94.3 per cent of life was disability-free for males and 92.6 per cent of life was disability-free life for females. This means there was an expansion of years lived with disability for males and females between 2006 and 2011 in both absolute and relative terms. The decomposition analysis shows differences in mortality are the majority contributor to differences in disability-free life expectancy between males and females. This is true for the 2011 and 2006, but differences in disability prevalence increase in relative importance over time.

The partial disability-life expectancies are shown in Table 13. The expectation of disability-free life is high well into the 70s for people who survive to these ages. In between the ages of 80 and 84, in 2011 males and females could still expect more than 3 years disability-free years of life. As would be expected from Laslett's (1989) theory of the third and fourth age, disability-free life expectancies exceed working-life expectancies. This lends support to Laslett's theory of healthy-aged years after exit from the labour market and before the onset of severe or profound disability (Laslett 1989).

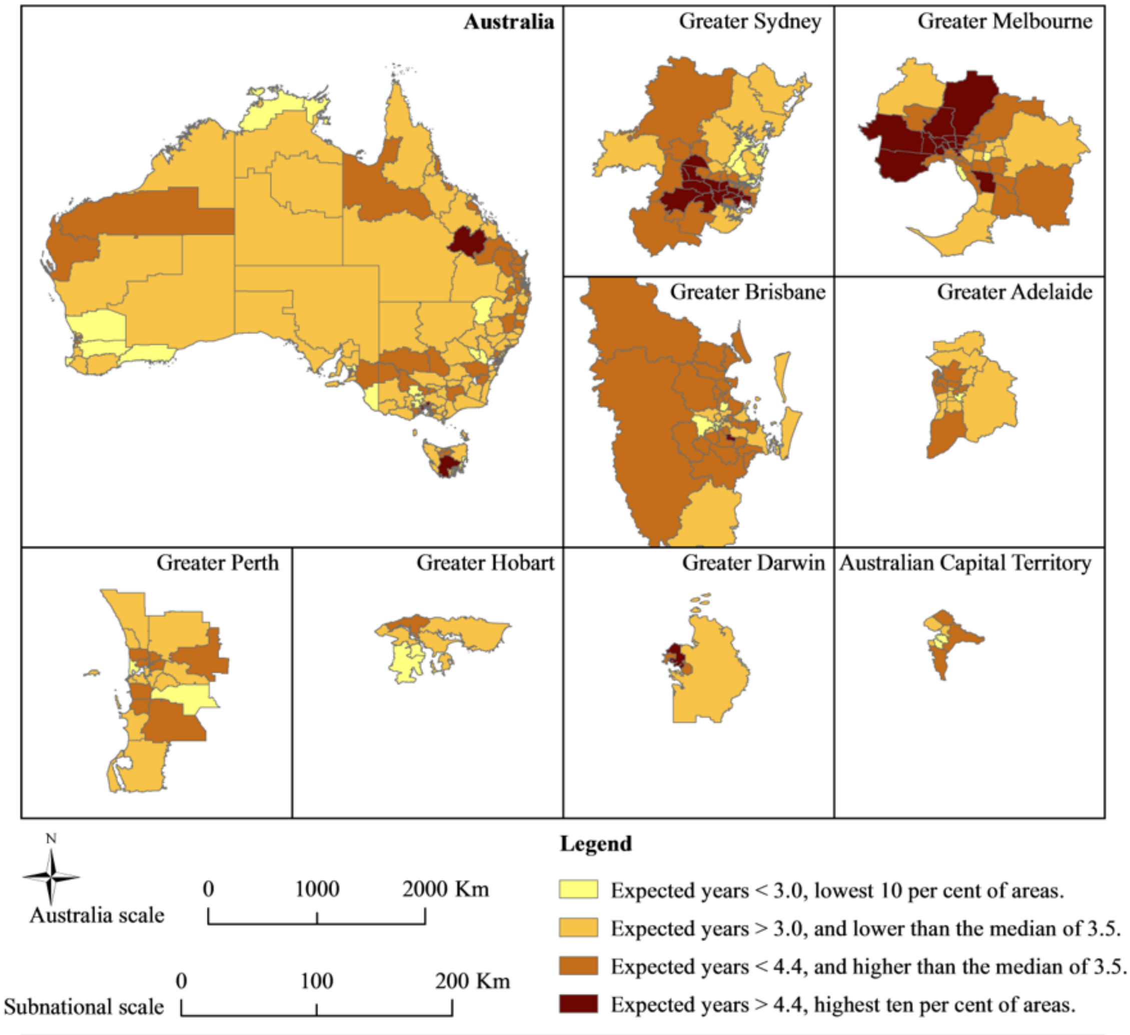
At the substate level disability-free life expectancy can vary significantly. For the 327 regions examined, at birth in 2011, the expectation of disability-free life expectancy at birth varied between 63.5 years and 81.1 years for males and between 66.2 and 82.8 years for females. The characteristics of the population appear to be important in this analysis, with the regions with high Indigenous population also experiencing low disability-free life expectancies. This is consistent with other empirical findings of high rates of disability among Indigenous communities (ABS 2014a). Similarly, regions with high life expectancy also have lower disability-free life expectancy.



Source: Author's calculations using ABS 2011d and ABS 2014c.

Figure 52 Expected years to be lived with disability for males at age 65: Australian regions, 2011

As can be seen in Figure 53, there is considerable diversity in the expectation of life lived with disability across Australia at age 65. For females in 2011, the expected years of life lived with disability can vary between 0.32 years and 9.8 years. For males in 2011, the expected years of life lived with disability can vary between 0.95 and 6.3 years. This analysis does not explain these differences, this is an area where further work would be beneficial. It is also worth noting that disability-free life expectancy does not necessarily relate to the number of people in the communities with disabilities. This will be a function of population size, age structure and the prevalence of disability. As there is growth in the aged population, the number of people with disability increases because of more people in the aged groups where the prevalence is high. If there is ageing within the aged population in a region, this too could drive demand for services.



Source: Author's calculations using ABS 2011d and ABS 2014c.

Figure 53 Expected years to be lived with disability for males at age 65: Australian regions, 2011

10.4 CONCLUSION

I use the life course perspective in this Chapter to better understand the aged and ageing processes in Australia. These perspectives are likely to reveal insights into the threshold of the aged, in understanding changes in the length of life and how any additional years of life are lived. It is clear from the analysis above that demographic conditions support an increase in the threshold of the aged. Based on the age-transition trajectories the threshold age of the aged years may exceed 70 already if a dynamic approach to setting the threshold had been in place during the working life of the baby boomers. If working-life expectancies were used to define the threshold age of the aged it would be around 60 to 65 while the disability-free life expectancy would be closer to 75. These analyses, when considered together, do not point to a single threshold of the aged. They do, however, support a policy response which differentiates between the early-aged and late-age years.

The evidence here shows that while additional years have been gained in life in the early-aged years, these are years that (at the population level at least) are free of work and disability. Furthermore, given the persistent presence of inequality both in the life span and life course markers of ageing, greater policy differentiation with the aged will be necessary to be responsive to variation in demographic conditions.

While life course perspectives are concerned with key transitions in life at the individual level, life course scholars are also concerned with how societal factors influence the individual life course (George 2003). There is a role for policy makers to shape the life course characteristics of the aged in Australia. Like the Sullivan life tables, the focus should not simply be on the aged years, but the whole life course. There are clearly benefits of increased life span available, and with the right policy settings these benefits could improve wellbeing at individual and societal level across the life course.

Chapter 11

Conclusion

Population ageing is the consequence of a great achievement of modern society—the lengthening life span. Longer lives, particularly when accompanied by an increase in life lived in health, wealth and activity, should be embraced. An ageing future should be celebrated. But, this is not to say that an ageing future will be free of challenges.

To set the scene for this study, I outlined how population ageing is challenging existing policy settings and is projected to be a considerable fiscal burden. A significant part of this challenge is to balance the needs of a growing aged population in the context of changing demands of the youth and working-aged populations, which also face their own challenges in this rapidly changing world.

The aim of this study was to better understand the aged and ageing processes in Australia. In Chapter 1, I identified that, for Australia, evidence about growth in the aged population at a subnational level does not use a consistent methodology and is undertaken on an ad hoc basis so that there is limited continuity of information for policy makers. To advance knowledge in this area, this analysis was guided by two research questions:

1. How can the demographic evidence-base for Australia be expanded to better inform the policy response to population ageing in Australia?
2. What does a demographic evidence-base incorporating geodemographic and life course perspectives reveal about the aged and ageing processes in Australia?

The study makes three substantial contributions to the knowledge base. The first is the design of a multidimensional approach to examine the aged and ageing processes in Australia, providing an expanded demographic evidence-base to better inform the policy response to population ageing in Australia. The second is to use this approach to conduct a comprehensive examination of the national and subnational characteristics of the aged and ageing processes in Australia, providing increased insights into the geodemographic and life course perspectives of the aged and ageing processes in Australia. The third is the application of these results to guide future directions for public policy in Australia.

I began with considering the policy directions which demographic analysis should inform. Three features of the existing policy debate informed the design of the study. The first is a reliance on vaguely defined populations to guide policy initiatives and plan local service delivery. For example, the aged care planning ratio, for example, uses a target population of age 70 and above and, in the context of increasing emphasis on work into the 60s, people aged 65 and over who acquire a disability are excluded from the new National Disability Insurance Scheme. Central to the Australian Government's response to population ageing is to support people to age-in-place, which means encouraging and providing services to aged Australians to remain in their homes for as long as possible. To meet these needs, service planners need more accurate local level information and to better understand the heterogeneity in the aged population. At the national level, policy makers need more detail than an average life expectancy to develop the policy response.

The second is the incomplete nature of the existing policy response. For more than twenty years, successive governments have been responding to population ageing–improving the policy architecture for retirement incomes through the introduction of the compulsory superannuation scheme, expanding access to support in the home or residential facilities, and consolidating responsibilities for the aged and ageing within one level of government. Since the first intergenerational report in 2002, the long-term economic and fiscal impacts of population ageing can be quantified and planning for a growing aged population has intensified. However, as outlined in Chapter 2.3, the policy response is incomplete and policy makers need to be better equipped to design policy for a growing aged and ageing population.

The third feature arises from the intersection of demography, the life course and policy settings. The lives of the aged are not simply determined by biology or demography, but by cultural, economic and policy conditions. When it comes to the issue of defining the aged, policy conditions are changing more slowly than demographic conditions. This issue warrants examination given the continual change in demographic conditions. In addition, policy settings may themselves be reinforcing demographic conditions. While this study did not set out to prove this relationship conclusively, the analysis does demonstrate the growing disconnect between policy and demographic conditions.

I examined current policy issues in Chapter 4 and argued, that for this study to expand the demographic analysis available to inform policy makers it should inform four policy directions: increased differentiation in the policy response within the aged years; a more comprehensive approach to longevity risk; increased responsiveness to variation within the aged population and ageing processes; and, the better distribution of the benefits of increased life span across the life course to improve wellbeing.

For demographic analysis to guide decision making in each of these areas, it needs to be broader than the conventional demographic analysis typically associated with demographic analysis—that being the study of the size and age structure of the population. Instead, to better understand the aged and ageing processes in Australia and inform emerging policy directions, the demographic analysis should take into account spatial and temporal variation through geodemographic and life course perspectives. In response to Research Question 1, I elaborate on the details of this multidimensional approach arguing for geodemographic and life course analysis to be structured around analysis of the size; age structure; characteristics; age-transitions to better understand the threshold age demarcating the commencement of the aged years; mortality conditions such as the length of life and inequality in the length of life; and life course markers of ageing such as working life and disability-free life expectancies.

I make two key methodological contributions through the development of a subnational projection model of the aged and an area typology for the aged. The life course analysis assists to define who is aged, to uncover inequality in life course outcomes and understand longevity risks including its spatial and temporal dimensions.

As a result of performing the analysis I reveal new insights into the aged and ageing processes in Australia (Research Question 2). I highlight three as among the key insights. The first key insight is that there is substantial variation in the size and age structure of the Australia aged population, and this shows no sign of diminishing over the next twenty years. By looking at the dynamics of more than 300 regions in Australia, it is clear there are ageing hotspots which warrant closer analysis in service planning. Additionally, these results show that planning for growth may not need to be linear, with growth stronger in most regions between 2011 and 2021. One of the benefits of having such detailed analysis available to policy makers, is that it also shows there are exceptions to these general trends. Overall, all regions should plan for growth, but growth will vary. In addition, national governments should monitor mortality conditions very closely as improving mortality conditions would substantially boost the size of the aged population and result in even greater service needs.

The second key insight is that variation between regions by characteristics appears to be substantially less compared to variation between regions by size and age structure of the aged population. The multivariate k-means cluster analysis examining variation using 18 individual, economic and social characteristics found that around half the aged population in Australia resides in areas with similar characteristics (typical aged regions). Interestingly, in a country where the largest aged population resides in capital city regions, this study shows that regions outside of capital cities are more representative of the typical aged region (based on characteristics) in Australia.

The third key insight is that life course perspectives do not point to a single threshold of the aged. Taken in isolation, the age-transition trajectories, point to a threshold age of the aged years in excess of age 70 if a dynamic approach to setting the threshold had been in place during the working life of the baby boomers. However, the life course perspectives do not appear to support much upward movement in the threshold age of the aged from around 60 to 65 years. This disconnect between demographic and life course conditions can be reconciled, however, by accepting there needs to be greater differentiation within the aged years. Laslett (1989) proposed differentiation between the third and fourth age, and this study recommends pursuing such a differentiation in policy directions. However, this will be a complex undertaking, as this study also shows there is persistent evidence of inequality; suggesting that a population level threshold of the aged will be difficult to define.

This study is also informed by the international and domestically-oriented research. The research informing this study is theoretical, methodological and applied. Previous research has established that once there is momentum towards population ageing it is unlikely that a population will shift from this trajectory. The dynamics of mortality at older ages, the geographic distribution of the aged and the characteristics of the aged are, however, less certain. Increasingly the aged are examined as a more heterogeneous group, and this study is no different. I differentiate within the aged population and incorporate substantial analysis of the spatial and temporal variation in the aged and ageing processes. Consistent with broader research directions, I went beyond the life span to incorporate analysis of the key markers of ageing, particularly in relation to work and disability.

A summary of each chapter is as follows:

Chapter 2: Australian society, demography and current policy concerns relating to population ageing.

In this Chapter I provided the contextual background to the study. I outlined the key features of current Australian society and demography and current policy concerns relevant to a growing aged population and population ageing. I focused on three policy areas: work and training, health and care and retirement income to argue the public policy response to the demographic changes is incomplete.

Chapter 3: Key research directions and Australian studies of the aged and ageing process.

There is a vast literature relevant to ageing and I focus on the demographic research and Australian studies. Four key themes were identified. Firstly, there is the research defining the threshold age of the aged population, which shows retrospective chronological age is the dominant approach. Secondly, there is the research focusing on the dynamics of a growing aged population. This is the research covering the demographic conditions which produce population ageing. The third theme identified was the new analytical dimensions to understand the aged. Research in this area increasingly differentiates within the aged population in recognition of the complexity and heterogeneity of the aged population. The fourth theme identified draws from sociological research to situate the aged within the life course. These are the 'bigger questions' associated with what lengthening life means for how individuals live their lives.

In this Chapter I also focused on the existing Australian studies. Few studies have attempted to examine the entire aged population in Australia at small areas. Also, few Australian studies investigate subnational characteristics of the aged, subnational projections of the aged, life span inequality, working life expectancies or the threshold of the aged.

Chapter 4: Directions for the future policy response to population ageing in Australia.

In this Chapter I proposed four policy design directions to guide future policy development to population ageing in Australia. I argued there needs to be increased differentiation in the policy response within the aged years to better recognise the differences in the early-aged and late-aged years. Also required is a more comprehensive approach to longevity risk to incorporate longevity risks associated with both the life span and life course, such as early exit from the labour market. Policy and program settings also need to be responsive to variation within the aged population and ageing processes. Lastly, the benefits of increased life span could be distributed across the life course to generate even greater improvements to wellbeing. When taken together, these directions would change the policy response to population ageing.

Chapter 5: A multidimensional approach for examining population ageing in Australia

In this Chapter I introduced a multidimensional approach for examining the aged in Australia–the foundation for an expanded demographic evidence-base. It includes a geodemographic and life course perspective of the aged population. The geodemographic perspective includes the conventional demographic dimensions of size, age structure and characteristics of the aged population while the life course perspective focuses on age-transitions to better understand the threshold age demarcating the commencement of the aged years, mortality conditions such as the length of life and inequality in the length of life, and life course markers of ageing such as working life and disability-free life expectancies.

I also argued in this Chapter that the demographic evidence-base should encompass national and subnational approaches and different time periods so that spatial and temporal variation of the aged population and ageing processes can be examined. I introduced the subnational analytical unit selected for this study as 327 Statistical Area 3 regions from the Australian Statistical Geography Standard. I also introduced the temporal unit of analysis selected as 1901 to 2011 for the historical and current analysis and 2011 to 2031 for the forward-looking analysis.

Chapter 6: Demographic data for Australia

In this Chapter I outlined the data selected for the study. All the data is official demographic data produced by the ABS. The key data sources are the 2011 and 2006 Census of Population and Housing, the Australian historical population estimates, population projections, mortality and migration estimates. The population characteristics examined are from the Census and include individual, economic and social characteristics. Not only is this data of high quality, but its regular release (for no cost or low cost) means that the results of this analysis can be replicated following future releases to update the results and support, over time, time series analysis.

Chapter 7: Calculating key demographic variables to use in the multidimensional approach

In this Chapter I outlined how the key demographic variables were calculated for use in the multidimensional analysis. I grouped the variables into population counts, population characteristics, mortality and migration (international and internal) variables. The result was a set of national demographic variables covering 1901 to 2011 for historical analysis and national and subnational demographic variables for a projection horizon of 2011 to

2031. Considerable indirect estimation was required to calculate this suite of variables and they provide a powerful toolbox to examine the geodemographic and life course perspectives of the aged in Australia.

Chapter 8: Geodemographic perspectives of the aged: the size and age structure of the Australian aged population.

Currently, for Australia, evidence about growth in the aged population at a subnational level does not use a consistent methodology and is undertaken on an ad hoc basis so that there is limited continuity of information for policy makers. In this Chapter I outlined a new subnational projection model. It is uniquely calibrated for each of the 327 regions examined and specifically designed to complement the official national projections.

To begin this Chapter I outlined the size and age structure of the aged population as it was in 2011. Next, I examined how this may change between 2011 and 2031. I show that while growth in the aged population is uneven, growth in the aged population is likely to occur for all regions. Therefore, responding to ageing is not simply a matter of redistributing existing services. Using partial projection models to isolate the effect of different demographic conditions on ageing processes, I show ageing-in-place is the most significant component of growth in the aged population. Overseas migration contributes positively to the size of the aged population, but its impact is generally small and spatially concentrated in capital cities. Internal migration is a drag on growth of the aged population in most regions, but the effect is not large enough to produce negative growth rates in any region. In addition to the spatial variation, temporal variation is observed. For most regions growth in the ten years to 2021 exceeds growth between 2021 and 2031. Growth in the late-aged population is stronger relative to the early-aged population despite the large baby boomer birth cohort ageing into the early-aged years during the projection horizon in this study.

The results of this analysis confirm policy makers should pay attention to the temporal and spatial variation in the size and age structure of the aged population. It will be particularly important as well for policy makers to monitor changes in mortality conditions to reduce uncertainty in population projections. Improved mortality conditions, as modelled in this study, could add more than 300,000 aged people to the size of Australia's aged population relative to current mortality conditions over the twenty years to 2031. That said, the effects of internal migration should not be overlooked, particularly in regions outside of capital cities where internal migration mostly reduces growth in the aged population, to avoid over servicing in some regions.

Projecting the size and age structure of the aged population is critically important for service planning. The projection model I developed reveals the areas where growth may be higher or lower than average, giving policy makers insights into the services a community may need and when. To draw maximum benefits from the results, however, policy makers should think about the results more broadly, by looking at the potential for active ageing campaigns in regions with relatively young aged populations and actively planning for end-of-life service needs in regions where there are significant aged populations reaching the end of life. This analysis of size and age structure would need to be complemented by policy design work, but provides a starting point for identifying regions which could benefit from a local level initiatives.

Chapter 9: Geodemographic perspectives of the aged: characteristics of the aged population.

Given the characteristics of the aged shape demand for services, I examined the characteristics of the aged looking at individual, economic and social characteristics of individuals and the characteristics of the aged at a regional level. One of the weaknesses of existing subnational studies is that the aged are examined by remoteness regions where distinct geographical regions are considered together. In this study, I maintained a high degree of spatial segregation (the 327 regions) by using a multivariate analysis to examine patterns by region in 18 individual, economic and social characteristics of the aged population. I showed that there are distinct area types for the aged population. Using a k-mean cluster methodology, I developed an area classification to differentiate regions into six types: foreign born (dissimilar) and relative disadvantage; foreign born (dissimilar) and relative advantage; active ageing and relative advantage; remote indigenous; typical aged; and, Australian born typical aged.

While distinct area types were observed, overall, the results demonstrated less heterogeneity than expected. Around half the aged population in Australia resided in areas with similar characteristics (typical aged regions). Furthermore, given it was a particular goal of this study to examine the characteristics of the aged at a subnational level without using the remoteness classification, it is surprising that there is a clear differentiation by rural, remote and capital city regions (as seen in Figure 47).

The classification was strongly influenced by a small number of characteristics, including country of birth, specifically the characteristics of foreign born (dissimilar) and Australian born. The Indigenous aged population also influences the area types. This is consistent with the single variate analysis showing the characteristics that occur less frequently, such as poor proficiency in English and Indigenous aged, are more likely to be geographically concentrated. Additionally, while the foreign born (dissimilar and similar) population is more spatially concentrated compared with the Australian born population, the foreign born (dissimilar) population is more spatially concentrated compared with the foreign born (similar) population. This spatial concentration is influencing the multivariate analysis and area types.

Policy makers can draw insights from both the single variate and multivariate analysis of the characteristics of the aged. Not only are there spatial differences in the distribution of the aged population by characteristics, there are likely to be significant differences in the characteristics of the aged over time. One group to highlight, in particular, is the aged population with disability. Across all regions, there are sizeable aged populations with disabilities and most are within the early-aged years. It will be important to ensure adequate services are available to support these aged populations in the regions they live, and to slow further declines in their core activity limitations.

The analysis also points policy makers to test national assumptions of the typical aged by showing there are regions not consistent with national trends. One example highlighted in this study, is the 15 per cent of regions were the male aged population exceeds the female aged population. If policy makers pursue greater responsiveness to local level conditions, evidence from this study, will support policy makers to test the applicability of national policy assumptions at the local level.

Chapter 10: Life course perspectives of the aged in Australia

There are few studies available in Australia investigating life span inequality, working life expectancies or the threshold age demarcating the commencement of the aged years. Consequently, there is inadequate discussion in Australia about these issues and even less consideration of these issues in the policy response to population ageing. In this Chapter I examined a range of life course perspectives on the aged. I used an analysis of age-transition trajectories to show the threshold age of the aged years may already exceed age 70 if a dynamic approach to setting the threshold had been in place during the working life of the baby boomers. However, if working-life expectancies are used to define the threshold age of the aged it would be around age 60 to 65, while the disability-free life expectancy would be closer to age 75. These analyses, when considered together, do not point to a single threshold of aged. They do, however, support a policy response which differentiates between the early-aged and late-aged years. The evidence here shows that while additional years have been gained in life in the early-aged years, there are years that (at the population level at least) are free of work and disability. Furthermore, given the persistent presence of inequality both in the life span and life course markers of ageing, greater policy differentiation within the aged years will be necessary to be responsive to variation in demographic conditions within the aged population.

Among the most interesting findings to highlight, are the results on life span disparity. Life span disparity is generally considered to be reducing (see Chapter 2.2.2). In this study, I have shown, in contrast to life span disparity at birth, life span disparities at age 65 and age 85 have increased. I suggested several mortality patterns could produce this result, including persistent mortality in the early-aged years coupled with lengthening life spans for at least some in the population. This is an area where further research and time series analysis is warranted, and could ultimately lead to new directions in health interventions.

11.1 STUDY LIMITATIONS

As with all research, this study has limitations. As some were outlined in the preceding chapters, I focus here on key overarching limitations. One of the significant constraints is the need to utilise data that is made available at no charge. As a result, some of the data inputs are not consistent with best practice in demographic research. The two key limitations attributable to this restriction are not using a launch population for the projection by single year of age for the population projections and not including more household variables in the analysis.

I also do not claim to have incorporated all policy-relevant analysis in this analysis or given equal weight to all policy issues relevant to population ageing. For example, the reader will not find economic demographic models, Age-Period-Cohort models or longitudinal analysis of the aged population. The next iteration of this study could be expanded to include such modules. In this study, I have laid a foundation for future work and targeted a mix of short-term tangible policy issues like aged-based policy settings and allocation of care place around the country and long-term direction setting for the policy agenda.

Individual analyses in this study could also be enhanced in the future. A key emerging opportunity, therefore, will be to generate a time series for each analysis. This will particularly enhance the substate analysis where the geography used in this study has only been in place since 2011.

Limitations on time also limited the scope of this work. Examples of this limitation include: focusing on cross-sectional data, when valuable insights can also be drawn from analysis of longitudinal data sources particularly in studying the life course; projecting the population at age 45 an up to avoid the need project fertility while still enabling detailed analysis of the population aged 65 and over; and, limiting my public policy lens to the issues arising for the Australian Government and leaving analysis of state and territory and local government policy issues to subsequent studies.

