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Modelling Residential Aged Care in Australia: Entry and Exit

Marijan Jukic

A thesis submitted for the degree of Doctor of Philosophy
of the University of Melbourne

10 December 2017

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Statement on Original Work

I declare that this thesis is my original work, and is an account of research carried out by myself while enrolled as a PhD candidate at the University of Melbourne. This thesis does not contain material that has been accepted for the award or any other degree or diploma in any university, nor material published or written by another person, except where due reference is made.

Author: Dr Marijan Jukic

Signature:

A handwritten signature in blue ink that reads "Marijan Jukic". The signature is written in a cursive style with a large, stylized 'M' and 'J'.

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ABSTRACT

Ageing of the Australian population affects the residential aged care system, yet the structure and dynamics of the system remain uncertain. A comprehensive model of residential care based on the individual perspective of residential aged care events is missing. Thus, older Australians, government and care providers have only a limited model of aged care actions. This study uses big administrative unit record data on aged care assessments (ACAP), aged care appraisals (ACFI) and unit record survey data (SDAC) to identify factors associated with aged care events in older persons' trajectories towards and through residential care. To achieve this goal and broaden understanding of Australian residential care, this study uses the following steps: (1) modelling of the probability of entry to and exit from residential care, with a multi-state model of transitions between levels of care needs; (2) modelling the applications for aged care and approvals for entry to residential care; (3) derivation of transition and mortality assumptions for individual care needs that can be used in a projection model; (4) estimation of life expectancy in residential care based on needs for assistance; and (5) assessing the quality of Australian data on aged care for statistical modelling and projections of residential care demand. The results show that health factors, above all needs for assistance, determine the speed and direction of a person's progression towards institutional care. Probabilities of aged care events, transition rates and life expectancy estimates, derived in this study, provide a comprehensive picture of Australian residential aged care. These findings are expected to have important implications for residential aged care policies in Australia in terms of having better understanding and more accurate predictive power for the future of aged care.

Key words: Ageing, aged care, residential care, assistance needs, ACAP, ACFI, SDAC.

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1. Introduction

1.1 