I have not set out to make a substantial theoretical contribution to the field of demographic ageing. The big questions—limits to life expectancy, the drivers of the health versus survival paradox between males and females or the causes of life span disparity—are not solved by me at this time. My goal has been a practical and comprehensive examination of the aged in Australia using a multidimensional approach designed to inform the policy response to population ageing.

While a public policy lens has been central to the design of this study, not all public policy issues are given equal weight. This is not an economics study. I do not try to form conclusions about the macroeconomic or fiscal impacts of ageing—itself a burgeoning area of research. This study is informed by the research on the expected macroeconomic impacts, but I did not set out to contribute to the economics field directly.

11.2 SUGGESTIONS FOR FUTURE RESEARCH

In all probabilities, Australia is likely to experience continuous ageing.[86] There is uncertainty about the pace of growth, the size of the aged population relative to the size of the working-age and youth population, and the characteristics of the aged population. With this analysis, these changes can be tracked over time using the data and key demographic variables calculated in Chapters Five, Six and Seven.

For each of the analysis there are options to extend and advance over time. Some of these have been highlighted in the preceding chapters. Beginning with the size and age structure analysis, as a time series develops, there will be more scope to examine the performance of the projections and to build in measures of forecast uncertainty including using expert judgement. In addition, there may be scope to introduce probability intervals based on historical forecast accuracy (see Tayman 2011 for an overview of methods) and to

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[86] Borrowing from the insight of Hult and Stattin (2009) refer to "economic and social challenge of continuous population ageing".

incorporate microsimulation approaches better understand individual trajectories (including multi-state methods) (Willekens 2005). If the Australian Statistical Geography Standard stays stable over time (as is the plan), this will greatly assist the development of more sophisticated projections of the Australian aged populations.

There could also be additional work on the inputs into the projections. Two pieces of data could significantly improve the reliability of the estimates—estimates of deaths by age five-year age groups and population counts by single year of age to improve estimates of the launch population. In terms of forecast methodology, further work could be undertaken on the internal migration estimates to move from a constant level net migration model to more dynamic estimates of internal migration.

For the characteristics analysis, there are opportunities to add analysis and to improve the geodemographic classification. In this study, dependency ratios were measured by the traditional old age dependency ratio and the economic support ratio. Neither approach offers a sophisticated or accurate measure of dependency, and this should be an area for improvement in future research. The results of the geodemographic classification analysis established that there are area types differentiating between regions based on the characteristics of the aged. For some regions, however, there is evidence of heterogeneity of the aged population within the region. In future analysis, using a smaller geographic (such as the Statistical Area 2 regions) within capital city boundaries could be effective.

There are several research directions which could be developed to complement the existing life course perspective. The priorities for future research should be to link the results observed to population characteristics analysis. More could be done to understand the role of individual, social and economic characteristics in contributing the life span disparity and variation in disability-free life expectancies and working-life expectancies at the regional level and between population subgroups (such as males and females). Jagger et al (2008) provides an example of using a meta-regression to examine association between the characteristics of a population or area and disability-free life expectancy which could provide a starting point for this analysis. Within the life span analysis, additional analysis could be performed to understand mortality after the modal age of death.

In time, with additional data, there could be opportunity for the cross-pollination of research undertaken in this study. Longitudinal data at the individual level, for example, could reveal individual life trajectories and be compared to the area characteristics. With the application of a temporal and spatial lens it may also be possible to assess how population dynamics and cohort changes shape area characteristics.

Lastly, the aged population will change over time. I discussed some existing predictions for a healthier baby boomer cohort and some factors producing momentum for change such as increased education. I also proposed that policy settings can shape these characteristics. While more for the realm for the political and social scientists to pursue, demographic analysis can contribute to a better understanding of the cohort changes in the aged population.

11.3 SUGGESTIONS FOR POLICY MAKERS

The single most significant contribution of this study for policy is the four policy directions set out in Chapter 4. These are to pursue policy directions which: increase differentiation in the policy response within the aged years; deliver a more comprehensive approach to longevity risk; increase responsiveness to variation within the aged population and ageing processes; and, distribute the benefits of increased life span across the life course to improve wellbeing. This requires policy makers to pursue a mix of technical policy design work and adaptive policy responses—convincing a population that there are better ways to harness the benefits of longer lives.

The multidimensional approach developed in this study supports both the technical and adaptive policy challenges. The results of the geodemographic analysis provide tangible results which policy makers can incorporate into service planning models and policy development for place-based initiatives. Some of the results of the life course perspective can be easily translated into direct policy action; for example, that individuals should plan for longevity lends itself to a communication campaign. On the whole, however, life course perspectives will be the more complex area for policy makers to navigate. The results do support greater differentiation with the aged years and point to these measures being individually defined due to population metrics being undermined by the presence of inequality. Yet, policy makers will need to build community support for such changes. Too much focus on shifting policy settings (i.e. dynamic setting of the Aged Pension age) will increase the risk of policy failure and opponents can easily focus on what is 'lost'. This is why I argue for a policy direction to distribute the benefits of increased life span across the life course to improve wellbeing. With the whole life course in play—youth, working age, early-aged and late-aged years—it may be possible to design policy settings which can offer gains in wellbeing and be better equipped to endure further demographic change.

11.4 FINAL OBSERVATIONS

The most difficult of the policy challenges relating to population ageing lies ahead. Our capacity to respond to a growing aged population has improved significantly; but, with increasing life span we will need more fundamental social and economic change. In this study, I have challenged some of the traditional conceptions, particularly in relation the threshold of the aged. I have also encouraged policy makers to be more sensitive to variation and disparity in setting policy directions. There is mounting evidence that these are necessary steps to improve the lived experience of the typical aged. More fundamentally, I have argued that wellbeing across the life course can be improved if the benefits of longer lives are spread across the life course. I have recommended to policy makers to differentiate the policy response between the early-aged and late-aged years.

Responding to the challenges of population ageing will require years, probably decades of reforms. The demographic analysis developed in this study will need to be combined with economic and policy modelling. A narrative will need to be developed, specific proposals costed, reforms designed and sequenced for implementation. In Australia's federal system of government, collaboration will be required across national, state and local governments. Radical reforms occur rarely, and when they do they are often precipitated by a crisis or sudden shift in public sentiment. Population ageing will be slow moving and uncertain, so policy makers will be moving forward without certainty about future demographic conditions or a strong impetus for change.

This study provides a foundation for moving towards a more sophisticated approach to examining the aged population in Australia. In this study, more than 100 years of Australia's demographic history is examined, and different projection scenarios for the next twenty years are revealed for more than 300 geographic regions of Australia. The results of the analysis show both the complexity and simplicity of the aged and ageing processes in Australia. There is variation in the characteristics of the aged. There is variation in the length of life. There is demographic change underway which is outpacing changes in policy settings and thus changing the cultural and social norms regarding who is aged and the characteristics of the aged.

How these demographic conditions will evolve in the medium to long-term is uncertain. I opened this study with the observation that "ageing of populations around the world is one of the most significant demographic changes underway, with far reaching implications for the design of policy settings.” I demonstrated in this study why this is true for Australia. Further, I demonstrated that a better understanding of the aged and ageing processes could inform a more effective, efficient and innovative response to population ageing. At the heart of all demographic change, however, are individuals. In this study, I have organised these individuals into groups across space and time to understand their characteristics. In reality, there are already more than 3 million unique life trajectories among the aged population and as the population grows so too will the diversity of lived experience of being aged in Australia. This should not be forgotten in future research and the policy response this aged population.

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Appendix 1

Geodemographic and life course perspectives of the aged: key indicators for Australian regions

In the subsequent tables I include the key indicators of the aged and ageing process for each the subnational regions in this study. The indicators are split over four tables. Full geographic information is included in the first table and only the Statistical Area 3 code is included in the subsequent tables. Additional results are available upon request.

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Goulburn - Yass	10101	Rest of NSW	Typical aged	12039	88.1	1.1
Queanbeyan	10102	Rest of NSW	Foreign born (dissimilar) and relative advantage	5620	89.9	1.0
Snowy Mountains	10103	Rest of NSW	Active ageing and relative advantage	3133	86.8	0.9
South Coast	10104	Rest of NSW	Typical aged	16522	88.2	1.0
Gosford	10201	Greater Sydney	Typical aged	32036	83.8	1.0
Wyong	10202	Greater Sydney	Typical aged	28570	86.5	1.1
Bathurst	10301	Rest of NSW	Typical aged	6375	88.5	1.2
Lachlan Valley	10302	Rest of NSW	Typical aged	11147	87.2	1.2
Lithgow - Mudgee	10303	Rest of NSW	Typical aged	8136	89.1	1.2
Orange	10304	Rest of NSW	Typical aged	8245	87.9	1.2
Clarence Valley	10401	Rest of NSW	Typical aged	10710	88.2	1.0
Coffs Harbour	10402	Rest of NSW	Typical aged	15204	86.4	1.1
Bourke - Cobar - Coonamble	10501	Rest of NSW	Remote and indigenous	3900	90.9	1.4
Broken Hill and Far West	10502	Rest of NSW	Typical aged	4067	87.5	1.3
Dubbo	10503	Rest of NSW	Typical aged	11202	88.2	1.1
Lower Hunter	10601	Rest of NSW	Typical aged	11202	88.5	1.3
Maitland	10602	Rest of NSW	Typical aged	8380	87.5	1.0
Port Stephens	10603	Rest of NSW	Typical aged	14114	89.4	0.9
Upper Hunter	10604	Rest of NSW	Typical aged	3968	88.6	1.2

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Dapto - Port Kembla	10701	Rest of NSW	Foreign born (dissimilar) and relative disadvantage	12841	88.3	1.1
Kiama - Shellharbour	10703	Rest of NSW	Australian born typical aged	13621	88.8	1.1
Wollongong	10704	Rest of NSW	Australian born typical aged	19656	85.6	0.9
Great Lakes	10801	Rest of NSW	Typical aged	9066	86.4	1.0
Kempsey - Nambucca	10802	Rest of NSW	Typical aged	10311	86.7	1.1
Lord Howe Island	10803	Rest of NSW	Typical aged	70	94.3	1.5
Port Macquarie	10804	Rest of NSW	Typical aged	18424	86.5	0.9
Taree - Gloucester	10805	Rest of NSW	Typical aged	11931	88.2	1.1
Albury	10901	Rest of NSW	Typical aged	9146	86.2	1.1
Lower Murray	10902	Rest of NSW	Typical aged	2161	90.4	1.1
Upper Murray exc. Albury	10903	Rest of NSW	Typical aged	9486	88.6	1.1
Armidale	11001	Rest of NSW	Typical aged	5667	87.7	1.0
Inverell - Tenterfield	11002	Rest of NSW	Typical aged	7878	88.5	1.2
Moree - Narrabri	11003	Rest of NSW	Typical aged	3609	89.8	1.4
Tamworth - Gunnedah	11004	Rest of NSW	Typical aged	13667	87.9	1.1
Lake Macquarie - East	11101	Rest of NSW	Typical aged	21610	87.0	0.9
Lake Macquarie - West	11102	Rest of NSW	Typical aged	13615	85.1	1.2

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Newcastle	11103	Rest of NSW	Australian born typical aged	24971	84.2	1.1
Richmond Valley - Coastal	11201	Rest of NSW	Typical aged	13749	84.5	0.9
Richmond Valley - Hinterland	11202	Rest of NSW	Typical aged	11284	86.7	1.1
Tweed Valley	11203	Rest of NSW	Typical aged	19944	85.4	1.1
Griffith - Murrumbidgee (West)	11301	Rest of NSW	Australian born typical aged	7199	87.5	1.0
Tumut - Tumbarumba	11302	Rest of NSW	Typical aged	2743	86.4	1.0
Wagga Wagga	11303	Rest of NSW	Typical aged	14010	86.5	1.0
Shoalhaven	11401	Rest of NSW	Typical aged	22029	88.3	1.1
Southern Highlands	11402	Rest of NSW	Active ageing and relative advantage	9898	88.1	1.0
Baulkham Hills	11501	Greater Sydney	Foreign born (dissimilar) and relative advantage	16892	86.4	0.8
Dural - Wisemans Ferry	11502	Greater Sydney	Active ageing and relative advantage	3997	87.9	0.9
Hawkesbury	11503	Greater Sydney	Active ageing and relative advantage	2769	92.1	0.7
Rouse Hill - McGraths Hill	11504	Greater Sydney	Active ageing and relative advantage	2284	92.6	0.8
Blacktown	11601	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	14448	88.9	1.0

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Blacktown - North	11602	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	4595	92.8	0.9
Mount Druitt	11603	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	8993	90.5	1.4
Botany	11701	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	5896	88.5	1.0
Marrickville - Sydenham - Petersham	11702	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	5946	88.8	1.1
Sydney Inner City	11703	Greater Sydney	Foreign born (dissimilar) and relative advantage	14200	89.5	0.9
Eastern Suburbs - North	11801	Greater Sydney	Foreign born (dissimilar) and relative advantage	17518	82.9	0.7
Eastern Suburbs - South	11802	Greater Sydney	Foreign born (dissimilar) and relative advantage	17896	84.2	0.9
Bankstown	11901	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	22796	84.6	0.9
Canterbury	11902	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	17260	88.1	0.8
Hurstville	11903	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	18800	83.5	0.8
Kogarah - Rockdale	11904	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	19132	84.3	0.9
Canada Bay	12001	Greater Sydney	Foreign born (dissimilar) and relative advantage	10996	86.1	0.8

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Leichhardt	12002	Greater Sydney	Foreign born (dissimilar) and relative advantage	5594	88.8	1.1
Strathfield - Burwood - Ashfield	12003	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	19011	83.7	0.9
Chatswood - Lane Cove	12101	Greater Sydney	Foreign born (dissimilar) and relative advantage	13572	82.7	0.8
Hornsby	12102	Greater Sydney	Foreign born (dissimilar) and relative advantage	10168	85.6	0.9
Ku-ring-gai	12103	Greater Sydney	Foreign born (dissimilar) and relative advantage	19997	82.3	0.7
North Sydney - Mosman	12104	Greater Sydney	Foreign born (dissimilar) and relative advantage	12990	85.2	0.8
Manly	12201	Greater Sydney	Active ageing and relative advantage	5674	84.1	0.6
Pittwater	12202	Greater Sydney	Active ageing and relative advantage	10210	85.0	0.9
Warringah	12203	Greater Sydney	Foreign born (dissimilar) and relative advantage	22634	82.8	0.9
Camden	12301	Greater Sydney	Australian born typical aged	4838	85.4	1.0
Campbelltown (NSW)	12302	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	13993	90.1	1.2
Wollondilly	12303	Greater Sydney	Australian born typical aged	4182	89.9	1.0
Blue Mountains	12401	Greater Sydney	Active ageing and relative advantage	12067	87.0	1.0
Penrith	12403	Greater Sydney	Australian born typical aged	12539	89.0	1.1

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Richmond - Windsor	12404	Greater Sydney	Australian born typical aged	4127	86.2	1.2
St Marys	12405	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	4717	90.2	1.0
Auburn	12501	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	6724	86.8	0.9
Carlingford	12502	Greater Sydney	Foreign born (dissimilar) and relative advantage	9041	88.1	0.8
Merrylands - Guildford	12503	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	17114	86.7	1.0
Parramatta	12504	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	15032	84.4	1.0
Pennant Hills - Epping	12601	Greater Sydney	Foreign born (dissimilar) and relative advantage	6768	85.3	0.7
Ryde - Hunters Hill	12602	Greater Sydney	Foreign born (dissimilar) and relative advantage	18396	82.4	0.9
Bringelly - Green Valley	12701	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	7101	92.5	1.0
Fairfield	12702	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	21878	89.9	0.9
Liverpool	12703	Greater Sydney	Foreign born (dissimilar) and relative disadvantage	10655	89.7	1.1
Cronulla - Miranda - Caringbah	12801	Greater Sydney	Australian born typical aged	18750	84.7	0.8
Sutherland - Menai - Heathcote	12802	Greater Sydney	Australian born typical aged	13544	87.0	1.0
Ballarat	20101	Rest of Vic.	Typical aged	14254	86.3	1.0

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Creswick - Daylesford - Ballan	20102	Rest of Vic.	Typical aged	4570	89.4	1.1
Maryborough - Pyrenees	20103	Rest of Vic.	Typical aged	5198	89.3	1.3
Bendigo	20201	Rest of Vic.	Typical aged	13465	85.1	1.1
Heathcote - Castlemaine - Kyneton	20202	Rest of Vic.	Typical aged	7956	88.4	1.1
Loddon - Elmore	20203	Rest of Vic.	Typical aged	2305	88.2	1.2
Barwon - West	20301	Rest of Vic.	Active ageing and relative advantage	1967	89.6	1.1
Geelong	20302	Rest of Vic.	Australian born typical aged	28152	85.0	1.0
Surf Coast - Bellarine Peninsula	20303	Rest of Vic.	Active ageing and relative advantage	11734	87.2	0.9
Upper Goulburn Valley	20401	Rest of Vic.	Typical aged	9390	88.9	1.0
Wangaratta - Benalla	20402	Rest of Vic.	Typical aged	8820	85.9	1.0
Wodonga - Alpine	20403	Rest of Vic.	Australian born typical aged	10073	87.7	1.0
Baw Baw	20501	Rest of Vic.	Typical aged	7122	88.4	0.9
Gippsland - East	20502	Rest of Vic.	Typical aged	9875	88.8	1.0
Gippsland - South West	20503	Rest of Vic.	Typical aged	12473	88.0	1.0
Latrobe Valley	20504	Rest of Vic.	Australian born typical aged	11300	87.8	1.2
Wellington	20505	Rest of Vic.	Typical aged	6963	87.5	1.2

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Brunswick - Coburg	20601	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	9859	85.9	0.9
Darebin - South	20602	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	6226	85.3	1.1
Essendon	20603	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	7696	81.7	0.9
Melbourne City	20604	Greater Melbourne	Foreign born (dissimilar) and relative advantage	6517	87.8	0.8
Port Phillip	20605	Greater Melbourne	Foreign born (dissimilar) and relative advantage	9589	87.8	1.0
Stonnington - West	20606	Greater Melbourne	Foreign born (dissimilar) and relative advantage	8382	85.5	0.8
Yarra	20607	Greater Melbourne	Foreign born (dissimilar) and relative advantage	7680	88.3	0.9
Boroondara	20701	Greater Melbourne	Foreign born (dissimilar) and relative advantage	24468	81.1	0.8
Manningham - West	20702	Greater Melbourne	Foreign born (dissimilar) and relative advantage	18582	88.6	0.8
Whitehorse - West	20703	Greater Melbourne	Foreign born (dissimilar) and relative advantage	16862	82.8	0.8
Bayside	20801	Greater Melbourne	Foreign born (dissimilar) and relative advantage	16841	80.4	0.9
Glen Eira	20802	Greater Melbourne	Foreign born (dissimilar) and relative advantage	20880	79.7	0.8
Kingston	20803	Greater Melbourne	Australian born typical aged	18015	83.3	0.9

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	**Head count 65 and over**	**Early-aged proportion**	**Standardised Mortality Ratio**
Stonnington - East	20804	Greater Melbourne	Foreign born (dissimilar) and relative advantage	5719	82.5	0.8
Banyule	20901	Greater Melbourne	Foreign born (dissimilar) and relative advantage	19193	84.6	0.9
Darebin - North	20902	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	14413	85.1	1.0
Nillumbik - Kinglake	20903	Greater Melbourne	Active ageing and relative advantage	6153	89.8	0.8
Whittlesea - Wallan	20904	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	17754	91.1	1.0
Keilor	21001	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	11086	89.0	0.9
Macedon Ranges	21002	Greater Melbourne	Active ageing and relative advantage	3238	89.7	0.8
Moreland - North	21003	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	12695	83.2	1.0
Sunbury	21004	Greater Melbourne	Australian born typical aged	3923	90.0	1.0
Tullamarine - Broadmeadows	21005	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	11891	93.8	1.1
Knox	21101	Greater Melbourne	Australian born typical aged	19485	86.9	1.0
Manningham - East	21102	Greater Melbourne	Foreign born (dissimilar) and relative advantage	3788	88.1	0.9
Maroondah	21103	Greater Melbourne	Australian born typical aged	15682	84.8	1.0

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Whitehorse - East	21104	Greater Melbourne	Foreign born (dissimilar) and relative advantage	10268	86.3	0.9
Yarra Ranges	21105	Greater Melbourne	Active ageing and relative advantage	18237	89.4	0.9
Cardinia	21201	Greater Melbourne	Australian born typical aged	7952	89.5	1.0
Casey - North	21202	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	13290	88.2	1.1
Casey - South	21203	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	9710	90.2	1.0
Dandenong	21204	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	25323	88.1	1.0
Monash	21205	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	29404	87.0	0.8
Brimbank	21301	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	20131	90.0	1.0
Hobsons Bay	21302	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	11471	86.4	1.0
Maribyrnong	21303	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	7536	84.7	1.1
Melton - Bacchus Marsh	21304	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	9270	90.3	1.1
Wyndham	21305	Greater Melbourne	Foreign born (dissimilar) and relative disadvantage	11594	90.2	1.0
Frankston	21401	Greater Melbourne	Australian born typical aged	17719	87.0	1.0

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Mornington Peninsula	21402	Greater Melbourne	Active ageing and relative advantage	31926	86.9	0.9
Grampians	21501	Rest of Vic.	Typical aged	12232	85.6	1.0
Mildura	21502	Rest of Vic.	Australian born typical aged	8259	87.0	1.0
Murray River - Swan Hill	21503	Rest of Vic.	Typical aged	7453	85.7	1.0
Campaspe	21601	Rest of Vic.	Typical aged	7060	87.4	1.0
Moira	21602	Rest of Vic.	Typical aged	6059	87.3	1.1
Shepparton	21603	Rest of Vic.	Australian born typical aged	8984	86.1	1.0
Glenelg - Southern Grampians	21701	Rest of Vic.	Typical aged	6697	86.5	1.2
Warrnambool - Otway Ranges	21702	Rest of Vic.	Typical aged	14677	86.2	1.0
Capalaba	30101	Greater Brisbane	Australian born typical aged	8179	87.3	1.0
Cleveland - Stradbroke	30102	Greater Brisbane	Typical aged	13219	86.9	1.0
Wynnum - Manly	30103	Greater Brisbane	Australian born typical aged	8440	85.1	1.0
Bald Hills - Everton Park	30201	Greater Brisbane	Active ageing and relative advantage	5708	86.9	0.8
Chermside	30202	Greater Brisbane	Australian born typical aged	10515	81.9	0.9
Nundah	30203	Greater Brisbane	Australian born typical aged	4346	82.8	0.8

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Sandgate	30204	Greater Brisbane	Australian born typical aged	8010	85.0	1.2
Carindale	30301	Greater Brisbane	Australian born typical aged	6226	84.5	1.0
Holland Park - Yeronga	30302	Greater Brisbane	Foreign born (dissimilar) and relative advantage	6943	83.9	1.0
Mt Gravatt	30303	Greater Brisbane	Foreign born (dissimilar) and relative advantage	9295	86.1	1.0
Nathan	30304	Greater Brisbane	Australian born typical aged	4982	84.6	0.8
Rocklea - Acacia Ridge	30305	Greater Brisbane	Foreign born (dissimilar) and relative disadvantage	4772	87.1	1.3
Sunnybank	30306	Greater Brisbane	Foreign born (dissimilar) and relative disadvantage	5160	87.1	0.8
Centenary	30401	Greater Brisbane	Foreign born (dissimilar) and relative advantage	3803	84.6	1.1
Kenmore - Brookfield - Moggill	30402	Greater Brisbane	Active ageing and relative advantage	6167	86.9	0.9
Sherwood - Indooroopilly	30403	Greater Brisbane	Foreign born (dissimilar) and relative advantage	5236	83.5	0.8
The Gap - Enoggera	30404	Greater Brisbane	Australian born typical aged	6243	82.9	1.0
Brisbane Inner	30501	Greater Brisbane	Foreign born (dissimilar) and relative advantage	5426	83.6	1.3
Brisbane Inner - East	30502	Greater Brisbane	Australian born typical aged	3049	85.8	0.8

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Brisbane Inner - North	30503	Greater Brisbane	Foreign born (dissimilar) and relative advantage	7567	84.2	0.9
Brisbane Inner - West	30504	Greater Brisbane	Active ageing and relative advantage	4678	86.2	0.8
Cairns - North	30601	Rest of Qld	Active ageing and relative advantage	4234	91.8	1.0
Cairns - South	30602	Rest of Qld	Australian born typical aged	9866	88.0	1.2
Innisfail - Cassowary Coast	30603	Rest of Qld	Australian born typical aged	5347	90.0	1.1
Port Douglas - Daintree	30604	Rest of Qld	Typical aged	1358	92.9	1.2
Tablelands (East) - Kuranda	30605	Rest of Qld	Australian born typical aged	7139	90.2	1.1
Darling Downs (West) - Maranoa	30701	Rest of Qld	Typical aged	6003	90.3	1.2
Darling Downs - East	30702	Rest of Qld	Typical aged	6510	89.1	1.1
Granite Belt	30703	Rest of Qld	Typical aged	7405	87.8	1.1
Central Highlands (Qld)	30801	Rest of Qld	Typical aged	1837	92.6	1.0
Gladstone - Biloela	30802	Rest of Qld	Typical aged	7148	91.4	1.1
Rockhampton	30803	Rest of Qld	Typical aged	15556	88.4	1.2
Broadbeach - Burleigh	30901	Rest of Qld	Active ageing and relative advantage	10813	86.7	0.8
Coolangatta	30902	Rest of Qld	Typical aged	9083	86.0	0.9

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Gold Coast - North	30903	Rest of Qld	Australian born typical aged	12386	86.6	1.0
Gold Coast Hinterland	30904	Rest of Qld	Active ageing and relative advantage	2685	92.9	0.8
Mudgeeraba - Tallebudgera	30905	Rest of Qld	Active ageing and relative advantage	3267	91.8	0.9
Nerang	30906	Rest of Qld	Australian born typical aged	7515	88.4	0.9
Ormeau - Oxenford	30907	Rest of Qld	Active ageing and relative advantage	8843	91.2	1.0
Robina	30908	Rest of Qld	Australian born typical aged	6799	86.4	1.0
Southport	30909	Rest of Qld	Australian born typical aged	8181	83.9	1.1
Surfers Paradise	30910	Rest of Qld	Active ageing and relative advantage	6192	87.6	0.7
Forest Lake - Oxley	31001	Greater Brisbane	Foreign born (dissimilar) and relative disadvantage	6875	86.8	1.1
Ipswich Hinterland	31002	Greater Brisbane	Typical aged	8485	90.6	1.0
Ipswich Inner	31003	Greater Brisbane	Typical aged	11869	87.6	1.2
Springfield - Redbank	31004	Greater Brisbane	Australian born typical aged	3776	93.2	1.0
Beaudesert	31101	Greater Brisbane	Typical aged	2120	86.8	1.5
Beenleigh	31102	Greater Brisbane	Australian born typical aged	4711	90.7	1.1

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Browns Plains	31103	Greater Brisbane	Australian born typical aged	5905	91.0	1.3
Jimboomba	31104	Greater Brisbane	Active ageing and relative advantage	2658	95.2	1.0
Loganlea - Carbrook	31105	Greater Brisbane	Australian born typical aged	6040	89.0	1.1
Springwood - Kingston	31106	Greater Brisbane	Australian born typical aged	7512	90.5	1.2
Bowen Basin - North	31201	Rest of Qld	Typical aged	2847	90.7	1.0
Mackay	31202	Rest of Qld	Typical aged	12265	89.6	1.1
Whitsunday	31203	Rest of Qld	Typical aged	1839	92.3	1.1
Bribie - Beachmere	31301	Greater Brisbane	Typical aged	9157	90.7	0.9
Caboolture	31302	Greater Brisbane	Australian born typical aged	6951	87.3	1.3
Caboolture Hinterland	31303	Greater Brisbane	Typical aged	1630	92.0	1.1
Narangba - Burpengary	31304	Greater Brisbane	Typical aged	6489	90.9	1.2
Redcliffe	31305	Greater Brisbane	Typical aged	11018	85.8	1.1
Hills District	31401	Greater Brisbane	Active ageing and relative advantage	7118	92.2	0.8
North Lakes	31402	Greater Brisbane	Australian born typical aged	4896	85.4	1.0

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Strathpine	31403	Greater Brisbane	Australian born typical aged	3764	89.8	1.1
Far North	31501	Rest of Qld	Remote and indigenous	2234	93.5	1.4
Outback - North	31502	Rest of Qld	Remote and indigenous	2419	93.8	1.4
Outback - South	31503	Rest of Qld	Typical aged	2794	90.5	1.2
Buderim	31601	Rest of Qld	Typical aged	8300	85.1	0.7
Caloundra	31602	Rest of Qld	Typical aged	15359	86.8	1.0
Maroochy	31603	Rest of Qld	Typical aged	8809	87.8	1.0
Nambour - Pomona	31604	Rest of Qld	Typical aged	9463	89.0	1.0
Noosa	31605	Rest of Qld	Active ageing and relative advantage	7586	87.3	0.9
Sunshine Coast Hinterland	31606	Rest of Qld	Active ageing and relative advantage	7899	91.0	0.9
Toowoomba	31701	Rest of Qld	Typical aged	20942	86.8	1.1
Charters Towers - Ayr - Ingham	31801	Rest of Qld	Australian born typical aged	7624	88.6	1.3
Townsville	31802	Rest of Qld	Typical aged	17482	89.2	1.1
Bundaberg	31901	Rest of Qld	Typical aged	16952	89.5	1.1
Burnett	31902	Rest of Qld	Typical aged	8806	90.1	1.1
Gympie - Cooloola	31903	Rest of Qld	Typical aged	8410	90.1	1.1
Hervey Bay	31904	Rest of Qld	Typical aged	12154	89.9	1.2
Maryborough	31905	Rest of Qld	Typical aged	8459	90.1	1.1
Adelaide City	40101	Greater Adelaide	Foreign born (dissimilar) and relative advantage	2335	83.7	0.9

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Adelaide Hills	40102	Greater Adelaide	Active ageing and relative advantage	8868	88.6	0.9
Burnside	40103	Greater Adelaide	Foreign born (dissimilar) and relative advantage	8921	82.5	0.9
Campbelltown (SA)	40104	Greater Adelaide	Foreign born (dissimilar) and relative disadvantage	9755	86.2	0.9
Norwood - Payneham - St Peters	40105	Greater Adelaide	Foreign born (dissimilar) and relative advantage	6419	79.9	0.9
Prospect - Walkerville	40106	Greater Adelaide	Foreign born (dissimilar) and relative advantage	4152	81.8	1.1
Unley	40107	Greater Adelaide	Foreign born (dissimilar) and relative advantage	6096	75.0	1.3
Gawler - Two Wells	40201	Greater Adelaide	Australian born typical aged	4658	88.5	0.9
Playford	40202	Greater Adelaide	Australian born typical aged	9680	89.3	1.4
Port Adelaide - East	40203	Greater Adelaide	Foreign born (dissimilar) and relative disadvantage	9289	84.8	1.1
Salisbury	40204	Greater Adelaide	Foreign born (dissimilar) and relative disadvantage	15529	89.4	1.2
Tea Tree Gully	40205	Greater Adelaide	Australian born typical aged	13805	88.1	0.9
Holdfast Bay	40301	Greater Adelaide	Australian born typical aged	7422	77.4	0.9
Marion	40302	Greater Adelaide	Australian born typical aged	14449	82.8	1.0

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Mitcham	40303	Greater Adelaide	Foreign born (dissimilar) and relative advantage	11171	82.6	0.7
Onkaparinga	40304	Greater Adelaide	Australian born typical aged	22565	87.6	1.0
Charles Sturt	40401	Greater Adelaide	Foreign born (dissimilar) and relative disadvantage	19210	83.0	1.0
Port Adelaide - West	40402	Greater Adelaide	Foreign born (dissimilar) and relative disadvantage	8677	83.7	1.2
West Torrens	40403	Greater Adelaide	Foreign born (dissimilar) and relative disadvantage	10664	81.8	1.0
Barossa	40501	Rest of SA	Typical aged	5213	86.1	1.1
Lower North	40502	Rest of SA	Typical aged	4331	85.4	1.1
Mid North	40503	Rest of SA	Typical aged	5448	87.2	1.2
Yorke Peninsula	40504	Rest of SA	Typical aged	6269	88.8	1.2
Eyre Peninsula and South West	40601	Rest of SA	Australian born typical aged	8853	87.9	1.2
Outback - North and East	40602	Rest of SA	Remote and indigenous	3159	91.0	1.4
Fleurieu - Kangaroo Island	40701	Rest of SA	Typical aged	12356	88.1	0.9
Limestone Coast	40702	Rest of SA	Typical aged	10010	87.1	1.1
Murray and Mallee	40703	Rest of SA	Australian born typical aged	12286	87.7	1.0
Augusta - Margaret River - Busselton	50101	Rest of WA	Typical aged	6631	88.6	1.0
Bunbury	50102	Rest of WA	Australian born typical aged	11975	88.9	1.1

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Manjimup	50103	Rest of WA	Typical aged	3650	90.3	0.9
Mandurah	50201	Greater Perth	Typical aged	17518	90.1	1.0
Cottesloe - Claremont	50301	Greater Perth	Active ageing and relative advantage	11183	83.4	0.8
Perth City	50302	Greater Perth	Foreign born (dissimilar) and relative advantage	10863	83.2	1.0
Bayswater - Bassendean	50401	Greater Perth	Foreign born (dissimilar) and relative disadvantage	11499	85.4	1.0
Mundaring	50402	Greater Perth	Active ageing and relative advantage	5532	89.9	0.8
Swan	50403	Greater Perth	Australian born typical aged	9768	90.6	1.1
Joondalup	50501	Greater Perth	Active ageing and relative advantage	17481	88.4	0.8
Stirling	50502	Greater Perth	Foreign born (dissimilar) and relative advantage	28297	86.0	0.8
Wanneroo	50503	Greater Perth	Australian born typical aged	14121	89.9	1.1
Armadale	50601	Greater Perth	Australian born typical aged	7092	90.3	1.1
Belmont - Victoria Park	50602	Greater Perth	Australian born typical aged	8008	85.8	1.0
Canning	50603	Greater Perth	Australian born typical aged	11863	83.6	1.0
Gosnells	50604	Greater Perth	Australian born typical aged	11390	90.6	1.0
Kalamunda	50605	Greater Perth	Active ageing and relative advantage	7785	90.1	0.9
Serpentine - Jarrahdale	50606	Greater Perth	Active ageing and relative advantage	1680	92.0	0.9

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
South Perth	50607	Greater Perth	Foreign born (dissimilar) and relative advantage	5754	80.6	1.1
Cockburn	50701	Greater Perth	Foreign born (dissimilar) and relative disadvantage	9447	90.2	1.1
Fremantle	50702	Greater Perth	Foreign born (dissimilar) and relative advantage	5694	86.1	1.1
Kwinana	50703	Greater Perth	Australian born typical aged	2851	91.0	1.0
Melville	50704	Greater Perth	Foreign born (dissimilar) and relative advantage	16568	84.1	0.7
Rockingham	50705	Greater Perth	Australian born typical aged	12613	90.3	1.0
Esperance	50801	Rest of WA	Typical aged	2213	90.5	1.1
Gascoyne	50802	Rest of WA	Remote and indigenous	1144	94.1	1.0
Goldfields	50803	Rest of WA	Remote and indigenous	2262	91.5	1.6
Kimberley	50804	Rest of WA	Remote and indigenous	1734	93.7	2.1
Mid West	50805	Rest of WA	Typical aged	6964	90.7	1.1
Pilbara	50806	Rest of WA	Remote and indigenous	1183	94.5	1.1
Albany	50901	Rest of WA	Typical aged	9407	88.6	1.0
Wheat Belt - North	50902	Rest of WA	Typical aged	8622	90.8	1.0
Wheat Belt - South	50903	Rest of WA	Typical aged	3175	88.9	1.2
Brighton	60101	Greater Hobart	Typical aged	1509	90.2	1.5
Hobart - North East	60102	Greater Hobart	Typical aged	8520	86.3	1.1
Hobart - North West	60103	Greater Hobart	Australian born typical aged	8608	86.5	1.3
Hobart - South and West	60104	Greater Hobart	Typical aged	4577	88.1	1.2

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Hobart Inner	60105	Greater Hobart	Foreign born (dissimilar) and relative advantage	7321	82.1	1.2
Sorell - Dodges Ferry	60106	Greater Hobart	Typical aged	2206	90.7	1.2
Launceston	60201	Rest of Tas.	Typical aged	13105	84.7	1.2
Meander Valley - West Tamar	60202	Rest of Tas.	Typical aged	3982	91.1	0.9
North East	60203	Rest of Tas.	Typical aged	6718	90.9	1.2
Central Highlands (Tas.)	60301	Rest of Tas.	Typical aged	1610	92.6	1.0
Huon - Bruny Island	60302	Rest of Tas.	Typical aged	3091	92.2	1.2
South East Coast	60303	Rest of Tas.	Typical aged	1647	92.5	1.3
Burnie - Ulverstone	60401	Rest of Tas.	Typical aged	8978	87.8	1.2
Devonport	60402	Rest of Tas.	Typical aged	7933	87.4	1.0
West Coast	60403	Rest of Tas.	Typical aged	2509	91.2	1.2
Darwin City	70101	Greater Darwin	Foreign born (dissimilar) and relative advantage	1663	95.1	1.4
Darwin Suburbs	70102	Greater Darwin	Foreign born (dissimilar) and relative advantage	4050	95.2	1.1
Litchfield	70103	Greater Darwin	Active ageing and relative advantage	1312	97.3	1.1
Palmerston	70104	Greater Darwin	Remote and indigenous	1118	94.5	1.5
Alice Springs	70201	Rest of NT	Remote and indigenous	2167	93.2	1.7
Barkly	70202	Rest of NT	Remote and indigenous	399	94.5	2.6

Location Name	SA3 Code	State Region	Key indicators of the aged and ageing process in 2011			
			Area Type	Head count 65 and over	Early-aged proportion	Standardised Mortality Ratio
Daly - Tiwi - West Arnhem	70203	Rest of NT	Remote and indigenous	735	97.3	3.2
East Arnhem	70204	Rest of NT	Remote and indigenous	330	95.2	3.2
Katherine	70205	Rest of NT	Remote and indigenous	1068	95.0	2.3
Belconnen	80101	ACT	Foreign born (dissimilar) and relative advantage	10460	89.3	1.0
Fyshwick - Pialligo - Hume	80103	ACT	Typical aged	203	93.6	0.8
Gungahlin	80104	ACT	Foreign born (dissimilar) and relative advantage	2273	94.1	0.6
North Canberra	80105	ACT	Foreign born (dissimilar) and relative advantage	5311	83.6	0.9
South Canberra	80106	ACT	Foreign born (dissimilar) and relative advantage	3658	79.5	1.0
Tuggeranong (including Cotter Namadgi)	80107	ACT	Foreign born (dissimilar) and relative advantage	6926	91.9	0.8
Weston Creek	80108	ACT	Foreign born (dissimilar) and relative advantage	3944	87.4	1.0
Woden	80109	ACT	Foreign born (dissimilar) and relative advantage	6110	86.1	0.9

SA3 Code	Key indicators of the aged and ageing process in 2011							
	Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
10101	25.2	25.7	24.7	30.8	57.2	112	2017	369
10102	20.6	20.4	20.8	15.9	30.5	112	878	1046
10103	23.0	22.8	23.2	27.5	48.7	103	465	209
10104	24.2	25.6	22.8	43.9	93.7	104	2351	780
10201	29.9	31.3	28.8	33.9	62.8	126	4974	1987
10202	29.1	31.9	26.8	34.2	73.3	124	5109	1649
10301	27.7	28.1	27.4	24.4	53.0	116	930	206
10302	29.8	31.2	28.5	37.2	66.9	114	1859	166
10303	26.6	26.9	26.3	32.0	71.3	109	1301	295
10304	28.0	29.0	27.1	26.1	50.4	118	1341	360
10401	23.9	25.3	22.6	39.1	99.0	110	1958	167
10402	27.0	29.3	24.9	32.2	73.2	116	2446	564
10501	28.3	29.3	27.2	25.9	57.2	87	590	155
10502	32.1	33.0	31.3	32.5	78.5	127	790	128
10503	25.9	27.4	24.6	29.3	56.6	115	1843	239
10601	29.4	28.8	30.0	22.6	59.7	116	2211	224
10602	24.7	24.8	24.7	21.5	50.8	123	1469	300
10603	20.3	21.8	19.0	37.1	77.0	106	1892	534

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
10604	28.0	28.8	27.3	22.2	47.3	115	593	56
10701	27.0	30.0	24.6	30.1	74.3	118	2869	3360
10703	24.9	26.9	23.2	27.6	61.8	120	2550	1699
10704	24.6	26.3	23.3	25.6	60.7	120	3706	3519
10801	26.7	28.8	24.8	59.0	124.2	106	1301	262
10802	28.0	29.4	26.8	39.8	110.7	108	1933	222
10803	12.3	11.5	12.9	26.9	36.6	141	11	0
10804	24.8	26.9	22.9	47.3	91.6	117	2723	523
10805	25.9	27.6	24.4	42.7	97.6	109	1919	270
10901	29.4	30.2	28.8	26.7	51.4	123	1547	463
10902	22.3	24.0	20.4	29.9	57.3	95	344	127
10903	25.5	28.1	23.0	43.3	69.0	102	1307	208
11001	24.4	25.2	23.7	26.7	56.1	122	887	127
11002	27.2	27.4	27.0	37.9	79.3	111	1226	137
11003	28.9	29.4	28.4	23.5	47.1	103	536	55
11004	26.1	27.2	25.3	31.2	59.1	117	2151	208
11101	24.1	26.1	22.5	31.1	63.3	121	3592	1049
11102	32.5	33.6	31.5	33.5	73.0	118	2859	508
11103	31.4	31.6	31.3	24.8	57.0	132	5049	2257

SA3 Code	Key indicators of the aged and ageing process in 2011 Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
11201	27.3	28.9	25.9	31.1	68.9	119	2149	478
11202	29.3	30.6	28.2	27.5	68.4	119	2050	404
11203	30.6	34.2	27.5	42.1	84.9	116	3642	694
11301	26.9	28.2	25.7	26.8	49.9	113	1284	1241
11302	24.6	24.6	24.6	33.4	62.1	107	399	76
11303	25.7	26.2	25.3	26.7	54.5	121	2206	278
11401	27.5	30.3	25.1	43.2	95.7	109	3490	1183
11402	22.8	24.1	21.7	40.6	67.0	114	1387	527
11501	20.7	19.3	22.0	20.1	37.8	115	2636	4379
11502	21.8	22.2	21.5	26.4	41.7	100	581	726
11503	12.2	12.1	12.3	18.6	34.5	93	309	228
11504	12.1	12.6	11.6	13.7	27.9	97	274	546
11601	23.8	25.2	22.7	18.0	48.9	120	3048	5522
11602	13.5	13.0	13.9	9.5	29.9	106	860	1886
11603	24.7	24.6	24.8	14.5	57.4	123	2406	3447
11701	23.7	24.7	22.9	22.8	50.6	124	1206	2819
11702	25.2	28.2	22.4	15.6	36.7	107	1486	3363
11703	20.7	20.4	21.0	9.2	30.2	102	2178	4448
11801	22.6	22.7	22.6	19.8	32.9	127	2210	5011

SA3 Code	Key indicators of the aged and ageing process in 2011 Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
11802	27.5	28.9	26.4	19.4	47.3	127	3189	6064
11901	28.2	29.0	27.5	23.5	68.5	119	5307	8930
11902	20.9	22.9	19.2	21.4	66.9	111	3738	10564
11903	24.1	24.4	23.9	25.0	55.6	128	3635	6714
11904	25.9	27.3	24.9	23.3	51.4	122	4086	9084
12001	22.3	23.4	21.4	21.7	42.0	122	1994	4667
12002	24.1	25.0	23.3	14.3	28.0	125	1013	1439
12003	28.4	29.2	27.8	19.8	45.1	124	4745	10396
12101	24.5	24.0	24.9	20.2	39.1	130	2130	3816
12102	25.0	25.1	24.9	20.9	39.6	120	1531	2121
12103	23.5	23.8	23.3	31.9	51.3	125	2439	3523
12104	20.6	19.5	21.4	19.6	31.6	132	1411	1759
12201	18.9	19.8	18.1	20.7	36.9	120	588	593
12202	25.6	25.5	25.6	29.3	43.8	116	1256	833
12203	27.8	28.6	27.2	25.5	40.8	128	3551	3275
12301	25.9	24.3	27.2	15.2	31.7	130	924	507
12302	22.7	22.7	22.7	14.9	48.2	118	3046	3491
12303	19.5	19.8	19.2	18.9	41.8	106	675	435
12401	24.7	25.3	24.3	26.2	51.8	129	1710	849

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
12403	23.3	22.7	23.9	15.8	38.8	118	2353	2171
12404	30.0	30.4	29.6	18.5	47.6	128	859	463
12405	20.0	19.9	20.1	14.1	42.2	113	931	1447
12501	23.0	22.1	23.7	13.0	65.4	111	1698	3968
12502	20.7	22.3	19.4	24.1	53.7	116	1311	2571
12503	27.2	27.7	26.8	20.1	69.8	117	4188	7719
12504	28.0	26.3	29.3	17.5	46.8	128	3225	4977
12601	21.3	22.8	20.1	25.1	46.7	127	899	1377
12602	28.8	29.3	28.4	23.0	50.0	132	3635	6177
12701	16.5	18.4	14.9	14.3	51.6	109	1706	3582
12702	19.9	21.8	18.3	19.6	76.2	113	6353	14684
12703	22.8	23.7	22.1	16.0	54.1	118	2625	4707
12801	24.2	26.1	22.7	28.7	44.8	127	2481	2195
12802	23.9	24.3	23.5	20.2	36.5	119	1972	1661
20101	27.1	27.9	26.5	25.1	55.7	131	2567	553
20102	23.1	22.8	23.3	28.8	59.2	103	673	246
20103	28.0	28.8	27.3	39.2	92.9	99	863	142
20201	31.3	31.9	30.8	26.6	57.6	129	2430	330
20202	25.7	26.3	25.2	31.6	64.1	105	1085	288

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
20203	29.5	32.1	26.8	36.7	71.4	92	335	66
20301	20.8	20.0	21.5	20.0	43.0	95	334	89
20302	29.1	30.5	28.0	26.8	58.2	127	5544	4193
20303	23.2	24.5	22.1	33.6	62.1	116	1694	664
20401	22.9	23.9	22.1	32.9	61.2	103	1510	449
20402	28.0	29.2	27.0	35.7	60.3	119	1351	495
20403	23.6	24.4	22.9	26.5	51.9	114	1740	898
20501	22.0	22.0	22.0	29.0	54.2	111	1043	347
20502	23.0	24.4	21.6	42.8	83.3	103	1401	375
20503	23.7	24.8	22.7	39.1	70.7	108	1811	730
20504	28.7	29.9	27.7	26.4	65.9	116	2136	1308
20505	28.3	29.3	27.5	28.8	66.6	113	1132	310
20601	25.4	29.1	22.4	17.0	41.1	126	2650	6034
20602	31.0	34.7	28.1	18.0	38.4	124	1703	3644
20603	31.0	32.9	29.7	18.4	39.5	138	1862	2934
20604	19.6	18.8	20.3	8.1	40.1	103	1111	1640
20605	23.7	24.7	22.7	12.8	27.7	109	1567	2888
20606	21.5	22.7	20.6	20.1	35.2	125	1242	2352
20607	21.7	24.2	19.6	12.8	31.1	120	1724	3277

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
20701	27.8	27.2	28.3	23.9	43.4	136	4224	5600
20702	19.3	20.5	18.3	35.5	60.9	115	2993	7512
20703	27.8	30.8	25.7	28.2	57.0	137	2595	4348
20801	31.2	30.9	31.5	30.8	50.3	136	2653	2494
20802	30.2	31.5	29.2	23.1	43.4	138	4155	7885
20803	27.3	29.3	25.8	26.2	46.2	131	3176	3458
20804	23.8	24.4	23.4	21.9	41.7	132	927	1343
20901	25.3	26.2	24.7	25.6	48.7	129	3425	4058
20902	29.9	32.8	27.6	24.8	64.1	130	3505	7489
20903	16.0	14.4	17.4	14.9	31.4	107	676	743
20904	20.2	22.3	18.3	16.5	48.4	111	4341	9628
21001	20.7	23.5	18.2	33.4	58.2	116	2165	5145
21002	14.7	13.9	15.6	20.1	39.4	101	402	239
21003	32.6	38.0	28.5	30.6	69.3	137	3462	6269
21004	22.2	23.7	21.0	16.8	37.7	122	714	558
21005	18.1	20.4	16.0	14.1	59.6	105	2974	6141
21101	23.4	23.7	23.2	20.3	41.1	123	3414	4120
21102	19.2	18.6	19.7	24.1	41.1	111	545	779
21103	27.5	28.3	26.9	24.3	44.5	132	2603	1752

SA3 Code	Key indicators of the aged and ageing process in 2011 Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
21104	22.7	24.1	21.7	29.2	52.0	130	1396	2352
21105	19.8	20.3	19.4	20.3	41.7	109	2592	1613
21201	22.2	23.7	20.8	17.7	39.6	111	1267	691
21202	24.7	26.3	23.4	17.0	44.1	122	2728	4123
21203	20.9	21.8	20.1	12.0	37.6	113	1898	2515
21204	24.4	25.9	23.2	23.0	66.4	118	5835	12942
21205	20.7	22.6	19.2	28.3	59.2	120	4997	10266
21301	20.8	21.6	20.2	17.4	59.7	113	5373	12985
21302	27.2	30.1	24.9	22.2	49.9	124	2517	4446
21303	32.9	35.8	30.6	14.5	43.1	123	1971	3700
21304	20.3	19.5	21.1	11.6	41.2	115	1989	2421
21305	19.6	19.9	19.4	10.6	37.7	114	2299	3358
21401	24.8	26.7	23.3	22.4	47.7	126	2655	1863
21402	22.9	25.2	21.0	39.4	66.6	119	4078	2356
21501	29.5	30.1	29.0	37.0	66.2	116	2126	238
21502	26.5	27.7	25.4	28.5	62.6	116	1566	937
21503	27.7	28.8	26.8	36.5	64.5	111	1244	344
21601	24.0	25.0	23.1	35.1	62.8	111	1172	254
21602	27.6	29.7	25.7	40.1	73.1	105	1044	288

SA3 Code	Key indicators of the aged and ageing process in 2011							
	Per cent of the aged above the prospective threshold of aged (note: average of males and females)	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
21603	26.9	27.2	26.6	25.6	56.4	113	1677	1051
21701	31.9	32.5	31.4	32.8	59.3	115	1159	114
21702	26.6	27.3	26.1	30.5	53.1	121	2263	250
30101	23.1	23.6	22.6	18.5	38.4	117	1407	731
30102	25.9	27.1	24.9	29.4	55.0	115	2133	766
30103	27.3	27.9	26.8	20.7	40.5	126	1469	492
30201	21.8	21.8	21.8	24.2	41.6	128	878	607
30202	30.5	32.1	29.4	25.1	44.0	146	1596	1129
30203	25.0	25.2	24.8	18.4	37.0	130	763	409
30204	33.4	35.7	31.6	24.2	47.2	135	1759	626
30301	30.1	30.5	29.8	20.4	37.7	135	1183	979
30302	31.3	31.6	31.1	14.5	33.5	135	1284	1072
30303	26.3	27.0	25.8	21.7	48.6	129	1583	1745
30304	24.5	26.6	23.0	20.7	48.1	132	805	672
30305	28.7	28.0	29.3	13.5	37.9	112	1056	1187
30306	19.4	18.9	19.8	16.4	51.5	118	992	1402
30401	27.4	26.2	28.4	18.4	34.7	115	734	659
30402	21.2	20.3	21.9	23.5	38.6	114	666	670
30403	25.9	26.8	25.2	15.8	45.5	138	655	476

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
30404	29.4	28.2	30.4	20.9	39.2	138	1126	446
30501	32.7	29.7	35.4	11.2	31.2	110	1056	1221
30502	23.1	23.6	22.8	11.0	25.1	119	499	303
30503	25.2	23.9	26.1	13.7	30.2	125	1237	864
30504	21.8	22.3	21.4	11.9	27.4	124	636	428
30601	16.8	16.7	16.9	13.8	31.5	93	542	391
30602	26.4	26.3	26.5	16.2	41.6	105	1823	1052
30603	23.6	25.7	21.5	26.8	58.4	95	878	599
30604	20.0	20.9	19.0	19.0	40.9	89	207	89
30605	22.4	23.7	21.0	32.8	68.1	97	1036	780
30701	26.4	28.8	24.0	23.4	40.2	100	961	90
30702	24.0	25.7	22.4	28.5	54.1	103	1043	99
30703	24.7	25.3	24.1	34.9	68.5	108	1245	403
30801	14.9	16.1	13.4	9.6	25.1	81	243	36
30802	19.9	21.1	18.8	15.8	38.0	100	1083	248
30803	27.7	29.0	26.6	23.9	51.2	115	2361	296
30901	22.0	24.5	20.0	28.1	50.2	122	1467	1085
30902	25.0	27.7	22.7	29.0	56.4	116	1290	429
30903	26.2	28.6	24.2	33.3	62.6	118	2150	1082

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
30904	11.5	13.5	9.4	25.5	54.4	96	308	126
30905	15.0	15.8	14.3	17.3	39.4	101	514	282
30906	21.4	21.3	21.5	19.3	41.4	108	1175	708
30907	18.2	18.9	17.5	15.2	36.3	100	1354	713
30908	26.5	27.0	26.0	24.0	49.5	117	1156	914
30909	31.6	31.9	31.5	22.8	53.1	129	1620	889
30910	15.9	17.2	14.7	24.8	48.6	105	747	786
31001	27.5	29.3	26.1	17.1	59.6	135	1173	1442
31002	19.5	20.0	19.1	25.3	65.5	95	1473	206
31003	27.9	28.8	27.1	20.8	53.3	121	2353	411
31004	14.5	15.4	13.7	9.1	34.4	108	632	637
31101	33.6	33.7	33.5	30.3	65.3	104	428	45
31102	22.9	25.3	20.9	20.6	56.1	111	863	357
31103	24.8	26.6	23.2	13.2	40.6	110	1249	829
31104	11.5	12.4	10.4	11.6	32.8	87	399	190
31105	22.9	23.0	22.9	17.5	40.7	112	986	630
31106	20.3	19.6	21.0	15.8	49.3	105	1316	1125
31201	19.7	20.5	18.7	12.3	30.4	91	402	87
31202	23.1	23.9	22.3	17.2	37.9	109	2133	534

SA3 Code	Key indicators of the aged and ageing process in 2011							
	Per cent of the aged above the prospective threshold of aged (note: average of males and females)	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
31203	18.6	18.4	18.8	14.3	33.5	88	267	88
31301	19.1	22.8	15.6	57.5	123.4	105	1409	320
31302	29.5	31.3	27.9	20.0	55.6	108	1272	423
31303	18.5	19.3	17.6	23.1	73.3	93	249	43
31304	23.0	25.4	20.8	18.7	47.0	109	1109	372
31305	30.2	31.8	29.0	33.1	68.6	129	2110	623
31401	12.5	12.0	13.0	14.1	30.2	104	878	477
31402	25.5	25.2	25.7	15.4	35.8	126	968	317
31403	21.9	21.3	22.3	16.6	40.0	116	612	258
31501	20.8	24.4	16.0	11.8	57.5	78	385	190
31502	22.3	22.9	21.6	11.1	30.0	83	349	123
31503	26.8	28.8	24.7	23.1	37.2	91	431	43
31601	21.3	23.7	19.5	31.9	57.6	128	1279	391
31602	25.3	27.8	23.2	38.8	71.3	119	2347	633
31603	24.1	25.7	22.7	26.7	55.6	115	1379	358
31604	22.5	23.4	21.6	27.4	61.0	104	1619	378
31605	21.2	22.1	20.4	36.3	69.6	113	1120	385
31606	16.6	18.4	14.8	28.9	61.1	98	946	346
31701	26.4	28.0	25.3	25.6	52.8	127	3166	597

SA3 Code	Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
	Key indicators of the aged and ageing process in 2011							
31801	29.9	30.9	28.9	31.3	59.8	110	1425	867
31802	24.1	24.7	23.5	15.7	37.9	113	3095	963
31901	23.4	26.0	21.0	35.7	81.9	105	2854	672
31902	23.2	24.3	22.1	33.2	79.1	92	1543	174
31903	21.3	22.7	19.8	32.5	81.3	96	1173	239
31904	24.5	27.5	21.6	42.9	106.4	107	2128	487
31905	22.4	23.3	21.6	34.8	100.5	99	1406	188
40101	26.2	25.1	27.1	14.6	62.2	113	377	258
40102	20.0	19.9	20.0	21.3	39.5	109	1222	495
40103	29.8	29.9	29.8	35.3	54.9	131	1246	1489
40104	24.5	26.7	22.7	33.7	62.2	126	1842	3689
40105	31.9	33.2	31.0	28.0	54.0	150	1487	1972
40106	34.6	36.0	33.7	23.5	46.1	138	863	1082
40107	43.0	39.6	45.2	25.3	46.6	155	1578	1236
40201	22.0	25.3	19.2	24.8	51.3	114	719	325
40202	32.5	36.2	29.4	20.5	68.2	124	2074	941
40203	32.2	35.0	30.0	23.7	64.6	128	1918	2140
40204	25.7	27.7	23.9	19.2	56.0	119	3226	2896
40205	22.0	22.7	21.5	24.1	46.9	118	2120	1532

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
40301	35.6	34.3	36.5	35.6	59.6	148	1312	454
40302	31.2	33.4	29.6	27.1	55.2	139	2510	1744
40303	24.3	24.0	24.5	29.9	51.6	125	1612	1448
40304	24.7	26.3	23.4	22.7	51.3	117	3846	1570
40401	30.6	32.5	29.1	30.2	62.0	127	4164	6281
40402	34.3	36.4	32.9	23.8	62.5	135	2022	2130
40403	33.0	35.9	30.9	28.5	55.1	135	2155	3062
40501	28.3	27.9	28.6	26.5	48.9	116	815	120
40502	29.2	28.9	29.5	34.9	65.2	108	746	86
40503	29.2	29.9	28.6	36.0	80.3	114	1009	226
40504	27.2	29.0	25.5	48.8	103.0	104	1006	128
40601	27.5	28.6	26.6	26.5	56.1	114	1437	479
40602	26.8	26.5	27.2	17.3	48.1	90	547	252
40701	22.1	24.1	20.3	49.3	89.4	109	1775	301
40702	27.4	28.7	26.4	26.9	50.4	120	1554	497
40703	24.8	25.2	24.4	31.3	67.1	108	2085	837
50101	24.7	26.9	22.8	26.3	51.7	119	823	271
50102	24.0	25.3	22.8	20.6	48.0	116	1891	949
50103	16.7	16.4	16.9	28.4	56.2	98	491	263

SA3 Code	Key indicators of the aged and ageing process in 2011							
	Per cent of the aged above the prospective threshold of aged (note: average of males and females)	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
50201	22.1	24.5	19.8	36.6	77.4	107	2244	725
50301	23.5	22.1	24.6	28.0	51.7	124	1245	1236
50302	30.8	29.3	32.0	15.2	32.7	127	2116	3025
50401	27.2	27.9	26.6	21.9	43.8	121	2113	3315
50402	15.8	16.4	15.3	21.5	51.8	106	696	574
50403	23.0	24.5	21.7	14.7	37.5	112	1554	2015
50501	19.0	19.0	19.0	17.2	34.8	115	2168	2292
50502	22.7	24.5	21.3	23.6	45.6	130	4283	7189
50503	23.3	25.6	21.4	14.7	37.8	116	2144	2295
50601	21.7	23.0	20.4	17.8	44.0	110	983	689
50602	26.6	28.3	25.2	17.2	40.8	129	1370	1831
50603	30.5	29.6	31.1	19.8	46.9	133	2214	2587
50604	20.3	21.9	18.9	16.3	42.9	114	1625	2043
50605	17.6	19.1	16.3	23.1	43.0	113	914	939
50606	14.6	17.2	11.8	14.9	40.5	90	223	128
50607	34.1	31.6	35.8	19.8	41.9	142	1017	870
50701	22.9	23.6	22.3	16.2	38.0	112	1599	2539
50702	30.3	33.2	28.0	24.5	47.8	118	1009	1431
50703	18.6	20.0	17.3	15.0	50.3	102	449	249

SA3 Code	Key indicators of the aged and ageing process in 2011 Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
50704	22.5	23.1	22.0	26.1	47.1	130	2261	2829
50705	21.3	24.2	18.8	19.6	47.0	112	1850	827
50801	21.8	23.1	20.5	24.0	43.3	109	279	52
50802	15.9	18.7	12.2	19.0	41.9	74	164	103
50803	26.0	24.2	28.0	7.9	28.5	96	407	168
50804	28.9	32.0	24.8	7.3	49.6	81	345	70
50805	21.6	23.8	19.3	21.2	47.3	99	1011	314
50806	10.1	8.9	12.0	2.6	13.9	67	186	102
50901	23.3	24.8	22.0	29.0	58.6	112	1424	511
50902	20.0	21.4	18.5	26.9	53.3	96	1050	378
50903	26.5	27.3	25.6	25.2	42.1	98	439	105
60101	24.5	24.6	24.3	15.9	59.4	101	325	49
60102	28.6	30.9	26.9	28.8	60.3	123	1442	293
60103	32.0	34.2	30.3	28.5	68.2	130	1703	578
60104	27.7	29.8	26.0	24.8	49.1	120	728	236
60105	35.3	34.3	36.0	22.3	48.5	127	1380	806
60106	27.7	30.5	25.0	24.7	56.2	101	400	59
60201	32.8	34.5	31.6	27.2	59.3	130	2585	509
60202	18.4	20.5	16.4	30.4	68.2	99	556	88

	Key indicators of the aged and ageing process in 2011							
SA3 Code	**Per cent of the aged above the prospective threshold of aged (note: average of males and females)**	**Per cent of the aged above the prospective threshold of aged (males)**	**Per cent of the aged above the prospective threshold of aged (females)**	**Old Age Dependency Ratio**	**Economic Support Ratio**	**Sex Ratio**	**Disabled population (count)**	**Foreign Born (Dissimilar) (count)**
60203	22.7	24.6	20.8	30.9	74.4	95	1026	144
60301	16.4	16.5	16.3	22.5	67.5	82	259	31
60302	21.9	24.3	19.2	28.1	73.5	86	473	98
60303	21.8	22.5	21.0	42.1	94.8	89	223	39
60401	27.0	28.8	25.6	32.0	72.8	118	1519	208
60402	23.8	24.6	23.1	30.9	71.1	114	1331	159
60403	22.0	22.9	21.0	22.6	52.4	88	370	60
70101	22.9	24.0	21.4	9.0	23.2	74	232	278
70102	14.8	14.7	15.0	11.1	32.3	94	643	950
70103	12.5	15.1	8.7	10.1	25.1	68	121	97
70104	22.6	24.7	20.6	6.1	21.0	98	216	121
70201	25.4	25.5	25.3	8.1	39.4	103	389	110
70202	26.4	25.7	27.2	10.2	67.3	71	83	19
70203	31.1	33.8	27.5	6.8	68.4	72	143	15
70204	27.7	24.2	30.8	3.4	58.0	86	77	16
70205	28.9	32.3	24.5	8.8	44.9	71	193	35
80101	20.7	20.5	20.8	17.0	36.9	117	1500	1993
80103	7.9	12.4	2.2	18.1	91.3	74	21	9
80104	6.8	7.1	6.6	7.2	21.2	108	264	642

SA3 Code	Key indicators of the aged and ageing process in 2011 Per cent of the aged above the prospective threshold of aged (note: average of males and females)	Per cent of the aged above the prospective threshold of aged (males)	Per cent of the aged above the prospective threshold of aged (females)	Old Age Dependency Ratio	Economic Support Ratio	Sex Ratio	Disabled population (count)	Foreign Born (Dissimilar) (count)
80105	28.1	31.5	25.6	15.1	39.9	128	867	938
80106	35.3	32.9	37.0	22.3	37.3	134	707	548
80107	14.2	15.5	13.2	12.0	27.4	112	948	1364
80108	21.0	20.3	21.6	28.9	45.4	116	646	596
80109	24.5	26.4	23.1	30.2	45.4	129	907	1028

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
10101	3042	55.4	2.8	18.7	21.6	3.5	5.2
10102	1342	47.5	4.4	19.2	22.1	3.9	5.6
10103	799	51.1	3.1	19.7	22.5	3.3	5.2
10104	3600	53.1	2.0	19.0	21.9	3.1	4.8
10201	8561	49.6	2.6	19.3	22.1	3.2	4.6
10202	7309	58.3	1.3	18.5	21.4	3.4	5.1
10301	1602	53.7	2.7	17.9	20.8	2.9	4.3
10302	2876	57.7	1.8	18.1	21.1	3.1	4.6
10303	2083	60.2	2.1	17.7	20.7	3.3	4.4
10304	2116	54.7	2.7	18.1	21.1	3.0	4.8
10401	2448	59.1	1.2	19.1	22.0	4.1	5.4
10402	3537	54.3	1.6	18.8	21.7	3.4	5.0
10501	1126	56.0	2.7	16.8	19.8	3.1	4.1
10502	1156	61.4	1.1	17.6	20.5	3.4	5.3
10503	2861	57.3	2.0	18.6	21.5	3.4	4.9
10601	2602	60.1	2.1	17.4	20.3	3.4	5.4
10602	1976	58.8	2.2	19.1	22.0	3.8	5.5
10603	2949	52.0	2.4	19.7	22.6	3.6	5.0
10604	1033	55.2	2.4	17.7	20.6	3.1	4.0
10701	2796	65.2	0.9	18.5	21.4	4.2	6.7
10703	2928	60.0	1.7	18.9	21.7	3.7	6.0

	Key indicators of the aged and ageing process in 2011						
SA3 Code	**Lone Person Households (Count)**	**Per cent of aged with low income**	**Per cent of aged with high income**	**Remaining life expectancy at age 65 (males)**	**Remaining life expectancy at age 65 (females)**	**Expected years to be lived with disability at age 65 (males)**	**Expected years to be lived with disability (females)**
10704	4953	55.7	2.5	20.2	23.0	4.1	6.2
10801	2121	55.7	1.8	19.2	22.1	3.4	4.4
10802	2496	62.1	1.1	18.3	21.2	3.8	5.3
10803	13	54.8	6.8	16.2	19.2	0.9	0.3
10804	4264	55.2	1.6	19.7	22.5	3.2	4.9
10805	2728	59.3	1.5	18.5	21.4	3.4	4.9
10901	2419	51.7	2.4	18.3	21.2	3.1	4.8
10902	501	56.2	2.3	18.8	21.7	3.8	5.1
10903	2301	55.7	1.5	18.7	21.6	3.0	4.2
11001	1452	49.7	3.6	19.1	22.0	3.5	5.0
11002	2016	59.3	1.4	17.9	20.8	3.4	4.2
11003	915	50.0	3.4	17.0	19.9	2.9	4.1
11004	3410	57.1	1.7	18.5	21.4	3.4	4.6
11101	5154	57.1	1.9	19.8	22.6	3.6	5.5
11102	2885	55.5	1.8	17.8	20.7	3.6	5.4
11103	6850	55.2	2.5	18.7	21.6	3.6	5.6
11201	3399	51.0	2.7	19.6	22.5	3.4	4.8
11202	2805	58.7	1.4	18.3	21.2	3.4	5.0
11203	4840	55.9	1.6	18.7	21.6	3.5	5.1
11301	1778	55.8	1.8	18.9	21.8	3.8	5.3
11302	688	61.8	2.1	19.3	22.2	3.0	4.8
11303	3596	55.0	2.2	19.3	22.2	3.3	4.9
11401	4931	57.6	1.6	18.2	21.1	3.2	4.8

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
11402	2169	42.9	5.2	19.3	22.2	3.1	4.9
11501	2432	41.7	5.5	20.6	23.4	3.4	6.2
11502	654	38.4	7.7	19.9	22.8	3.1	5.6
11503	395	47.6	4.6	21.5	24.2	3.8	6.2
11504	321	47.2	5.0	20.4	23.2	4.4	5.1
11601	3012	61.5	1.1	18.9	21.8	4.3	6.8
11602	745	55.8	2.2	20.4	23.2	5.0	8.4
11603	1517	67.2	0.7	17.1	20.0	4.8	7.6
11701	1455	59.9	1.3	19.3	22.2	4.5	6.6
11702	1226	59.3	1.8	18.8	21.7	5.2	7.8
11703	4813	44.3	8.1	19.7	22.5	4.0	6.2
11801	4934	26.1	17.3	21.7	24.5	3.3	5.2
11802	4314	44.5	4.8	19.9	22.7	3.7	6.0
11901	4869	60.3	1.2	19.7	22.5	4.7	7.0
11902	3117	62.1	1.0	20.5	23.3	5.3	7.5
11903	4105	52.6	3.0	21.1	23.8	4.3	6.6
11904	4040	56.0	2.2	20.2	23.0	4.6	6.8
12001	2418	47.3	5.3	20.9	23.7	4.4	6.5
12002	1559	44.2	7.9	18.7	21.6	3.7	6.1
12003	3782	52.5	3.4	19.8	22.6	4.9	7.7
12101	3186	32.9	11.5	21.0	23.8	3.4	5.7
12102	2173	43.7	4.3	19.6	22.5	2.9	5.2
12103	3604	25.6	15.4	21.8	24.5	2.8	5.0

SA3 Code	Key indicators of the aged and ageing process in 2011						
	Lone Person Households (Count)	**Per cent of aged with low income**	**Per cent of aged with high income**	**Remaining life expectancy at age 65 (males)**	**Remaining life expectancy at age 65 (females)**	**Expected years to be lived with disability at age 65 (males)**	**Expected years to be lived with disability (females)**
12104	3907	22.2	18.8	21.3	24.0	2.9	4.6
12201	1416	26.7	12.2	22.4	25.1	2.8	5.0
12202	1960	31.7	10.2	19.8	22.7	2.7	4.4
12203	5303	41.0	4.6	20.0	22.9	3.2	5.0
12301	926	57.3	2.5	19.1	22.0	3.8	5.9
12302	2809	58.5	1.7	18.1	21.0	4.3	6.7
12303	770	56.6	2.4	19.4	22.2	3.5	5.7
12401	3098	48.4	3.3	18.9	21.8	3.0	4.7
12403	2772	56.1	2.2	18.6	21.5	3.7	6.1
12404	1021	52.7	2.5	18.1	21.0	3.7	5.7
12405	929	61.3	1.1	19.0	21.9	4.6	6.9
12501	1150	61.5	1.3	20.1	22.9	5.7	8.3
12502	1704	47.9	3.5	20.4	23.2	3.7	5.6
12503	3603	62.7	0.9	19.0	21.9	5.0	7.3
12504	3245	54.4	2.1	19.1	21.9	4.3	6.5
12601	1346	36.4	6.6	21.3	24.1	3.3	5.1
12602	4318	44.6	4.9	20.2	23.0	3.8	6.1
12701	1035	62.6	1.3	19.5	22.3	5.7	9.1
12702	3171	68.4	0.9	20.0	22.8	6.3	9.8
12703	2050	60.6	1.3	18.8	21.7	5.1	7.9
12801	4479	43.9	5.1	20.9	23.7	3.1	4.9
12802	2756	47.7	2.9	19.4	22.3	3.0	5.2
20101	3996	53.1	1.8	19.0	21.9	3.7	5.2

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
20102	1091	57.2	1.9	18.6	21.5	3.0	5.0
20103	1441	62.5	0.8	17.5	20.5	3.2	4.5
20201	3550	53.5	1.6	18.3	21.2	3.2	4.8
20202	1937	53.3	2.2	18.3	21.2	2.7	4.5
20203	599	61.4	1.9	17.9	20.8	2.6	4.2
20301	345	50.4	3.1	18.9	21.7	3.5	6.1
20302	7421	55.6	1.9	19.0	21.9	3.8	5.6
20303	2514	46.7	3.5	20.0	22.8	3.2	5.1
20401	2263	54.6	2.5	19.1	22.0	3.5	5.2
20402	2313	54.8	1.5	19.0	21.9	3.1	4.6
20403	2478	55.9	1.6	19.3	22.2	3.6	5.4
20501	1701	52.8	2.0	19.6	22.5	3.1	4.9
20502	2276	55.4	1.7	19.0	21.9	3.0	4.7
20503	2974	53.7	1.7	19.4	22.3	3.4	4.7
20504	2946	59.5	1.4	18.0	20.9	3.4	5.3
20505	1905	54.8	1.5	18.1	21.0	3.1	4.6
20601	2539	63.2	1.3	20.3	23.1	5.5	8.3
20602	1611	61.6	1.6	18.7	21.6	4.9	7.4
20603	2312	50.7	3.3	19.8	22.6	4.8	6.9
20604	1692	32.9	15.4	20.7	23.5	3.9	7.5
20605	2962	41.0	9.0	19.5	22.4	4.0	6.1
20606	2392	30.3	18.8	21.1	23.9	3.5	5.8
20607	2140	51.7	5.8	20.0	22.8	5.0	7.9

SA3 Code	Key indicators of the aged and ageing process in 2011						
	Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
20701	5907	31.0	12.2	20.7	23.5	3.3	5.6
20702	2979	45.1	4.3	20.7	23.5	3.9	6.5
20703	4249	45.5	3.2	20.5	23.3	3.1	5.2
20801	4128	32.3	9.9	19.9	22.8	2.8	4.7
20802	5814	45.0	4.5	20.8	23.6	3.8	6.1
20803	4858	48.8	2.4	20.1	23.0	3.7	5.5
20804	1464	33.7	12.3	21.3	24.0	3.6	5.8
20901	4274	47.5	3.3	20.1	22.9	3.7	5.9
20902	3475	62.5	0.9	19.3	22.2	4.8	7.1
20903	1000	41.5	5.0	20.7	23.5	3.6	5.1
20904	2673	62.8	1.0	19.1	22.0	5.5	8.3
21001	2038	57.5	1.7	20.3	23.1	4.4	6.9
21002	571	45.6	4.6	21.0	23.7	3.5	5.9
21003	3003	59.3	0.7	19.5	22.4	5.3	7.5
21004	837	52.8	2.0	19.0	21.9	3.9	5.8
21005	1896	64.3	1.0	18.6	21.5	5.5	8.3
21101	3970	53.5	1.8	19.5	22.4	3.5	5.9
21102	533	39.1	6.6	20.3	23.1	3.1	6.1
21103	3885	48.8	2.0	19.4	22.2	3.2	5.2
21104	2349	47.8	2.4	20.2	23.0	3.0	5.0
21105	3913	51.3	2.6	19.9	22.7	3.5	5.4
21201	1597	56.9	2.1	19.0	21.9	3.6	5.5
21202	2419	57.8	1.9	18.9	21.7	4.0	6.5

	Key indicators of the aged and ageing process in 2011						
SA3 Code	**Lone Person Households (Count)**	**Per cent of aged with low income**	**Per cent of aged with high income**	**Remaining life expectancy at age 65 (males)**	**Remaining life expectancy at age 65 (females)**	**Expected years to be lived with disability at age 65 (males)**	**Expected years to be lived with disability (females)**
21203	1721	59.7	1.2	19.1	22.0	4.1	6.7
21204	5116	63.2	1.0	19.2	22.1	4.7	7.3
21205	5286	49.2	3.0	21.0	23.8	3.9	6.5
21301	3386	66.5	0.6	19.2	22.1	5.9	8.7
21302	2790	58.7	2.0	19.2	22.0	4.4	6.4
21303	1990	63.6	1.1	18.5	21.4	4.7	7.3
21304	1864	57.7	1.1	18.8	21.7	4.7	6.9
21305	2204	56.4	1.7	19.2	22.1	4.6	6.9
21401	4519	54.4	1.5	19.3	22.1	3.2	5.1
21402	7142	46.1	4.0	20.3	23.1	3.1	4.8
21501	3360	53.8	1.9	18.9	21.8	3.4	4.9
21502	2279	58.2	1.6	19.3	22.2	4.0	5.6
21503	2035	57.0	1.4	19.0	21.9	3.5	4.8
21601	1673	55.1	1.5	19.4	22.3	3.6	5.3
21602	1424	58.3	1.0	18.6	21.5	3.4	5.0
21603	2187	53.6	1.9	19.0	21.9	3.8	5.4
21701	1938	56.8	2.3	17.7	20.7	3.0	4.2
21702	3819	50.4	2.4	19.2	22.1	3.2	4.6
30101	1759	53.7	2.4	19.5	22.4	3.7	5.9
30102	2950	51.6	2.8	19.2	22.1	3.4	5.2
30103	2161	53.9	2.2	19.1	22.0	3.4	5.2
30201	1133	45.5	3.8	20.5	23.3	3.5	5.5
30202	3025	47.9	2.9	19.9	22.8	2.9	4.8

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
30203	1251	54.4	2.1	20.5	23.3	3.7	6.1
30204	2141	52.4	1.4	17.8	20.7	4.0	5.3
30301	1593	49.6	3.5	19.2	22.1	3.7	5.3
30302	2395	46.1	4.3	18.9	21.8	3.4	5.3
30303	1890	50.4	3.3	19.2	22.0	3.3	5.5
30304	1256	49.2	2.9	20.4	23.2	3.8	5.1
30305	684	56.4	2.1	17.6	20.5	4.2	6.2
30306	880	49.3	2.8	20.9	23.7	4.7	7.5
30401	601	40.9	5.1	18.5	21.4	3.4	5.9
30402	904	30.5	9.9	20.3	23.1	2.7	4.9
30403	1407	31.5	12.0	20.6	23.4	3.0	4.4
30404	1481	45.5	3.7	19.2	22.0	3.4	5.2
30501	1564	35.1	10.0	17.6	20.5	3.1	5.5
30502	979	46.8	5.6	20.7	23.4	3.8	5.8
30503	2365	39.3	9.8	20.2	23.0	3.4	5.4
30504	1344	38.3	8.6	20.6	23.4	3.4	5.0
30601	850	44.9	4.0	19.3	22.1	3.3	5.9
30602	2683	49.8	2.6	18.0	20.9	3.7	5.5
30603	1222	56.4	1.7	18.7	21.6	3.6	5.4
30604	343	45.1	3.9	18.0	20.9	3.4	5.7
30605	1671	56.9	1.7	18.6	21.5	3.3	5.2
30701	1494	51.8	3.5	17.6	20.6	3.3	4.6
30702	1363	57.3	2.0	18.6	21.5	3.3	5.2

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
30703	1726	58.8	1.4	18.6	21.5	3.5	5.3
30801	410	45.0	4.8	19.1	21.9	4.6	4.6
30802	1510	55.7	3.1	18.7	21.6	3.5	5.5
30803	3783	55.3	2.0	17.9	20.9	3.1	4.6
30901	2653	47.8	3.2	20.7	23.5	3.5	5.2
30902	2399	51.1	2.4	19.9	22.7	3.3	4.9
30903	3044	49.2	3.1	19.1	21.9	3.9	5.3
30904	503	51.0	4.0	21.2	24.0	3.7	6.2
30905	427	54.6	2.9	20.1	22.9	4.6	6.9
30906	1468	53.3	2.6	19.6	22.5	3.6	5.8
30907	1309	50.2	4.3	19.1	21.9	3.8	5.9
30908	1213	48.2	2.9	19.0	21.9	3.5	5.9
30909	2112	49.0	2.9	18.4	21.3	3.8	5.5
30910	1532	36.6	9.0	22.1	24.8	3.8	5.8
31001	1645	56.5	1.4	18.5	21.4	3.5	5.3
31002	1693	59.7	1.5	19.0	21.9	4.1	5.8
31003	2817	58.0	1.2	17.9	20.9	3.7	5.5
31004	753	61.1	1.4	18.9	21.8	4.1	6.5
31101	461	63.3	2.0	16.3	19.3	3.2	4.7
31102	1046	60.8	0.8	18.4	21.3	3.9	5.5
31103	986	60.3	1.4	17.4	20.4	4.2	6.2
31104	310	59.1	2.4	19.5	22.4	4.3	7.0
31105	1223	53.8	1.6	18.3	21.2	3.7	5.5

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
31106	1709	58.4	1.6	18.2	21.1	3.8	6.0
31201	681	49.8	3.7	19.0	21.9	3.2	5.3
31202	2773	52.6	2.8	18.7	21.6	3.9	5.3
31203	397	50.2	3.3	18.6	21.5	3.3	5.2
31301	2000	56.0	1.4	19.8	22.6	4.0	5.4
31302	1497	56.5	1.0	17.5	20.4	3.5	5.4
31303	304	60.5	1.2	18.7	21.6	4.2	5.2
31304	1266	57.3	1.2	17.9	20.8	3.6	5.4
31305	3246	55.5	1.6	18.3	21.2	3.6	5.0
31401	1135	47.0	4.0	21.0	23.8	3.8	6.2
31402	1083	56.6	1.8	19.2	22.1	4.3	6.3
31403	801	54.7	1.0	18.6	21.5	3.7	5.2
31501	422	59.2	2.6	16.6	19.6	3.2	6.6
31502	540	46.4	4.5	16.7	19.7	3.7	5.0
31503	864	54.4	3.2	17.7	20.6	3.1	4.5
31601	1971	51.1	2.8	21.5	24.3	3.9	5.5
31602	3389	52.7	1.9	19.4	22.3	3.4	5.0
31603	2240	50.0	2.9	19.3	22.1	3.6	5.1
31604	1809	52.0	2.2	19.0	21.9	3.9	5.7
31605	1679	46.3	4.9	20.1	22.9	3.6	5.4
31606	1333	51.4	2.4	19.9	22.8	3.3	5.1
31701	5491	52.8	2.1	18.8	21.7	3.2	4.6
31801	1817	55.6	2.2	17.4	20.3	3.3	5.0

	Key indicators of the aged and ageing process in 2011						
SA3 Code	**Lone Person Households (Count)**	**Per cent of aged with low income**	**Per cent of aged with high income**	**Remaining life expectancy at age 65 (males)**	**Remaining life expectancy at age 65 (females)**	**Expected years to be lived with disability at age 65 (males)**	**Expected years to be lived with disability (females)**
31802	4162	52.1	2.4	18.4	21.3	3.8	5.5
31901	3764	61.2	1.4	18.8	21.7	3.7	5.3
31902	2026	60.9	1.1	18.3	21.2	3.7	5.4
31903	1848	59.3	1.3	18.8	21.7	4.1	4.4
31904	2475	58.3	1.0	18.1	21.0	3.8	5.1
31905	1938	61.0	1.1	18.4	21.3	3.6	5.4
40101	672	26.1	16.1	20.2	23.0	3.3	6.3
40102	1861	48.5	4.7	20.0	22.8	3.3	5.4
40103	2402	31.3	12.0	19.7	22.6	2.7	4.4
40104	2298	55.2	2.3	19.9	22.8	3.7	6.2
40105	2061	51.8	3.8	20.0	22.8	4.4	6.2
40106	1199	45.2	7.4	18.7	21.6	3.3	5.6
40107	1692	37.0	6.6	17.6	20.6	3.3	5.4
40201	1139	60.6	1.0	19.7	22.5	3.4	5.0
40202	2492	65.8	0.9	16.9	19.9	3.3	5.6
40203	2527	61.6	1.1	18.4	21.3	3.8	5.4
40204	3507	61.7	0.9	17.9	20.9	3.8	6.3
40205	2974	58.1	1.5	19.6	22.5	3.3	5.5
40301	2336	41.4	4.8	19.9	22.8	3.3	4.6
40302	4209	56.2	1.2	19.5	22.3	3.4	4.9
40303	2768	43.1	5.3	21.3	24.1	3.1	5.2
40304	4974	57.7	1.5	19.1	22.0	3.5	5.6
40401	5174	59.1	1.6	19.5	22.4	4.0	6.2

	Key indicators of the aged and ageing process in 2011						
SA3 Code	**Lone Person Households (Count)**	**Per cent of aged with low income**	**Per cent of aged with high income**	**Remaining life expectancy at age 65 (males)**	**Remaining life expectancy at age 65 (females)**	**Expected years to be lived with disability at age 65 (males)**	**Expected years to be lived with disability (females)**
40402	2643	65.3	1.1	18.0	20.9	3.7	6.0
40403	3061	53.4	2.1	19.2	22.1	3.4	5.5
40501	1206	59.1	2.0	18.4	21.3	2.5	4.5
40502	1090	57.7	1.8	18.3	21.2	3.3	4.6
40503	1554	62.2	1.0	18.1	21.0	3.2	5.1
40504	1457	60.8	1.4	17.8	20.8	3.0	4.6
40601	2322	59.8	1.4	18.1	21.0	3.1	4.8
40602	847	54.3	1.9	16.7	19.6	3.4	5.0
40701	2499	53.7	1.7	19.9	22.7	3.2	5.4
40702	2590	54.6	2.4	18.6	21.5	3.0	4.6
40703	3187	59.9	1.2	19.0	21.9	3.6	5.1
50101	1425	48.8	3.1	19.1	22.0	2.6	4.3
50102	2753	55.6	2.6	18.8	21.7	3.4	5.1
50103	813	58.1	1.9	20.1	22.9	3.4	5.5
50201	3555	54.3	2.2	19.3	22.1	3.2	4.6
50301	2706	24.4	16.6	21.2	24.0	2.7	4.4
50302	3321	42.3	7.3	18.9	21.8	3.6	5.8
50401	2986	57.2	1.9	19.1	22.0	3.5	5.8
50402	1168	50.7	3.6	20.9	23.7	3.8	5.6
50403	1950	54.9	2.7	18.3	21.2	3.4	5.6
50501	3363	47.6	3.8	20.6	23.4	3.2	5.4
50502	7585	49.2	3.7	20.7	23.5	3.5	5.6
50503	2596	54.7	1.9	18.5	21.4	3.3	5.4

SA3 Code	Key indicators of the aged and ageing process in 2011 Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
50601	1538	56.0	2.5	18.7	21.6	2.9	5.3
50602	2470	55.4	2.2	19.3	22.2	3.5	5.4
50603	2916	50.0	2.5	19.0	21.9	3.4	5.6
50604	2435	56.4	2.1	19.2	22.1	3.5	5.4
50605	1463	49.1	3.8	20.2	23.0	3.0	5.1
50606	199	54.5	3.7	20.0	22.8	3.5	6.4
50607	1637	37.3	6.7	18.6	21.5	3.1	4.7
50701	2176	57.1	2.1	18.6	21.5	3.6	5.6
50702	1512	48.6	4.8	18.4	21.3	3.4	5.2
50703	654	61.2	1.6	19.3	22.1	3.6	5.8
50704	4004	41.5	6.2	21.4	24.2	3.3	5.4
50705	2802	58.4	1.9	19.4	22.2	3.4	5.5
50801	536	46.3	3.4	18.6	21.5	2.9	4.4
50802	290	48.0	3.2	19.0	21.9	3.9	5.8
50803	547	51.5	5.2	15.9	18.9	3.2	5.4
50804	358	50.8	4.5	14.2	17.2	3.1	5.6
50805	1643	53.5	2.8	18.7	21.6	3.4	5.2
50806	213	36.1	15.3	18.6	21.5	4.1	9.1
50901	2238	54.5	2.2	19.4	22.2	3.3	5.1
50902	1910	54.0	3.4	19.0	21.9	3.0	4.4
50903	770	50.0	3.5	17.8	20.7	2.6	4.2
60101	293	63.8	1.2	16.5	19.4	3.8	5.8
60102	2178	51.4	1.9	18.4	21.3	3.3	4.6

SA3 Code	Key indicators of the aged and ageing process in 2011						
	Lone Person Households (Count)	Per cent of aged with low income	Per cent of aged with high income	Remaining life expectancy at age 65 (males)	Remaining life expectancy at age 65 (females)	Expected years to be lived with disability at age 65 (males)	Expected years to be lived with disability (females)
60103	2751	59.5	0.8	17.4	20.4	3.4	5.0
60104	1148	47.7	3.0	18.2	21.1	2.9	4.6
60105	2108	39.3	6.1	17.9	20.8	2.7	4.9
60106	539	59.6	1.8	17.8	20.7	3.4	5.3
60201	3732	57.7	2.1	17.9	20.8	3.4	5.1
60202	921	60.1	1.7	19.6	22.5	3.6	5.0
60203	1598	60.1	1.8	18.1	21.1	3.3	4.9
60301	374	64.3	1.7	18.9	21.8	5.1	6.2
60302	622	59.6	1.6	17.7	20.7	3.3	5.5
60303	354	55.3	2.0	17.3	20.3	2.6	4.3
60401	2341	61.5	1.1	18.1	21.0	3.2	5.0
60402	1908	60.8	1.4	19.1	21.9	3.7	5.3
60403	646	60.8	2.8	17.7	20.6	3.1	5.0
70101	375	34.3	11.6	17.1	20.0	3.5	5.6
70102	852	41.3	4.5	18.5	21.5	4.6	7.1
70103	208	41.2	3.6	18.9	21.7	3.4	4.3
70104	277	48.2	3.3	16.2	19.2	4.1	6.1
70201	436	45.8	3.9	15.5	18.5	3.3	5.6
70202	52	46.4	6.7	12.8	15.7	3.0	7.1
70203	113	60.5	2.4	11.5	14.4	2.3	4.8
70204	26	65.7	6.7	11.6	14.5	2.0	5.9
70205	182	50.8	4.6	13.6	16.6	3.0	5.5
80101	2261	35.9	5.6	19.5	22.4	3.3	5.5

SA3 Code	Key indicators of the aged and ageing process in 2011						
	Lone Person Households (Count)	**Per cent of aged with low income**	**Per cent of aged with high income**	**Remaining life expectancy at age 65 (males)**	**Remaining life expectancy at age 65 (females)**	**Expected years to be lived with disability at age 65 (males)**	**Expected years to be lived with disability (females)**
80103	74	43.4	4.2	20.6	23.4	3.5	5.7
80104	421	42.8	5.5	22.4	25.1	4.4	6.6
80105	1550	34.6	8.0	20.1	22.9	3.2	5.4
80106	925	25.9	18.0	19.1	22.0	2.9	5.2
80107	1505	42.8	4.2	20.5	23.3	4.0	5.7
80108	877	34.0	6.0	19.4	22.3	3.5	5.9
80109	1422	30.7	8.4	20.1	22.9	2.9	5.3

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
10101	2.0	2.3	2.4	2.6	2.7	1.3	1.7
10102	4.5	4.8	4.9	4.5	4.6	0.6	2.5
10103	2.7	3.0	3.1	3.0	3.0	0.7	1.8
10104	1.3	1.7	1.7	2.4	2.5	1.5	1.6
10201	1.5	1.8	1.9	2.3	2.4	-0.2	1.6
10202	1.1	1.4	1.5	2.2	2.3	0.4	1.6
10301	2.2	2.5	2.6	2.9	2.9	0.8	1.8
10302	1.0	1.4	1.4	1.3	1.3	1.2	1.3
10303	1.6	2.0	2.0	2.2	2.2	1.7	1.6
10304	2.1	2.4	2.5	2.5	2.5	0.7	1.7
10401	1.5	1.8	1.9	2.3	2.4	1.5	1.6
10402	2.0	2.3	2.4	2.7	2.7	0.2	1.7
10501	2.0	2.4	2.4	1.6	1.6	1.6	1.4
10502	1.4	1.8	1.8	1.3	1.3	0.5	1.3
10503	1.9	2.2	2.3	2.3	2.3	1.3	1.6
10601	2.6	2.9	2.9	2.9	2.9	0.0	1.8

	Key indicators of the aged and ageing process in 2011 - 2031						
SA3 Code	**Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)**	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
10602	2.9	3.2	3.3	3.4	3.5	0.2	2.0
10603	1.5	1.8	1.9	2.6	2.6	2.7	1.7
10604	2.5	2.9	2.9	2.3	2.3	0.7	1.6
10701	1.6	2.0	2.0	2.2	2.2	1.6	1.6
10703	2.3	2.6	2.7	3.0	3.1	1.4	1.9
10704	2.2	2.5	2.6	2.5	2.6	0.6	1.7
10801	-0.1	0.3	0.4	1.6	1.6	1.5	1.4
10802	1.3	1.7	1.7	2.3	2.3	0.4	1.6
10803	2.4	2.7	2.7	2.2	2.2	3.1	1.5
10804	0.7	1.1	1.1	2.1	2.1	1.7	1.5
10805	1.0	1.4	1.4	2.2	2.2	1.7	1.6
10901	2.0	2.4	2.4	2.5	2.6	-0.1	1.7
10902	2.3	2.7	2.7	2.4	2.5	2.7	1.6
10903	0.9	1.2	1.3	1.9	1.9	2.0	1.5
11001	2.4	2.7	2.8	2.7	2.7	1.3	1.7
11002	1.1	1.5	1.5	1.8	1.8	1.6	1.4
11003	2.3	2.6	2.7	2.2	2.2	1.0	1.6

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
11004	1.7	2.0	2.1	2.0	2.0	1.4	1.5
11101	1.9	2.3	2.3	2.1	2.2	1.4	1.5
11102	1.2	1.6	1.6	2.2	2.3	0.1	1.6
11103	1.9	2.2	2.3	2.3	2.3	-0.6	1.6
11201	2.4	2.7	2.8	3.0	3.1	-0.5	1.8
11202	2.4	2.8	2.8	2.9	2.9	-0.4	1.8
11203	0.7	1.1	1.2	1.7	1.8	0.2	1.4
11301	2.2	2.5	2.6	2.2	2.3	0.9	1.6
11302	1.8	2.1	2.2	2.0	2.1	1.2	1.5
11303	2.2	2.5	2.6	2.5	2.6	0.8	1.7
11401	0.7	1.0	1.1	1.9	2.0	1.5	1.5
11402	1.3	1.7	1.7	2.6	2.7	2.1	1.7
11501	4.0	4.4	4.5	4.0	4.2	0.9	2.3
11502	3.1	3.5	3.6	2.8	2.9	2.2	1.8
11503	4.7	5.1	5.1	4.7	4.8	3.3	2.6
11504	5.1	5.4	5.5	5.4	5.6	2.6	3.0
11601	3.4	3.7	3.9	3.1	3.3	0.8	1.9

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031 Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)	Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)	Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)	Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)	Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)	Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)
11602	5.9	6.2	6.5	6.5	6.7	1.4	3.8
11603	3.9	4.2	4.4	4.0	4.2	0.5	2.3
11701	2.2	2.5	2.7	2.4	2.5	1.9	1.7
11702	3.1	3.4	3.5	2.8	2.9	1.1	1.8
11703	4.2	4.5	4.7	4.5	4.7	0.2	2.6
11801	2.6	2.9	3.1	2.3	2.4	0.4	1.6
11802	2.3	2.7	2.8	2.3	2.5	-0.1	1.6
11901	2.4	2.8	2.9	2.5	2.7	-0.6	1.7
11902	2.7	3.0	3.2	2.4	2.6	1.3	1.7
11903	2.5	2.8	3.1	2.5	2.8	0.1	1.7
11904	2.2	2.5	2.7	2.2	2.3	0.0	1.6
12001	2.7	3.0	3.1	3.0	3.2	0.8	1.9
12002	3.9	4.2	4.4	3.7	3.9	0.3	2.2
12003	2.5	2.9	3.1	2.4	2.6	-0.4	1.7
12101	3.1	3.4	3.6	2.9	3.1	-0.5	1.9
12102	3.1	3.5	3.7	2.8	3.0	0.3	1.8
12103	2.5	2.9	3.0	2.3	2.5	0.4	1.7

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
12104	2.9	3.2	3.4	3.0	3.2	0.9	1.9
12201	3.0	3.4	3.5	2.7	2.8	-0.2	1.8
12202	2.5	2.8	2.9	2.9	3.0	0.4	1.8
12203	2.1	2.5	2.6	2.1	2.2	0.2	1.6
12301	4.0	4.3	4.4	5.0	5.1	-1.0	2.8
12302	4.4	4.7	4.8	4.4	4.5	0.3	2.5
12303	3.9	4.3	4.3	4.4	4.4	1.4	2.4
12401	2.9	3.2	3.3	3.3	3.3	0.1	2.0
12403	4.0	4.3	4.4	4.1	4.2	0.3	2.3
12404	3.1	3.4	3.4	3.6	3.6	-0.7	2.1
12405	4.8	5.1	5.2	4.7	4.7	0.3	2.6
12501	4.2	4.5	4.8	4.2	4.5	-0.8	2.5
12502	2.9	3.2	3.4	2.6	2.9	1.1	1.8
12503	2.6	3.0	3.1	2.7	2.9	0.0	1.8
12504	2.4	2.8	3.1	2.5	2.8	0.0	1.8
12601	3.1	3.5	3.7	2.7	2.9	0.5	1.8
12602	2.3	2.6	2.8	2.2	2.5	-0.8	1.6

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
12701	4.8	5.1	5.2	4.8	4.9	2.0	2.7
12702	3.6	3.9	4.1	3.4	3.6	1.6	2.1
12703	3.6	4.0	4.2	3.9	4.1	0.9	2.3
12801	2.0	2.4	2.4	2.3	2.4	1.0	1.6
12802	3.5	3.9	3.9	3.4	3.4	0.8	2.0
20101	2.2	2.6	2.6	3.2	3.3	0.1	1.9
20102	2.8	3.2	3.2	3.4	3.4	1.2	2.0
20103	1.2	1.6	1.6	1.9	2.0	1.0	1.5
20201	1.8	2.1	2.2	2.7	2.8	-0.6	1.7
20202	2.3	2.6	2.7	3.0	3.1	0.5	1.9
20203	1.7	2.0	2.1	1.8	1.9	0.3	1.5
20301	4.0	4.3	4.4	4.7	4.7	1.2	2.6
20302	1.9	2.3	2.4	2.5	2.6	-0.1	1.7
20303	1.9	2.3	2.4	3.3	3.4	0.7	2.0
20401	2.0	2.4	2.4	2.9	3.0	1.8	1.8
20402	1.6	1.9	2.0	2.3	2.4	0.5	1.6
20403	2.7	3.0	3.1	3.2	3.2	0.9	1.9

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
20501	2.4	2.8	2.8	3.9	3.9	1.1	2.2
20502	1.1	1.5	1.6	2.3	2.4	2.2	1.6
20503	1.3	1.7	1.8	2.4	2.5	1.7	1.6
20504	2.1	2.5	2.5	2.8	2.8	0.5	1.8
20505	2.1	2.5	2.5	2.7	2.7	0.2	1.7
20601	2.4	2.7	2.9	2.2	2.4	0.2	1.6
20602	2.4	2.7	2.8	2.4	2.5	-0.8	1.6
20603	2.9	3.3	3.4	3.0	3.2	-2.3	1.9
20604	4.0	4.3	4.8	4.9	5.3	0.3	2.9
20605	3.6	3.9	4.2	3.8	4.1	-0.5	2.3
20606	1.9	2.3	2.5	1.9	2.2	2.0	1.5
20607	3.4	3.8	4.0	3.6	3.8	0.7	2.1
20701	2.7	3.1	3.2	2.5	2.7	-0.7	1.7
20702	1.5	1.9	2.1	1.3	1.6	4.2	1.4
20703	1.5	1.9	2.2	1.4	1.7	0.1	1.4
20801	2.2	2.6	2.7	2.4	2.6	-1.5	1.7
20802	2.4	2.7	2.9	2.3	2.5	-1.7	1.7

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
20803	2.1	2.5	2.7	2.3	2.5	-0.2	1.7
20804	2.8	3.1	3.3	2.4	2.6	-0.4	1.7
20901	2.3	2.7	2.8	2.1	2.2	0.6	1.6
20902	1.2	1.6	1.8	1.2	1.4	0.5	1.3
20903	5.7	6.0	6.1	5.3	5.4	1.1	2.9
20904	3.6	4.0	4.1	4.5	4.7	1.9	2.6
21001	1.5	1.9	2.0	1.2	1.3	3.9	1.3
21002	4.4	4.8	4.9	4.9	5.0	1.7	2.7
21003	0.4	0.8	1.0	0.6	0.8	0.3	1.2
21004	4.2	4.5	4.6	4.9	5.0	0.8	2.7
21005	4.3	4.6	4.9	4.5	4.8	3.1	2.6
21101	3.5	3.8	4.0	3.5	3.7	0.6	2.1
21102	3.5	3.9	4.0	3.2	3.3	2.7	1.9
21103	2.4	2.7	2.9	2.4	2.6	0.5	1.7
21104	1.8	2.2	2.4	1.4	1.8	1.9	1.4
21105	3.8	4.1	4.2	3.7	3.8	1.5	2.1
21201	3.6	3.9	4.1	5.0	5.1	0.7	2.7

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
21202	3.9	4.2	4.4	4.2	4.4	0.1	2.4
21203	4.8	5.2	5.4	5.7	5.9	0.2	3.3
21204	2.2	2.5	2.8	2.0	2.3	1.8	1.6
21205	1.7	2.1	2.4	1.2	1.5	3.2	1.4
21301	3.5	3.8	4.1	3.5	3.7	1.5	2.1
21302	2.6	3.0	3.1	2.6	2.7	-0.2	1.7
21303	2.9	3.2	3.4	2.7	2.9	-2.6	1.8
21304	4.9	5.2	5.4	6.2	6.4	0.0	3.6
21305	5.1	5.4	5.7	5.8	6.2	-0.2	3.4
21401	2.7	3.1	3.2	3.1	3.2	0.3	1.9
21402	1.3	1.6	1.8	2.3	2.4	1.8	1.6
21501	1.3	1.7	1.8	1.6	1.7	0.7	1.4
21502	2.1	2.5	2.5	2.7	2.8	0.8	1.7
21503	1.3	1.7	1.7	1.4	1.4	0.9	1.3
21601	1.6	2.0	2.0	2.2	2.3	2.0	1.6
21602	0.9	1.3	1.3	1.9	2.0	1.4	1.5
21603	2.3	2.7	2.8	2.7	2.8	0.2	1.7

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
21701	1.6	2.0	2.1	1.9	2.0	-0.3	1.5
21702	2.0	2.4	2.4	2.5	2.5	0.5	1.7
30101	4.1	4.4	4.5	3.7	3.8	0.1	2.1
30102	2.2	2.6	2.7	3.2	3.3	0.8	1.9
30103	3.0	3.3	3.4	3.1	3.3	-0.9	1.9
30201	2.8	3.1	3.2	2.8	2.8	1.4	1.8
30202	1.6	2.0	2.1	1.5	1.6	-0.7	1.4
30203	3.0	3.4	3.5	2.8	2.9	-1.0	1.8
30204	1.9	2.3	2.4	2.2	2.3	-0.7	1.6
30301	2.8	3.1	3.2	2.8	2.9	-0.8	1.8
30302	3.1	3.4	3.5	2.5	2.6	-2.9	1.7
30303	2.3	2.6	2.7	1.7	1.8	1.2	1.4
30304	2.3	2.6	2.7	1.5	1.7	-0.1	1.4
30305	4.1	4.4	4.6	4.3	4.5	-1.1	2.5
30306	3.8	4.1	4.3	3.1	3.3	1.6	1.9
30401	3.8	4.1	4.3	3.3	3.4	-0.7	2.0
30402	3.5	3.8	3.9	3.0	3.2	1.5	1.9

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
30403	3.0	3.3	3.4	2.5	2.7	-0.6	1.7
30404	2.7	3.0	3.1	2.4	2.5	-0.2	1.6
30501	3.3	3.7	4.0	3.6	4.0	-3.2	2.2
30502	4.7	5.0	5.2	4.1	4.3	-2.0	2.4
30503	3.8	4.2	4.3	3.3	3.5	-1.6	2.0
30504	4.4	4.7	4.8	3.6	3.7	-1.2	2.1
30601	5.4	5.7	5.8	6.0	6.1	0.6	3.4
30602	3.7	4.0	4.1	4.2	4.3	-0.7	2.4
30603	2.7	3.0	3.0	2.7	2.7	2.0	1.7
30604	3.8	4.1	4.2	4.3	4.5	2.6	2.4
30605	2.0	2.3	2.4	2.7	2.7	2.3	1.7
30701	2.4	2.7	2.8	2.5	2.6	1.3	1.7
30702	2.0	2.4	2.4	2.5	2.5	1.9	1.6
30703	1.6	2.0	2.0	2.8	2.8	1.0	1.8
30801	6.0	6.3	6.4	5.5	5.6	0.8	3.1
30802	4.3	4.6	4.7	4.1	4.2	1.2	2.3
30803	2.4	2.8	2.8	2.7	2.8	0.3	1.7

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
30901	1.8	2.1	2.3	1.7	1.8	1.5	1.4
30902	2.1	2.4	2.5	2.1	2.2	0.3	1.5
30903	1.2	1.6	1.8	2.1	2.2	1.1	1.6
30904	3.8	4.1	4.2	3.9	4.0	4.3	2.2
30905	4.5	4.8	4.9	4.8	4.9	2.2	2.7
30906	3.5	3.9	4.0	4.1	4.2	1.0	2.3
30907	4.2	4.5	4.7	5.4	5.6	1.2	3.1
30908	2.2	2.6	2.7	2.8	3.0	0.9	1.8
30909	2.0	2.3	2.5	2.4	2.6	-0.6	1.7
30910	2.5	2.9	3.1	2.9	3.1	2.2	1.8
31001	3.2	3.5	3.6	3.3	3.5	-0.5	2.0
31002	2.9	3.3	3.3	3.7	3.7	2.1	2.1
31003	2.6	2.9	3.0	3.0	3.1	-0.1	1.9
31004	5.7	6.0	6.2	5.9	6.0	1.4	3.3
31101	1.2	1.6	1.7	2.3	2.4	-0.5	1.6
31102	2.7	3.0	3.1	3.6	3.8	1.7	2.1
31103	4.5	4.8	4.9	4.4	4.5	0.7	2.5

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
31104	6.0	6.3	6.4	6.5	6.5	3.6	3.7
31105	3.5	3.9	4.0	4.1	4.2	0.5	2.3
31106	3.9	4.2	4.3	3.0	3.1	2.1	1.9
31201	5.1	5.4	5.5	4.4	4.5	0.7	2.4
31202	3.9	4.2	4.2	3.8	3.9	0.4	2.2
31203	4.5	4.8	4.9	4.6	4.7	2.0	2.5
31301	0.3	0.7	0.8	2.0	2.1	4.1	1.5
31302	2.6	2.9	3.0	3.5	3.6	-0.5	2.0
31303	3.2	3.5	3.6	3.9	4.0	2.3	2.2
31304	3.4	3.7	3.8	3.9	3.9	1.0	2.2
31305	1.3	1.7	1.8	2.1	2.2	0.1	1.6
31401	5.5	5.8	5.9	5.5	5.6	2.7	3.0
31402	3.6	3.9	4.1	5.3	5.4	-0.3	3.0
31403	3.7	4.1	4.1	3.1	3.2	1.2	1.9
31501	4.8	5.1	5.1	4.6	4.7	0.7	2.6
31502	4.8	5.1	5.1	4.0	4.1	1.5	2.3
31503	2.6	2.9	2.9	2.4	2.5	1.1	1.6

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
31601	2.1	2.5	2.6	3.0	3.1	1.2	1.9
31602	1.0	1.3	1.5	2.4	2.5	1.3	1.7
31603	2.2	2.5	2.6	2.8	3.0	0.9	1.8
31604	2.8	3.2	3.3	3.4	3.5	1.3	2.0
31605	1.9	2.2	2.4	3.1	3.2	1.7	1.9
31606	2.9	3.2	3.3	3.6	3.7	3.0	2.1
31701	2.1	2.5	2.5	2.8	2.9	0.4	1.8
31801	1.5	1.8	1.9	1.8	1.8	0.7	1.4
31802	3.8	4.1	4.2	4.0	4.1	0.1	2.3
31901	1.4	1.8	1.8	2.5	2.6	2.2	1.7
31902	1.8	2.1	2.2	2.7	2.7	2.2	1.7
31903	2.1	2.4	2.5	3.0	3.1	2.1	1.9
31904	0.6	1.0	1.1	2.6	2.7	2.2	1.7
31905	1.7	2.1	2.1	2.8	2.8	2.0	1.7
40101	2.7	3.1	3.3	3.7	3.9	-0.2	2.2
40102	3.9	4.3	4.4	4.1	4.2	1.2	2.3
40103	1.6	1.9	2.1	1.5	1.6	-0.3	1.4

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
40104	1.2	1.5	1.6	1.4	1.5	2.4	1.4
40105	1.4	1.8	1.9	2.1	2.2	-0.7	1.5
40106	2.2	2.6	2.7	2.3	2.4	-2.1	1.6
40107	1.7	2.1	2.2	2.1	2.2	-3.3	1.6
40201	2.8	3.1	3.2	3.6	3.7	1.4	2.1
40202	2.3	2.6	2.7	2.6	2.6	-0.2	1.7
40203	1.5	1.8	2.0	1.3	1.4	-0.6	1.3
40204	2.9	3.3	3.4	3.2	3.3	0.9	1.9
40205	2.9	3.3	3.3	2.8	2.9	2.0	1.8
40301	1.4	1.7	1.8	2.1	2.2	-2.6	1.6
40302	2.0	2.3	2.4	2.0	2.1	-1.3	1.5
40303	2.2	2.6	2.7	2.1	2.1	0.6	1.5
40304	3.0	3.3	3.4	3.3	3.3	0.9	1.9
40401	1.5	1.9	2.0	1.7	1.8	-0.4	1.4
40402	2.3	2.6	2.7	2.5	2.6	-2.3	1.7
40403	0.9	1.3	1.4	1.0	1.1	-0.5	1.2
40501	2.6	3.0	3.0	3.5	3.5	-0.6	2.0

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
40502	1.6	2.0	2.0	2.3	2.3	0.1	1.6
40503	1.3	1.7	1.7	1.7	1.7	0.9	1.4
40504	0.4	0.8	0.8	1.8	1.8	1.6	1.4
40601	2.2	2.5	2.6	2.4	2.5	0.6	1.6
40602	3.3	3.6	3.7	3.0	3.1	0.7	1.8
40701	0.9	1.3	1.4	3.0	3.1	2.3	1.9
40702	2.3	2.7	2.7	2.8	2.8	0.3	1.8
40703	2.0	2.3	2.4	2.5	2.6	1.2	1.7
50101	2.4	2.8	2.9	3.8	3.9	0.7	2.2
50102	3.3	3.6	3.8	4.0	4.1	0.4	2.3
50103	3.1	3.5	3.6	3.7	3.8	2.6	2.1
50201	1.2	1.6	1.8	2.8	3.0	2.7	1.8
50301	2.6	3.0	3.2	2.5	2.8	0.3	1.7
50302	3.1	3.4	3.8	3.5	3.8	-2.1	2.2
50401	2.4	2.8	3.0	2.3	2.5	-0.1	1.7
50402	4.0	4.3	4.4	3.8	3.9	2.3	2.2
50403	4.3	4.6	4.8	4.7	4.9	0.3	2.7

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
50501	4.7	5.1	5.3	4.3	4.6	0.7	2.5
50502	2.2	2.6	2.8	2.2	2.5	1.1	1.6
50503	3.8	4.1	4.6	4.7	5.1	0.3	2.8
50601	3.5	3.9	4.1	3.8	4.0	1.0	2.2
50602	2.7	3.1	3.4	2.8	3.1	-1.0	1.9
50603	2.7	3.1	3.4	2.7	3.0	-0.7	1.8
50604	3.7	4.1	4.3	3.9	4.1	1.7	2.3
50605	3.2	3.5	3.7	3.3	3.5	2.8	2.0
50606	4.9	5.2	5.4	5.7	5.8	1.6	3.2
50607	2.7	3.0	3.4	2.8	3.2	-2.7	1.9
50701	3.5	3.9	4.1	4.1	4.3	0.8	2.4
50702	2.4	2.7	2.9	2.6	2.8	-0.8	1.8
50703	3.5	3.9	4.1	3.9	4.1	1.2	2.3
50704	2.9	3.2	3.5	2.7	2.9	0.3	1.8
50705	3.2	3.5	3.8	3.8	4.1	1.4	2.3
50801	2.8	3.1	3.2	3.1	3.2	2.2	1.9
50802	3.7	4.1	4.1	3.8	3.8	4.2	2.2

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031 Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)	Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)	Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)	Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)	Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)	Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)
50803	6.0	6.3	6.6	5.6	5.9	-2.4	3.3
50804	5.8	6.1	6.3	5.8	6.0	-2.5	3.3
50805	3.2	3.6	3.7	3.6	3.8	1.4	2.1
50806	11.5	11.8	12.1	11.7	12.0	-3.4	11.0
50901	2.4	2.7	2.8	2.9	3.1	1.5	1.8
50902	2.9	3.2	3.3	3.2	3.3	2.0	1.9
50903	2.6	2.9	3.0	2.7	2.8	0.6	1.7
60101	3.8	4.2	4.2	4.8	4.8	-0.1	2.6
60102	1.9	2.4	2.4	2.5	2.5	0.2	1.7
60103	1.5	1.9	1.9	1.8	1.8	-0.1	1.4
60104	2.6	3.0	3.0	3.5	3.5	0.1	2.0
60105	2.2	2.7	2.7	2.5	2.6	-2.0	1.7
60106	2.7	3.1	3.1	3.6	3.6	1.0	2.1
60201	1.6	2.0	2.1	2.2	2.2	-0.6	1.6
60202	2.8	3.2	3.2	3.4	3.4	2.7	2.0
60203	2.3	2.7	2.7	3.0	3.0	2.1	1.8
60301	3.7	4.2	4.2	4.1	4.1	2.6	2.3

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
60302	2.5	2.9	2.9	3.4	3.5	2.4	2.0
60303	1.2	1.7	1.7	2.4	2.4	3.3	1.6
60401	1.6	2.1	2.1	2.2	2.2	1.1	1.5
60402	2.0	2.5	2.5	3.0	3.0	1.0	1.8
60403	3.1	3.5	3.5	3.0	3.0	1.7	1.8
70101	5.5	5.6	5.7	5.6	5.6	1.7	3.1
70102	5.6	5.8	5.8	5.0	5.0	4.1	2.7
70103	6.7	6.8	6.8	6.6	6.6	5.4	3.8
70104	6.6	6.8	6.8	6.9	6.9	-0.5	3.9
70201	6.0	6.1	6.2	5.4	5.4	-1.6	3.0
70202	3.8	3.9	4.0	4.0	4.0	-2.6	2.2
70203	5.0	5.1	5.2	4.8	4.9	-2.0	2.6
70204	8.3	8.4	8.4	7.5	7.5	-6.6	4.5
70205	4.7	4.9	4.9	4.5	4.5	-1.2	2.5
80101	3.4	3.8	3.9	3.2	3.3	2.5	1.9
80103	4.0	4.3	4.4	4.9	4.9	4.5	2.7
80104	6.9	7.2	7.3	7.5	7.6	2.9	4.6

SA3 Code	Key indicators of the aged and ageing process in 2011 - 2031						
	Average annual per cent growth in the 65 + population: constant mortality and no migration (Partial Projection Model 1)	**Average annual per cent growth in the 65 + population: trend mortality and no migration (Partial Projection Model 2)**	**Average annual per cent growth in the 65 + population: trend mortality and medium international migration (Partial Projection Model 11)**	**Average annual per cent growth in the 65 + population: trend mortality and internal migration (Partial Projection Model 5)**	**Average annual per cent growth in the 65 + population: trend mortality, internal migration and medium international migration (Main Projection Model 20)**	**Average per annum growth of the 85 + population relative to the 65 to 84 population (Main Projection Model 20)**	**Multiplier of the 65 + population (Head count in 2031 relative to the 2011 population (Main Projection Model 20)**
80105	2.9	3.2	3.3	3.1	3.2	-1.2	1.9
80106	2.7	3.0	3.2	3.1	3.2	-2.7	1.9
80107	6.0	6.4	6.4	5.6	5.7	1.7	3.1
80108	1.9	2.3	2.4	1.4	1.5	3.1	1.4
80109	1.7	2.1	2.2	1.5	1.6	2.9	1.4

Appendix 2

Subnational population projection code in the R programming language

This is the R-Code developed to calculate the subnational projection model for the Australian population. This is a cohort component projection model which produces 24 projection variants and associated analysis for 327 regions across Australian over a twenty year projection horizon. The steps to calculate the input variables are outlined in chapters Four and Five.

This code is developed for R Studio 3.1.1.

```
rm(list=ls(all=TRUE))
setwd("[[insertfilename]]")
library(plyr)
# projection functions called up by the SA3 projection function

projsurvKt2 <- function(inputdata) {
  age <- unique(inputdata$Age)
 n <- length(age)
 Lx <- inputdata$Lx_2011
 Tx <- inputdata$Tx_2011
 Kt1 <- inputdata$popcountSA3
 Mx <- inputdata$Mig_2011
 lastrowindex <- nrow(inputdata)
 lastrowindex_minus1 <- nrow(inputdata)-1
 # to get the Lx+5/Lx
 survpropexceptlast <- rep(0,(length(age)-2))
 for (i in 1: length(survpropexceptlast)){
   survpropexceptlast[[i]] <- Lx[i+1]/Lx[i]}
  # note this is just Tx/Tx-5 for the last age group
 survpropopenint <-  Tx[lastrowindex]/(Tx[lastrowindex_minus1])
 propsurviving_2011 <- c(survpropexceptlast, survpropopenint,NA)
  # add migration
```

```
 halfmigration <- rep(0,length(age))
 for (i in 1: length(halfmigration)){
   halfmigration[[i]] <- Mx[i]/2}
   # allocate halfmigrants to launch population
   kt1plushalfmigrantsexceptlast <- rep(0, (length(age)-2))
 for (i in 1:length(kt1plushalfmigrantsexceptlast)){
   kt1plushalfmigrantsexceptlast[[i]] <- Kt1[i]+halfmigration[i]}
 kt1plushalfmigrantslast <-
(Kt1[lastrowindex_minus1]+Kt1[lastrowindex])+((halfmigration[lastrowindex_minus1]
+halfmigration[lastrowindex]))
   Kt1whalfmig <- c(kt1plushalfmigrantsexceptlast,kt1plushalfmigrantslast)
   #note Kt1whalfmig is effectively the entry population plus half migrants if they all
survived through the interval, explains why 17 age groups not 18
   # survive population (note: the are different lengths, but the prop surviving includes
an NA at end so it will fit back in with the dataset)
   survivingKt1whalfmigpop <- rep(0,(length(age)-1))
 for(i in 1: length(survivingKt1whalfmigpop)){
   survivingKt1whalfmigpop[[i]] <- Kt1whalfmig[i]*propsurviving_2011[i]
 }
   # add remaining migrants
   Kt1survivalwremainingmig <- rep(0,(length(age)-1))
 for(i in 1: length(Kt1survivalwremainingmig)){
   Kt1survivalwremainingmig[[i]] <- survivingKt1whalfmigpop[i]+halfmigration[i+1]
 }
  # projection frame
 projlaunch <- cbind(inputdata, propsurviving_2011)
   Kt2first <- NA
   # note: there is a difference in the length here to the straight survivorshipmodel
 Kt2middle <- rep(0,(length(age)-1))
   for (i in 1: length(Kt2middle)){
   Kt2middle[[i]] <- Kt1survivalwremainingmig[i]}
   Kt2 <- as.data.frame(c(Kt2first, Kt2middle))
   Kt2 <- round(Kt2,0)
 colnames(Kt2) <- "Kt2"

 projectframe1jump <- cbind(projlaunch,Kt2)
   return(projectframe1jump)
 }
```

```
projsurvKt3 <- function(inputdata) {
  data<-inputdata[!(inputdata$Age==45),]
 age <- c(50,55,60,65,70,75,80,85,90,95,100,105)
 n <- length(data$Age)
 Lx <- data$Lx_2016
 Tx <- data$Tx_2016
 Kt2 <- data$Kt2
 Mx <- data$Mig_2016
  locagesex <- data$locagesex
 lastrowindex <- nrow(data)
 lastrowindex_minus1 <- nrow(data)-1
  # to get the Lx+5/Lx
 survpropexceptlast <- rep(0,(length(age)-2))
 for (i in 1: length(survpropexceptlast)){
  survpropexceptlast[[i]] <- Lx[i+1]/Lx[i]}
  # note this is just Tx/Tx-5 for the last age group
  survpropopenint <-  Tx[lastrowindex]/(Tx[lastrowindex_minus1])
  propsurviving_2016 <- c(survpropexceptlast, survpropopenint,NA)
  # add migration
 halfmigration <- rep(0,length(age))
 for (i in 1: length(halfmigration)){
  halfmigration[[i]] <- Mx[i]/2}
  # allocate halfmigrants to launch population
  kt2plushalfmigrantsexceptlast <- rep(0, (length(age)-2))
 for (i in 1:length(kt2plushalfmigrantsexceptlast)){
  kt2plushalfmigrantsexceptlast[[i]] <- Kt2[i]+halfmigration[i]}
  kt2plushalfmigrantslast <-
(Kt2[lastrowindex_minus1]+Kt2[lastrowindex])+((halfmigration[lastrowindex_minus1]
+halfmigration[lastrowindex]))
  Kt2whalfmig <- c(kt2plushalfmigrantsexceptlast,kt2plushalfmigrantslast)


 # survive population (note: the are different lengths, but the prop surviving includes an
NA at end so it will fit back in with the dataset)
  survivingKt2whalfmigpop <- rep(0,(length(age)-1))
 for(i in 1: length(survivingKt2whalfmigpop)){
  survivingKt2whalfmigpop[[i]] <- Kt2whalfmig[i]*propsurviving_2016[i]
 }
```

```
  # add remaining migrants (this will become Kt3)
  Kt2survivalwremainingmig <- rep(0,(length(age)-1))
 for(i in 1: length(Kt2survivalwremainingmig)){
  Kt2survivalwremainingmig[[i]] <- survivingKt2whalfmigpop[i]+halfmigration[i+1]
 }
  # projection frame
 Kt3first <- NA
  # note: there is a difference in the length here to the straight survivorshipmodel
 Kt3middle <- rep(0,(length(age)-1))
  for (i in 1: length(Kt3middle)){
  Kt3middle[[i]] <- Kt2survivalwremainingmig[i]}
  Kt3 <- as.data.frame(c(Kt3first, Kt3middle))
  Kt3 <- round(Kt3,0)
 colnames(Kt3) <- "Kt3"
  projsurvjump <- cbind(locagesex,propsurviving_2016,Kt3)
  inputdata$Kt3 <- projsurvjump$Kt3[match(inputdata$locagesex,
projsurvjump$locagesex, nomatch=NA)]
inputdata$propsurviving_2016 <-
projsurvjump$propsurviving_2016[match(inputdata$locagesex,
projsurvjump$locagesex, nomatch=NA)]
 return(inputdata)
 }
projsurvKt4 <- function(inputdata) {
 data<-inputdata[!(inputdata$Age==45),]
 data<-data[!(data$Age==50),]
 age <- c(55,60,65,70,75,80,85,90,95,100,105)
 n <- length(data$Age)
 Lx <- data$Lx_2021
 Tx <- data$Tx_2021
 Kt3 <- data$Kt3
 Mx <- data$Mig_2021
  locagesex <- data$locagesex
 lastrowindex <- nrow(data)
 lastrowindex_minus1 <- nrow(data)-1
  # to get the Lx+5/Lx
 survpropexceptlast <- rep(0,(length(age)-2))
 for (i in 1: length(survpropexceptlast)){
```

```
  survpropexceptlast[[i]] <- Lx[i+1]/Lx[i]}
 # note this is just Tx/Tx-5 for the last age group
 survpropopenint <-  Tx[lastrowindex]/(Tx[lastrowindex_minus1])
 propsurviving_2021 <- c(survpropexceptlast, survpropopenint,NA)
 # add migration
halfmigration <- rep(0,length(age))
for (i in 1: length(halfmigration)){
  halfmigration[[i]] <- Mx[i]/2}
 # allocate halfmigrants to launch population
 kt3plushalfmigrantsexceptlast <- rep(0, (length(age)-2))
for (i in 1:length(kt3plushalfmigrantsexceptlast)){
  kt3plushalfmigrantsexceptlast[[i]] <- Kt3[i]+halfmigration[i]}
  kt3plushalfmigrantslast <-
(Kt3[lastrowindex_minus1]+Kt3[lastrowindex])+((halfmigration[lastrowindex_minus1]
+halfmigration[lastrowindex]))
  Kt3whalfmig <- c(kt3plushalfmigrantsexceptlast,kt3plushalfmigrantslast)
  # survive population (note: the are different lengths, but the prop surviving includes
an NA at end so it will fit back in with the dataset)
  survivingKt3whalfmigpop <- rep(0,(length(age)-1))
for(i in 1: length(survivingKt3whalfmigpop)){
  survivingKt3whalfmigpop[[i]] <- Kt3whalfmig[i]*propsurviving_2021[i]
}
  # add remaining migrants (this will become Kt3)
  Kt3survivalwremainingmig <- rep(0,(length(age)-1))
for(i in 1: length(Kt3survivalwremainingmig)){
  Kt3survivalwremainingmig[[i]] <- survivingKt3whalfmigpop[i]+halfmigration[i+1]
}
  # projection frame
Kt4first <- NA

# note: there is a difference in the length here to the straight survivorshipmodel
Kt4middle <- rep(0,(length(age)-1))
 for (i in 1: length(Kt4middle)){
  Kt4middle[[i]] <- Kt3survivalwremainingmig[i]}
  Kt4 <- as.data.frame(c(Kt4first, Kt4middle))
  Kt4 <- round(Kt4,0)
colnames(Kt4) <- "Kt4"
```

```
  projsurvjump <- cbind(locagesex,propsurviving_2021,Kt4)
  inputdata$Kt4 <- projsurvjump$Kt4[match(inputdata$locagesex,
projsurvjump$locagesex, nomatch=NA)]
 inputdata$propsurviving_2021 <-
projsurvjump$propsurviving_2021[match(inputdata$locagesex,
projsurvjump$locagesex, nomatch=NA)]
  return(inputdata)
 }
projsurvKt5 <- function(inputdata) {
 data<-inputdata[!(inputdata$Age==45),]
 data<-data[!(data$Age==50),]
 data<-data[!(data$Age==55),]
 age <- c(60,65,70,75,80,85,90,95,100,105)
 n <- length(data$Age)
 Lx <- data$Lx_2026
 Tx <-data$Tx_2026
 Kt4 <- data$Kt4
 Mx <- data$Mig_2026
  locagesex <- data$locagesex
 lastrowindex <- nrow(data)
 lastrowindex_minus1 <- nrow(data)-1
  # to get the Lx+5/Lx
 survpropexceptlast <- rep(0,(length(age)-2))
 for (i in 1: length(survpropexceptlast)){
  survpropexceptlast[[i]] <- Lx[i+1]/Lx[i]}
  # note this is just Tx/Tx-5 for the last age group
  survpropopenint <-  Tx[lastrowindex]/(Tx[lastrowindex_minus1])

 propsurviving_2026 <- c(survpropexceptlast, survpropopenint,NA)
  # add migration
 halfmigration <- rep(0,length(age))
 for (i in 1: length(halfmigration)){
  halfmigration[[i]] <- Mx[i]/2}
  # allocate halfmigrants to launch population
  kt4plushalfmigrantsexceptlast <- rep(0, (length(age)-2))
 for (i in 1:length(kt4plushalfmigrantsexceptlast)){
  kt4plushalfmigrantsexceptlast[[i]] <- Kt4[i]+halfmigration[i]}
```

```
   kt4plushalfmigrantslast <-
(Kt4[lastrowindex_minus1]+Kt4[lastrowindex])+((halfmigration[lastrowindex_minus1]
+halfmigration[lastrowindex]))
   Kt4whalfmig <- c(kt4plushalfmigrantsexceptlast,kt4plushalfmigrantslast)
   # survive population (note: the are different lengths, but the prop surviving includes
an NA at end so it will fit back in with the dataset)
   survivingKt4whalfmigpop <- rep(0,(length(age)-1))
  for(i in 1: length(survivingKt4whalfmigpop)){
   survivingKt4whalfmigpop[[i]] <- Kt4whalfmig[i]*propsurviving_2026[i]
  }
   # add remaining migrants (this will become Kt3)
   Kt4survivalwremainingmig <- rep(0,(length(age)-1))
  for(i in 1: length(Kt4survivalwremainingmig)){
   Kt4survivalwremainingmig[[i]] <- survivingKt4whalfmigpop[i]+halfmigration[i+1]
  }
   # projection frame
  Kt5first <- NA
   # note: there is a difference in the length here to the straight survivorshipmodel
  Kt5middle <- rep(0,(length(age)-1))
   for (i in 1: length(Kt5middle)){
   Kt5middle[[i]] <- Kt4survivalwremainingmig[i]}
   Kt5 <- as.data.frame(c(Kt5first, Kt5middle))
   Kt5 <- round(Kt5,0)
  colnames(Kt5) <- "Kt5"
   projsurvjump <- cbind(locagesex,propsurviving_2026,Kt5)


  inputdata$Kt5 <- projsurvjump$Kt5[match(inputdata$locagesex,
projsurvjump$locagesex, nomatch=NA)]
  inputdata$propsurviving_2026 <-
projsurvjump$propsurviving_2026[match(inputdata$locagesex,
projsurvjump$locagesex, nomatch=NA)]
  return(inputdata)
  }
projsurvrun <- function(lt){
  splt.by <- c('Location','Sex')
  ltsplit <- split(lt,lt[,splt.by])
  ltKt2split <- lapply(seq_along(ltsplit), function(x) projsurvKt2(inputdata=ltsplit[[x]]))
  ltKproj <- do.call(rbind.data.frame, ltKt2split)
```

```
  #Kt3
 ltKt3input <- split(ltKproj,ltKproj[,splt.by])
 ltKt3split <- lapply(seq_along(ltKt3input), function(x)
projsurvKt3(inputdata=ltKt3input[[x]]))
 ltKproj <- do.call(rbind.data.frame, ltKt3split)
  #kt4
  ltKt4input <- split(ltKproj,ltKproj[,splt.by])
 ltKt4split <- lapply(seq_along(ltKt4input), function(x)
projsurvKt4(inputdata=ltKt4input[[x]]))
 ltKproj <- do.call(rbind.data.frame, ltKt4split)
  #kt5
  ltKt5input <- split(ltKproj,ltKproj[,splt.by])
 ltKt5split <- lapply(seq_along(ltKt5input), function(x)
projsurvKt5(inputdata=ltKt5input[[x]]))
 ltKproj <- do.call(rbind.data.frame, ltKt5split)
  return(ltKproj)
 }
projtocountfunction <- function(inputdata){
 colnames(inputdata) <-
c("sex","age","location","pop2011","pop2016","pop2021","pop2026","pop2031")
 rdf_subset <-inputdata[!(inputdata$age<=60),]
 rdf_subset$age <- paste0("age", rdf_subset$age, sep="")
 rdf_split<- split(rdf_subset, rdf_subset$age)
 rdf_cbind <- do.call(cbind, rdf_split)
 rdf_cbind$age70.sex <- rdf_cbind$age75.sex <- rdf_cbind$age80.sex <-
rdf_cbind$age85.sex <- rdf_cbind$age90.sex <- rdf_cbind$age95.sex <-
rdf_cbind$age100.sex <- rdf_cbind$age105.sex <- NULL
 rdf_cbind$age70.age <- rdf_cbind$age75.age <- rdf_cbind$age80.age <-
rdf_cbind$age85.age <- rdf_cbind$age90.age <- rdf_cbind$age95.age <-
rdf_cbind$age100.age <- rdf_cbind$age105.age <- NULL
 rdf_cbind$age70.location <- rdf_cbind$age75.location <- rdf_cbind$age80.location <-
rdf_cbind$age85.location <- rdf_cbind$age90.location <- rdf_cbind$age95.location <-
rdf_cbind$age100.location <- rdf_cbind$age105.location <- NULL
 rdf <- rdf_cbind
 colnames(rdf)[which(names(rdf) == "age65.pop2011")] <- "K2011_65_69"
 colnames(rdf)[which(names(rdf) == "age65.pop2016")] <- "K2016_65_69"
 colnames(rdf)[which(names(rdf) == "age65.pop2021")] <- "K2021_65_69"
 colnames(rdf)[which(names(rdf) == "age65.pop2026")] <- "K2026_65_69"
 colnames(rdf)[which(names(rdf) == "age65.pop2031")] <- "K2031_65_69"
```

```
colnames(rdf)[which(names(rdf) == "age70.pop2011")] <- "K2011_70_74"
colnames(rdf)[which(names(rdf) == "age70.pop2016")] <- "K2016_70_74"
colnames(rdf)[which(names(rdf) == "age70.pop2021")] <- "K2021_70_74"
colnames(rdf)[which(names(rdf) == "age70.pop2026")] <- "K2026_70_74"
colnames(rdf)[which(names(rdf) == "age70.pop2031")] <- "K2031_70_74"
colnames(rdf)[which(names(rdf) == "age75.pop2011")] <- "K2011_75_79"
colnames(rdf)[which(names(rdf) == "age75.pop2016")] <- "K2016_75_79"
colnames(rdf)[which(names(rdf) == "age75.pop2021")] <- "K2021_75_79"
colnames(rdf)[which(names(rdf) == "age75.pop2026")] <- "K2026_75_79"
colnames(rdf)[which(names(rdf) == "age75.pop2031")] <- "K2031_75_79"
colnames(rdf)[which(names(rdf) == "age80.pop2011")] <- "K2011_80_84"
colnames(rdf)[which(names(rdf) == "age80.pop2016")] <- "K2016_80_84"
colnames(rdf)[which(names(rdf) == "age80.pop2021")] <- "K2021_80_84"
colnames(rdf)[which(names(rdf) == "age80.pop2026")] <- "K2026_80_84"
colnames(rdf)[which(names(rdf) == "age80.pop2031")] <- "K2031_80_84"
colnames(rdf)[which(names(rdf) == "age85.pop2011")] <- "K2011_85_89"
colnames(rdf)[which(names(rdf) == "age85.pop2016")] <- "K2016_85_89"
colnames(rdf)[which(names(rdf) == "age85.pop2021")] <- "K2021_85_89"
colnames(rdf)[which(names(rdf) == "age85.pop2026")] <- "K2026_85_89"
colnames(rdf)[which(names(rdf) == "age85.pop2031")] <- "K2031_85_89"
colnames(rdf)[which(names(rdf) == "age90.pop2011")] <- "K2011_90_94"
colnames(rdf)[which(names(rdf) == "age90.pop2016")] <- "K2016_90_94"
colnames(rdf)[which(names(rdf) == "age90.pop2021")] <- "K2021_90_94"
colnames(rdf)[which(names(rdf) == "age90.pop2026")] <- "K2026_90_94"
colnames(rdf)[which(names(rdf) == "age90.pop2031")] <- "K2031_90_94"
colnames(rdf)[which(names(rdf) == "age95.pop2011")] <- "K2011_95_99"
colnames(rdf)[which(names(rdf) == "age95.pop2016")] <- "K2016_95_99"
colnames(rdf)[which(names(rdf) == "age95.pop2021")] <- "K2021_95_99"
colnames(rdf)[which(names(rdf) == "age95.pop2026")] <- "K2026_95_99"
colnames(rdf)[which(names(rdf) == "age95.pop2031")] <- "K2031_95_99"
colnames(rdf)[which(names(rdf) == "age100.pop2011")] <- "K2011_100_104"
colnames(rdf)[which(names(rdf) == "age100.pop2016")] <- "K2016_100_104"
colnames(rdf)[which(names(rdf) == "age100.pop2021")] <- "K2021_100_104"
colnames(rdf)[which(names(rdf) == "age100.pop2026")] <- "K2026_100_104"
colnames(rdf)[which(names(rdf) == "age100.pop2031")] <- "K2031_100_104"
colnames(rdf)[which(names(rdf) == "age105.pop2011")] <- "K2011_105_109"
```

```
  colnames(rdf)[which(names(rdf) == "age105.pop2016")] <- "K2016_105_109"
  colnames(rdf)[which(names(rdf) == "age105.pop2021")] <- "K2021_105_109"
  colnames(rdf)[which(names(rdf) == "age105.pop2026")] <- "K2026_105_109"
  colnames(rdf)[which(names(rdf) == "age105.pop2031")] <- "K2031_105_109"
  colnames(rdf)[which(names(rdf) == "age65.sex")] <- "sex"
  colnames(rdf)[which(names(rdf) == "age65.age")] <- "age"
  colnames(rdf)[which(names(rdf) == "age65.location")] <- "location"
  rdf$age <- NULL
  col_idx <- grep("sex", names(rdf))
  rdf <- rdf[, c(col_idx, (1:ncol(rdf))[-col_idx])]
  col_idx <- grep("location", names(rdf))
  rdf <- rdf[, c(col_idx, (1:ncol(rdf))[-col_idx])]
  rdf$K2011_65_84 <- rdf$K2011_65_69 + rdf$K2011_70_74 + rdf$K2011_75_79 +
rdf$K2011_80_84
  rdf$K2016_65_84 <- rdf$K2016_65_69 + rdf$K2016_70_74 + rdf$K2016_75_79 +
rdf$K2016_80_84
  rdf$K2021_65_84 <- rdf$K2021_65_69 + rdf$K2021_70_74 + rdf$K2021_75_79 +
rdf$K2021_80_84
  rdf$K2026_65_84 <- rdf$K2026_65_69 + rdf$K2026_70_74 + rdf$K2026_75_79 +
rdf$K2026_80_84
  rdf$K2031_65_84 <- rdf$K2031_65_69 + rdf$K2031_70_74 + rdf$K2031_75_79 +
rdf$K2031_80_84
  rdf$K2011_65p <- rdf$K2011_65_69 + rdf$K2011_70_74 + rdf$K2011_75_79 +
rdf$K2011_80_84 + rdf$K2011_85_89 + rdf$K2011_90_94 + rdf$K2011_95_99 +
rdf$K2011_100_104 + rdf$K2011_105_109
  rdf$K2016_65p <- rdf$K2016_65_69 + rdf$K2016_70_74 + rdf$K2016_75_79 +
rdf$K2016_80_84 + rdf$K2016_85_89 + rdf$K2016_90_94 + rdf$K2016_95_99 +
rdf$K2016_100_104 + rdf$K2016_105_109
  rdf$K2021_65p <- rdf$K2021_65_69 + rdf$K2021_70_74 + rdf$K2021_75_79 +
rdf$K2021_80_84 + rdf$K2021_85_89 + rdf$K2021_90_94 + rdf$K2021_95_99 +
rdf$K2021_100_104 + rdf$K2021_105_109
  rdf$K2026_65p <- rdf$K2026_65_69 + rdf$K2026_70_74 + rdf$K2026_75_79 +
rdf$K2026_80_84 + rdf$K2026_85_89 + rdf$K2026_90_94 + rdf$K2026_95_99 +
rdf$K2026_100_104 + rdf$K2026_105_109
  rdf$K2031_65p <- rdf$K2031_65_69 + rdf$K2031_70_74 + rdf$K2031_75_79 +
rdf$K2031_80_84 + rdf$K2031_85_89 + rdf$K2031_90_94 + rdf$K2031_95_99 +
rdf$K2031_100_104 + rdf$K2031_105_109
  rdf$K2011_85p <- rdf$K2011_85_89 + rdf$K2011_90_94 + rdf$K2011_95_99 +
rdf$K2011_100_104 + rdf$K2011_105_109
  rdf$K2016_85p <- rdf$K2016_85_89 + rdf$K2016_90_94 + rdf$K2016_95_99 +
rdf$K2016_100_104 + rdf$K2016_105_109
```

```
  rdf$K2021_85p <- rdf$K2021_85_89 + rdf$K2021_90_94 + rdf$K2021_95_99 + rdf$K2021_100_104 + rdf$K2021_105_109
  rdf$K2026_85p <- rdf$K2026_85_89 + rdf$K2026_90_94 + rdf$K2026_95_99 + rdf$K2026_100_104 + rdf$K2026_105_109
  rdf$K2031_85p <- rdf$K2031_85_89 + rdf$K2031_90_94 + rdf$K2031_95_99 + rdf$K2031_100_104 + rdf$K2031_105_109
  return(rdf)}
growthratefunction <- function(inputdata) {
    inputdata$r2011_2031_65p <- (log(inputdata$K2031_65p/inputdata$K2011_65p))/20*100
  inputdata$r2011_2031_85p <- (log(inputdata$K2031_85p/inputdata$K2011_85p))/20*100
  inputdata$r2011_2031_65_84 <- (log(inputdata$K2031_65_84/inputdata$K2011_65_84))/20*100
  inputdata$r2011_2031_65_69 <- (log(inputdata$K2031_65_69/inputdata$K2011_65_69))/20*100
  inputdata$r2011_2031_70_74 <- (log(inputdata$K2031_70_74/inputdata$K2011_70_74))/20*100
  inputdata$r2011_2031_75_79 <- (log(inputdata$K2031_75_79/inputdata$K2011_75_79))/20*100
  inputdata$r2011_2031_80_84 <- (log(inputdata$K2031_80_84/inputdata$K2011_80_84))/20*100
    inputdata$r2011_2016_65p <- (log(inputdata$K2016_65p/inputdata$K2011_65p))/5*100
  inputdata$r2011_2016_85p <- (log(inputdata$K2016_85p/inputdata$K2011_85p))/5*100
  inputdata$r2011_2016_65_84 <- (log(inputdata$K2016_65_84/inputdata$K2011_65_84))/5*100
  inputdata$r2011_2016_65_69 <- (log(inputdata$K2016_65_69/inputdata$K2011_65_69))/5*100
  inputdata$r2011_2016_70_74 <- (log(inputdata$K2016_70_74/inputdata$K2011_70_74))/5*100
  inputdata$r2011_2016_75_79 <- (log(inputdata$K2016_75_79/inputdata$K2011_75_79))/5*100
  inputdata$r2011_2016_80_84 <- (log(inputdata$K2016_80_84/inputdata$K2011_80_84))/5*100
    inputdata$r2016_2021_65p <- (log(inputdata$K2021_65p/inputdata$K2016_65p))/5*100
  inputdata$r2016_2021_85p <- (log(inputdata$K2021_85p/inputdata$K2016_85p))/5*100
  inputdata$r2016_2021_65_84 <- (log(inputdata$K2021_65_84/inputdata$K2016_65_84))/5*100
```

```
  inputdata$r2016_2021_65_69 <-
(log(inputdata$K2021_65_69/inputdata$K2016_65_69))/5*100
  inputdata$r2016_2021_70_74 <-
(log(inputdata$K2021_70_74/inputdata$K2016_70_74))/5*100
  inputdata$r2016_2021_75_79 <-
(log(inputdata$K2021_75_79/inputdata$K2016_75_79))/5*100
  inputdata$r2016_2021_80_84 <-
(log(inputdata$K2021_80_84/inputdata$K2016_80_84))/5*100
    inputdata$r2021_2026_65p <-
(log(inputdata$K2026_65p/inputdata$K2021_65p))/5*100
  inputdata$r2021_2026_85p <-
(log(inputdata$K2026_85p/inputdata$K2021_85p))/5*100
  inputdata$r2021_2026_65_84 <-
(log(inputdata$K2026_65_84/inputdata$K2021_65_84))/5*100
  inputdata$r2021_2026_65_69 <-
(log(inputdata$K2026_65_69/inputdata$K2021_65_69))/5*100
  inputdata$r2021_2026_70_74 <-
(log(inputdata$K2026_70_74/inputdata$K2021_70_74))/5*100
  inputdata$r2021_2026_75_79 <-
(log(inputdata$K2026_75_79/inputdata$K2021_75_79))/5*100
  inputdata$r2021_2026_80_84 <-
(log(inputdata$K2026_80_84/inputdata$K2021_80_84))/5*100
    inputdata$r2026_2031_65p <-
(log(inputdata$K2031_65p/inputdata$K2026_65p))/5*100
  inputdata$r2026_2031_85p <-
(log(inputdata$K2031_85p/inputdata$K2026_85p))/5*100
  inputdata$r2026_2031_65_84 <-
(log(inputdata$K2031_65_84/inputdata$K2026_65_84))/5*100
  inputdata$r2026_2031_65_69 <-
(log(inputdata$K2031_65_69/inputdata$K2026_65_69))/5*100
  inputdata$r2026_2031_70_74 <-
(log(inputdata$K2031_70_74/inputdata$K2026_70_74))/5*100
  inputdata$r2026_2031_75_79 <-
(log(inputdata$K2031_75_79/inputdata$K2026_75_79))/5*100
  inputdata$r2026_2031_80_84 <-
(log(inputdata$K2031_80_84/inputdata$K2026_80_84))/5*100
  inputdata$r2011_2021_65p <-
(log(inputdata$K2021_65p/inputdata$K2011_65p))/10*100
  inputdata$r2011_2021_85p <-
(log(inputdata$K2021_85p/inputdata$K2011_85p))/10*100
  inputdata$r2011_2021_65_84 <-
(log(inputdata$K2021_65_84/inputdata$K2011_65_84))/10*100
```

```
  inputdata$r2011_2021_65_69 <-
(log(inputdata$K2021_65_69/inputdata$K2011_65_69))/10*100
  inputdata$r2011_2021_70_74 <-
(log(inputdata$K2021_70_74/inputdata$K2011_70_74))/10*100
  inputdata$r2011_2021_75_79 <-
(log(inputdata$K2021_75_79/inputdata$K2011_75_79))/10*100
  inputdata$r2011_2021_80_84 <-
(log(inputdata$K2021_80_84/inputdata$K2011_80_84))/10*100
  inputdata$r2021_2031_65p <-
(log(inputdata$K2031_65p/inputdata$K2021_65p))/10*100
  inputdata$r2021_2031_85p <-
(log(inputdata$K2031_85p/inputdata$K2021_85p))/10*100
  inputdata$r2021_2031_65_84 <-
(log(inputdata$K2031_65_84/inputdata$K2021_65_84))/10*100
  inputdata$r2021_2031_65_69 <-
(log(inputdata$K2031_65_69/inputdata$K2021_65_69))/10*100
  inputdata$r2021_2031_70_74 <-
(log(inputdata$K2031_70_74/inputdata$K2021_70_74))/10*100
  inputdata$r2021_2031_75_79 <-
(log(inputdata$K2031_75_79/inputdata$K2021_75_79))/10*100
  inputdata$r2021_2031_80_84 <-
(log(inputdata$K2031_80_84/inputdata$K2021_80_84))/10*100
  return(inputdata)
  }
# projection function
SA3projectionfunction <-
function(Mort_variant,NIM_variant,NOM_variant,NIM_NOM_variant,Sex,Proj_varian
t){
  # mortality variant (select "hqx","lqx" or "constant")
  Mort_variant <- Mort_variant
    # NIM variant (select "NIM_count_constant") [[NOTE: others may be added]]
  NIM_variant <- NIM_variant
  # NOM  variant (select "NOM_count_high", "NOM_count_med","NOM_count_low")
  NOM_variant <- NOM_variant
   # projection variant relating to migration (select
"NoNIM_NoNOM","NoNIM_NOM","NIM_NoNOM","NIM_NOM")
  NIM_NOM_variant <- NIM_NOM_variant
   # Sex (select "Female" or "Male" or "Male_Female")
  Sex <- Sex
  Proj_variant<- Proj_variant
   # Titles for output files
```

```
 Text_title <-
c("SA3proj",Proj_variant,Sex,Mort_variant,NIM_variant,NOM_variant,NIM_NOM_va
riant,"2011_2031")
 TitleProj <- paste0(c(Text_title,"Count"), collapse="_")
  TitleGrowth <- paste0(c(Text_title,"Growth"), collapse="_")
   # starting life table (2011 life table)
 setwd("[[ADD A WORKING DIRECTORY]]")
 fileltmf <- read.csv("SA3LT_SMR_2011_0_1_5_110_Gompertz.csv", header=T)
 filelt_reducecol <- subset(fileltmf,select=c(Sex,Age,Location,Lx,Tx))
 colnames(filelt_reducecol) <- c("Sex","Age","Location","Lx_2011","Tx_2011")
 filelt_reduceage <-
subset(filelt_reducecol,filelt_reducecol$Age>=45&filelt_reducecol$Age<110)
 LTmf_base <- filelt_reduceage
 cols <- c(3,2,1)
 LTmf_base$locagesex <- apply(LTmf_base[ ,cols], 1 , paste, collapse = "_")
 LTmf_base$locagesex <- gsub("[[:space:]]", "", LTmf_base$locagesex)
 # staring pop counts
setwd("[[ADD A WORKING DIRECTORY]]")
 filepcallages <- read.csv("SA32011ERPExtended_0_1_5_100.csv",header=T)
 colnames(filepcallages) <- c("Location","Age","Sex","locage","ERP")
 filepc <- subset(filepcallages,filepcallages$Age>=45)
 filepc$locage <- NULL
 cols <- c(1,2,3)
 filepc$locagesex <- apply(filepc[ ,cols], 1 , paste, collapse = "_")
 filepc$locagesex <- gsub("[[:space:]]", "", filepc$locagesex)
 # add the base population counts to the base life table


 LTmf_base$popcountSA3 <-
filepc$ERP[match(LTmf_base$locagesex,filepc$locagesex,nomatch=NA)]
 for(i in 1:nrow(LTmf_base)){
   if(LTmf_base$Age[i]==105){
     LTmf_base$popcountSA3[[i]] <- 0}}
  # mortality variants - input data for 2016 to 2026
 setwd("[[ADD A WORKING DIRECTORY]]")
 LT_mf_2016_2026_hqx_lqxin <-
read.csv("SA3LT_hqx_lqx_2016_2026_Gompertz.csv", header=T)
 LT_mf_2016_2026_hqx_lqxin_subset <- subset(LT_mf_2016_2026_hqx_lqxin,
select=c(sex,age,location,year,type,Lx,Tx))
```

```
  LT_mf_2016_2026_hqx_lqx <- subset(LT_mf_2016_2026_hqx_lqxin_subset,
LT_mf_2016_2026_hqx_lqxin_subset$age>=45 &
LT_mf_2016_2026_hqx_lqxin_subset$age < 110)
  cols <- c(3,2,1)
  LT_mf_2016_2026_hqx_lqx$locagesex <- apply(LT_mf_2016_2026_hqx_lqx[ ,cols],
1 , paste, collapse = "_")
  LT_mf_2016_2026_hqx_lqx$locagesex <- gsub("[[:space:]]", "",
LT_mf_2016_2026_hqx_lqx$locagesex)
  # selection of the  mortality variant for the years 2016,2021 and 2026 and combine
with the base life table
    if(Mort_variant == "hqx"){
    LT_mf_2016_2026 <- subset(LT_mf_2016_2026_hqx_lqx,
LT_mf_2016_2026_hqx_lqx$type=="hqx")}
    if(Mort_variant == "lqx"){
    LT_mf_2016_2026 <- subset(LT_mf_2016_2026_hqx_lqx,
LT_mf_2016_2026_hqx_lqx$type=="lqx")}
    if(Mort_variant == "constant"){
    LT_mf_2016 <- LTmf_base
    colnames(LT_mf_2016)[which(names(LT_mf_2016) == "Lx_2011")] <- "Lx"
    colnames(LT_mf_2016)[which(names(LT_mf_2016) == "Tx_2011")] <- "Tx"
    LT_mf_2016$year <- rep(2016,nrow(LT_mf_2016))
    LT_mf_2026 <- LT_mf_2021 <- LT_mf_2016
    LT_mf_2021$year <- rep(2021,nrow(LT_mf_2021))
    LT_mf_2026$year <- rep(2026,nrow(LT_mf_2026))
    LT_mf_2016_2026 <- rbind(LT_mf_2016,LT_mf_2021,LT_mf_2026)
  }

  LT_mf_2016 <- subset(LT_mf_2016_2026,LT_mf_2016_2026$year==2016)
  LT_mf_2021 <- subset(LT_mf_2016_2026,LT_mf_2016_2026$year==2021)
  LT_mf_2026 <- subset(LT_mf_2016_2026,LT_mf_2016_2026$year==2026)
  LTmf_base$Lx_2016 <-
LT_mf_2016$Lx[match(LT_mf_2016$locagesex,LT_mf_2016$locagesex)]
  LTmf_base$Tx_2016 <-
LT_mf_2016$Tx[match(LT_mf_2016$locagesex,LT_mf_2016$locagesex)]
  LTmf_base$Lx_2021 <-
LT_mf_2021$Lx[match(LT_mf_2021$locagesex,LT_mf_2021$locagesex)]
  LTmf_base$Tx_2021 <-
LT_mf_2021$Tx[match(LT_mf_2021$locagesex,LT_mf_2021$locagesex)]
  LTmf_base$Lx_2026 <-
LT_mf_2026$Lx[match(LT_mf_2026$locage,LT_mf_2026$locage)]
```

```
  LTmf_base$Tx_2026 <-
LT_mf_2026$Tx[match(LT_mf_2026$locage,LT_mf_2026$locage)]
  LTmf <- LTmf_base
  # internal migration - input data for 2011 to 2026
   setwd("[[ADD A WORKING DIRECTORY]]")
  internalmigration <-
read.csv("SA3Mnetmigration_45_100_Census2011_5Yr_forprojections.csv",header=T)
  colnames(internalmigration) <-
c("Location","Netinternalmigrants","Sex","Inarea_movers","In_migrants","Out_migrati
ons","Age")
  cols <- c(1,7,3)
  internalmigration$locagesex <- apply(internalmigration[ ,cols], 1 , paste, collapse =
"_")
  internalmigration$locagesex <- gsub("[[:space:]]", "", internalmigration$locagesex)
  NIM <- internalmigration
    if(NIM_variant == "NIM_count_constant"){
    NIM$NIM_2011 <- NIM$Netinternalmigrants
    NIM$NIM_2016 <- NIM$Netinternalmigrants
    NIM$NIM_2021 <- NIM$Netinternalmigrants
    NIM$NIM_2026 <- NIM$Netinternalmigrants
    NIM <- subset(NIM,
select=c(locagesex,NIM_2011,NIM_2016,NIM_2021,NIM_2026))}
    # overseas migration - input data for 2011 to 2026
    setwd("[[ADD A WORKING DIRECTORY]]")
  overseasmigration <-
read.csv("SA3NOM_EOshare_45_105_2011_2030.csv",header=T)
  colnames(overseasmigration)[which(names(overseasmigration) == "location")] <-
"Location"
  overseasmigration$Age_group <- as.character(overseasmigration$Age_group)
  overseasmigration$Age <- gsub("40_44","40",overseasmigration$Age)
  overseasmigration$Age <- gsub("45_49","45",overseasmigration$Age)
  overseasmigration$Age <- gsub("50_54","50",overseasmigration$Age)
  overseasmigration$Age <- gsub("55_59","55",overseasmigration$Age)
  overseasmigration$Age <- gsub("60_64","60",overseasmigration$Age)
  overseasmigration$Age <- gsub("65_69","65",overseasmigration$Age)
  overseasmigration$Age <- gsub("70_74","70",overseasmigration$Age)
  overseasmigration$Age <- gsub("75_79","75",overseasmigration$Age)
  overseasmigration$Age <- gsub("80_84","80",overseasmigration$Age)
  overseasmigration$Age <- gsub("85_89","85",overseasmigration$Age)
```

```
 overseasmigration$Age <- gsub("90_94","90",overseasmigration$Age)
 overseasmigration$Age <- gsub("95_99","95",overseasmigration$Age)
 overseasmigration$Age <- gsub("100_104","100",overseasmigration$Age)
 overseasmigration$Age <- as.numeric(overseasmigration$Age)
 overseasmigration$Age_group <- NULL
 cols <- c(1,40,2)
 overseasmigration$locagesex <- apply(overseasmigration[ ,cols], 1 , paste, collapse =
"_")
 overseasmigration$locagesex <- gsub("[[:space:]]", "", overseasmigration$locagesex)
 # select the variant of NOM
  if(NOM_variant == "NOM_count_high"){
  NOM <-
subset(overseasmigration,select=c(locagesex,NOM_High_2011_2015,NOM_High_201
6_2020,NOM_High_2021_2025,NOM_High_2026_2030))
  colnames(NOM) <-
c("locagesex","NOM_2011","NOM_2016","NOM_2021","NOM_2026")}
  if(NOM_variant == "NOM_count_med"){
  NOM <-
subset(overseasmigration,select=c(locagesex,NOM_Med_2011_2015,NOM_Med_2016
_2020,NOM_Med_2021_2025,NOM_Med_2026_2030))
  colnames(NOM) <-
c("locagesex","NOM_2011","NOM_2016","NOM_2021","NOM_2026")}
  if(NOM_variant == "NOM_count_low"){
  NOM <-
subset(overseasmigration,select=c(locagesex,NOM_Low_2011_2015,NOM_Low_2016
_2020,NOM_Low_2021_2025,NOM_Low_2026_2030))
  colnames(NOM) <-
c("locagesex","NOM_2011","NOM_2016","NOM_2021","NOM_2026")}


 # combine projection variant regarding migration (NOM and NIM) and with the
population and projected survivorship base
   if(NIM_NOM_variant=="NoNIM_NoNOM"){
     LTmf$Mig_2011 <- rep(0,nrow(LTmf))
     LTmf$Mig_2016 <- rep(0,nrow(LTmf))
     LTmf$Mig_2021 <- rep(0,nrow(LTmf))
     LTmf$Mig_2026 <- rep(0,nrow(LTmf))
    }
   if(NIM_NOM_variant=="NIM_NoNOM"){
      LTmf$Mig_2011 <-
NIM$NIM_2011[match(LTmf$locagesex,NIM$locagesex,nomatch=NA)]
```

```
LTmf$Mig_2016 <-
NIM$NIM_2016[match(LTmf$locagesex,NIM$locagesex,nomatch=NA)]
LTmf$Mig_2021 <-
NIM$NIM_2021[match(LTmf$locagesex,NIM$locagesex,nomatch=NA)]
LTmf$Mig_2026 <-
NIM$NIM_2026[match(LTmf$locagesex,NIM$locagesex,nomatch=NA)]}
if(NIM_NOM_variant=="NoNIM_NOM"){
LTmf$Mig_2011 <-
NOM$NOM_2011[match(LTmf$locagesex,NOM$locagesex,nomatch=NA)]
LTmf$Mig_2016 <-
NOM$NOM_2016[match(LTmf$locagesex,NOM$locagesex,nomatch=NA)]
LTmf$Mig_2021 <-
NOM$NOM_2021[match(LTmf$locagesex,NOM$locagesex,nomatch=NA)]
LTmf$Mig_2026 <-
NOM$NOM_2026[match(LTmf$locagesex,NOM$locagesex,nomatch=NA)]}
if(NIM_NOM_variant=="NIM_NOM"){
miglength <- nrow(NIM)
NIM_NOM_merge <- merge(NOM, NIM, by='locagesex', all.y = T, sort=
T)
NIM_NOM_combined <- data.frame(locagesex= character(miglength),
Mig_2011 = numeric(miglength), Mig_2016 = numeric(miglength),Mig_2021 =
numeric(miglength),Mig_2026 = numeric(miglength))
NIM_NOM_combined$locagesex <- NIM_NOM_merge$locagesex
NIM_NOM_combined$Mig_2011 <- NIM_NOM_merge$NIM_2011 +
NIM_NOM_merge$NOM_2011
NIM_NOM_combined$Mig_2016 <- NIM_NOM_merge$NIM_2016 +
NIM_NOM_merge$NOM_2016
NIM_NOM_combined$Mig_2021 <- NIM_NOM_merge$NIM_2021 +
NIM_NOM_merge$NOM_2021
NIM_NOM_combined$Mig_2026 <- NIM_NOM_merge$NIM_2026 +
NIM_NOM_merge$NOM_2026
LTmf$Mig_2011 <-
NIM_NOM_combined$Mig_2011[match(LTmf$locagesex,NIM_NOM_combined$loc
agesex,nomatch=NA)]
LTmf$Mig_2016 <-
NIM_NOM_combined$Mig_2016[match(LTmf$locagesex,NIM_NOM_combined$loc
agesex,nomatch=NA)]
LTmf$Mig_2021 <-
NIM_NOM_combined$Mig_2021[match(LTmf$locagesex,NIM_NOM_combined$loc
agesex,nomatch=NA)]
LTmf$Mig_2026 <-
NIM_NOM_combined$Mig_2026[match(LTmf$locagesex,NIM_NOM_combined$loc
agesex,nomatch=NA)]}
```

```
for(i in 1:nrow(LTmf)){
if(LTmf$Age[i]==105){
LTmf$Mig_2011[[i]] <-  LTmf$Mig_2016[[i]] <- LTmf$Mig_2021[[i]] <-
LTmf$Mig_2026[[i]] <- 0}}
if(Sex=="Female"){
lt <- subset(LTmf,LTmf$Sex=="Female")}
if(Sex=="Male"){
lt <- subset(LTmf,LTmf$Sex=="Male")}
if(Sex=="Male_Female"){
lt <- LTmf}
lt$Sex <- as.character(lt$Sex)
projKt2_Kt5 <- projsurvrun(lt=lt)
projKt2_Kt5$Proj_variant <- rep(TitleProj,nrow(projKt2_Kt5))
setwd("[[ADD A WORKING DIRECTORY]]")
write.table(projKt2_Kt5, file=paste(TitleProj,".csv",sep=""),sep=",",row.names=F)
if(Sex=="Male"){
SA3proj2011_2031 <-
projKt2_Kt5[c("Sex","Age","Location","popcountSA3","Kt2","Kt3","Kt4","Kt5")]
colnames(SA3proj2011_2031) <-
c("Sex","Age","Location","pop2011","pop2016","pop2021","pop2026","pop2031")}
if(Sex=="Female"){
SA3proj2011_2031 <-
projKt2_Kt5[c("Sex","Age","Location","popcountSA3","Kt2","Kt3","Kt4","Kt5")]
colnames(SA3proj2011_2031) <-
c("Sex","Age","Location","pop2011","pop2016","pop2021","pop2026","pop2031")}
if(Sex=="Male_Female"){
subset_femaleproj <- subset(projKt2_Kt5, projKt2_Kt5$Sex=="Female",
select=c(Age,Location,popcountSA3,Kt2,Kt3,Kt4,Kt5))
colnames(subset_femaleproj) <-
c("Age","Location","popcountSA3_F","Kt2_F","Kt3_F","Kt4_F","Kt5_F")
subset_maleproj <-
subset(projKt2_Kt5,projKt2_Kt5$Sex=="Male",select=c(Age,Location,popcountSA3,K
t2,Kt3,Kt4,Kt5))
colnames(subset_maleproj) <-
c("Age","Location","popcountSA3_M","Kt2_M","Kt3_M","Kt4_M","Kt5_M")
cols <- c(2,1)
subset_femaleproj$locage <- apply(subset_femaleproj[ ,cols], 1 , paste, collapse =
"_")
subset_maleproj$locage <- apply(subset_maleproj[ ,cols], 1 , paste, collapse = "_")
subset_femaleproj$locage <- gsub("[[:space:]]", "", subset_femaleproj$locage)
```

```
subset_maleproj$locage <- gsub("[[:space:]]", "", subset_maleproj$locage)
Male_Fem_project <- merge(subset_maleproj, subset_femaleproj, by='locage', all.y = T, sort= T)
Male_Fem_project$locage <- Male_Fem_project$Age.x <- Male_Fem_project$Location.x <- NULL
projmalesfemalesKt2_Kt5 <- subset(Male_Fem_project,select=c(Age.y,Location.y))
colnames(projmalesfemalesKt2_Kt5) <- c("Age","Location")
projmalesfemalesKt2_Kt5$Sex <- rep("Male_Female",nrow(projmalesfemalesKt2_Kt5))
projmalesfemalesKt2_Kt5<-projmalesfemalesKt2_Kt5[c("Sex","Age","Location")]
projmalesfemalesKt2_Kt5$pop2011 <- Male_Fem_project$popcountSA3_M + Male_Fem_project$popcountSA3_F
projmalesfemalesKt2_Kt5$pop2016 <- Male_Fem_project$Kt2_M + Male_Fem_project$Kt2_F
projmalesfemalesKt2_Kt5$pop2021 <- Male_Fem_project$Kt3_M + Male_Fem_project$Kt3_F
projmalesfemalesKt2_Kt5$pop2026 <- Male_Fem_project$Kt4_M + Male_Fem_project$Kt4_F
projmalesfemalesKt2_Kt5$pop2031 <- Male_Fem_project$Kt5_M + Male_Fem_project$Kt5_F
SA3proj2011_2031_F <- subset(projKt2_Kt5,projKt2_Kt5$Sex=="Female", select=c(Sex,Age,Location,popcountSA3,Kt2,Kt3,Kt4,Kt5))
colnames(SA3proj2011_2031_F) <- c("Sex","Age","Location","pop2011","pop2016","pop2021","pop2026","pop2031")
SA3proj2011_2031_M <- subset(projKt2_Kt5,projKt2_Kt5$Sex=="Male", select=c(Sex,Age,Location,popcountSA3,Kt2,Kt3,Kt4,Kt5))
colnames(SA3proj2011_2031_M) <- c("Sex","Age","Location","pop2011","pop2016","pop2021","pop2026","pop2031")
SA3proj2011_2031 <- rbind(projmalesfemalesKt2_Kt5,SA3proj2011_2031_F,SA3proj2011_2031_M)}
SA3proj2011_2031_split <- split(SA3proj2011_2031,SA3proj2011_2031$Sex)
SA3proj2011_2031_prepgrowfunction <- lapply(seq_along(SA3proj2011_2031_split), function(x) projtocountfunction(inputdata=SA3proj2011_2031_split[[x]]))
SA3proj2011_2031_growthratefunction <- lapply(seq_along(SA3proj2011_2031_prepgrowfunction), function(x) growthratefunction(inputdata=SA3proj2011_2031_prepgrowfunction[[x]]))
SA3proj2011_2031_growthrate <- do.call(rbind.data.frame,SA3proj2011_2031_growthratefunction)
SA3proj2011_2031_growthrate$Proj_variant <- rep(TitleGrowth,nrow(SA3proj2011_2031_growthrate))
setwd("[[ADD A WORKING DIRECTORY]]")
```

```
  write.table(SA3proj2011_2031_growthrate,
file=paste(TitleGrowth,".csv",sep=""),sep=",",row.names=F)
    return(SA3proj2011_2031_growthrate)}
# Run the projections
# mortality variant (select "hqx","lqx" or "constant")
# NIM variant (select "NIM_count_constant")
# NOM  variant (select "NOM_count_high", "NOM_count_med","NOM_count_low")
# projection variant relating to migration (select
"NoNIM_NoNOM","NoNIM_NOM","NIM_NoNOM","NIM_NOM")
# Sex (select "Female" or "Male" of "Male_Female")
Proj_variant1 <-
SA3projectionfunction(Proj_variant="1",Mort_variant="constant",NIM_variant="NIM
_NA",NOM_variant="NOM_NA",NIM_NOM_variant="NoNIM_NoNOM",Sex="Mal
e_Female")
Proj_variant2 <-
SA3projectionfunction(Proj_variant="2",Mort_variant="hqx",NIM_variant="NIM_NA
",NOM_variant="NOM_NA",NIM_NOM_variant="NoNIM_NoNOM",Sex="Male_Fe
male")
Proj_variant3 <-
SA3projectionfunction(Proj_variant="3",Mort_variant="lqx",NIM_variant="NIM_NA"
,NOM_variant="NOM_NA",NIM_NOM_variant="NoNIM_NoNOM",Sex="Male_Fe
male")
Proj_variant4 <-
SA3projectionfunction(Proj_variant="4",Mort_variant="constant",NIM_variant="NIM
_count_constant",NOM_variant="NOM_NA",NIM_NOM_variant="NIM_NoNOM",S
ex="Male_Female")
Proj_variant5 <-
SA3projectionfunction(Proj_variant="5",Mort_variant="hqx",NIM_variant="NIM_cou
nt_constant",NOM_variant="NOM_NA",NIM_NOM_variant="NIM_NoNOM",Sex="
Male_Female")
Proj_variant6 <-
SA3projectionfunction(Proj_variant="6",Mort_variant="lqx",NIM_variant="NIM_coun
t_constant",NOM_variant="NOM_NA",NIM_NOM_variant="NIM_NoNOM",Sex="M
ale_Female")
Proj_variant7 <-
SA3projectionfunction(Proj_variant="7",Mort_variant="constant",NIM_variant="NIM
_NA",NOM_variant="NOM_count_low",NIM_NOM_variant="NoNIM_NOM",Sex="
Male_Female")
Proj_variant8 <-
SA3projectionfunction(Proj_variant="8",Mort_variant="hqx",NIM_variant="NIM_NA
",NOM_variant="NOM_count_low",NIM_NOM_variant="NoNIM_NOM",Sex="Male
_Female")
Proj_variant9 <-
SA3projectionfunction(Proj_variant="9",Mort_variant="lqx",NIM_variant="NIM_NA"
```

```
,NOM_variant="NOM_count_low",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant10 <- SA3projectionfunction(Proj_variant="10",Mort_variant="constant",NIM_variant="NIM_NA",NOM_variant="NOM_count_med",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant11 <- SA3projectionfunction(Proj_variant="11",Mort_variant="hqx",NIM_variant="NIM_NA",NOM_variant="NOM_count_med",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant12 <- SA3projectionfunction(Proj_variant="12",Mort_variant="lqx",NIM_variant="NIM_NA",NOM_variant="NOM_count_med",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant13 <- SA3projectionfunction(Proj_variant="13",Mort_variant="constant",NIM_variant="NIM_NA",NOM_variant="NOM_count_high",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant14 <- SA3projectionfunction(Proj_variant="14",Mort_variant="hqx",NIM_variant="NIM_NA",NOM_variant="NOM_count_high",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant15 <- SA3projectionfunction(Proj_variant="15",Mort_variant="lqx",NIM_variant="NIM_NA",NOM_variant="NOM_count_high",NIM_NOM_variant="NoNIM_NOM",Sex="Male_Female")

Proj_variant16 <- SA3projectionfunction(Proj_variant="16",Mort_variant="constant",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_low",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant17 <- SA3projectionfunction(Proj_variant="17",Mort_variant="hqx",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_low",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant18 <- SA3projectionfunction(Proj_variant="18",Mort_variant="lqx",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_low",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant19 <- SA3projectionfunction(Proj_variant="19",Mort_variant="constant",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_med",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant20 <- SA3projectionfunction(Proj_variant="20",Mort_variant="hqx",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_med",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")
```

```
Proj_variant21 <-
SA3projectionfunction(Proj_variant="21",Mort_variant="lqx",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_med",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant22 <-
SA3projectionfunction(Proj_variant="22",Mort_variant="constant",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_high",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant23 <-
SA3projectionfunction(Proj_variant="23",Mort_variant="hqx",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_high",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

Proj_variant24 <-
SA3projectionfunction(Proj_variant="24",Mort_variant="lqx",NIM_variant="NIM_count_constant",NOM_variant="NOM_count_high",NIM_NOM_variant="NIM_NOM",Sex="Male_Female")

# combine as a list and select indicators of interest

setwd("[[ADD A WORKING DIRECTORY]]")

Proj_SA3variant_list <- lapply(ls(pattern='Proj_variant*'),get)

singindicatorcomparisonfunction <- function(inputdata,sexofinterest,compindicator) {
  keycolumn <- subset(inputdata,inputdata$sex==sexofinterest,
select=c(compindicator))
  name <- paste(c(compindicator,inputdata$Proj_variant[[1]]), collapse="_")
  colnames(keycolumn) <- name
  return(keycolumn)}

twoindicatorcomparisonfunction <-
function(inputdata,sexofinterest,compindicator_1,compindicator_2){
  keycolumn_1 <- subset(inputdata,inputdata$sex==sexofinterest,
select=c(compindicator_1))
  name_1 <- paste(c(compindicator_1,inputdata$Proj_variant[[1]]), collapse="_")
  colnames(keycolumn_1) <- name_1
   keycolumn_2 <- subset(inputdata,inputdata$sex==sexofinterest,
select=c(compindicator_2))
  name_2 <- paste(c(compindicator_2,inputdata$Proj_variant[[1]]), collapse="_")
  colnames(keycolumn_2) <- name_2
   diff <- keycolumn_2-keycolumn_1
    return(diff)}

sex <-
subset(Proj_SA3variant_list[[1]],Proj_SA3variant_list[[1]]$sex=="Male_Female",select=sex)

location <-
subset(Proj_SA3variant_list[[1]],Proj_SA3variant_list[[1]]$sex=="Male_Female",select=location)
```

```
Proj_SA3variant_comparisonfunction_K2031_65p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
singindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="Male_Female",compindicator="K2031_65p"))

Proj_comparison_K2031_65p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_K2031_65p)))

write.table(Proj_comparison_K2031_65p,"Proj_comparison_K2031_65p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_K2031_85p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
singindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="Male_Female",compindicator="K2031_85p"))

Proj_comparison_K2031_85p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_K2031_85p)))

write.table(Proj_comparison_K2031_85p,"Proj_comparison_K2031_85p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_r2011_2031_65p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
singindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="Male_Female",compindicator="r2011_2031_65p"))

Proj_comparison_r2011_2031_65p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_r2011_2031_65p)))

write.table(Proj_comparison_r2011_2031_65p,"Proj_comparison_r2011_2031_65p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_r2011_2031_85p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
singindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="Male_Female",compindicator="r2011_2031_85p"))

Proj_comparison_r2011_2031_85p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_r2011_2031_85p)))

write.table(Proj_comparison_r2011_2031_85p,"Proj_comparison_r2011_2031_85p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_K2011_65p_K2031_65p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
twoindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="Male_Female",compindicator_1="K2011_65p",compindicator_2="K2031_65p"))

Proj_comparison_K2011_65p_K2031_65p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_K2011_65p_K2031_65p)))

write.table(Proj_comparison_K2011_65p_K2031_65p,"Proj_comparison_K2011_65p_K2031_65p_Male_Female.csv",sep=",",row.names=F)
```

```
Proj_SA3variant_comparisonfunction_K2011_85p_K2031_85p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
twoindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="M
ale_Female",compindicator_1="K2011_85p",compindicator_2="K2031_85p"))

Proj_comparison_K2011_85p_K2031_85p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_K20
11_85p_K2031_85p)))

write.table(Proj_comparison_K2011_85p_K2031_85p,"Proj_comparison_K2011_85p_
K2031_85p_K2031_65p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_r2021_2031_65p_r2011_2021_65p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
twoindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="M
ale_Female",compindicator_1="r2021_2031_65p",compindicator_2="r2011_2021_65p
"))

Proj_comparison_r2021_2031_65p_r2011_2021_65p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_r20
21_2031_65p_r2011_2021_65p)))

write.table(Proj_comparison_r2021_2031_65p_r2011_2021_65p,"Proj_comparison_r20
21_2031_65p_r2011_2021_65p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_r2021_2031_85p_r2011_2021_85p <-
lapply(seq_along(Proj_SA3variant_list), function(x)
twoindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="M
ale_Female",compindicator_1="r2021_2031_85p",compindicator_2="r2011_2021_85p
"))

Proj_comparison_r2021_2031_85p_r2011_2021_85p <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_r20
21_2031_85p_r2011_2021_85p)))

write.table(Proj_comparison_r2021_2031_85p_r2011_2021_85p,"Proj_comparison_r20
21_2031_85p_r2011_2021_85p_Male_Female.csv",sep=",",row.names=F)

Proj_SA3variant_comparisonfunction_r2011_2031_85p_r2011_2031_65_84 <-
lapply(seq_along(Proj_SA3variant_list), function(x)
twoindicatorcomparisonfunction(inputdata=Proj_SA3variant_list[[x]],sexofinterest="M
ale_Female",compindicator_1="r2011_2031_85p",compindicator_2="r2011_2031_65_
84"))

Proj_comparison_r2011_2031_85p_r2011_2031_65_84 <-
cbind(sex,location,(do.call(cbind.data.frame,Proj_SA3variant_comparisonfunction_r20
11_2031_85p_r2011_2031_65_84)))

write.table(Proj_comparison_r2011_2031_85p_r2011_2031_65_84,"Proj_comparison_r
2011_2031_85p_r2011_2031_65_84_Male_Female.csv",sep=",",row.names=F)
```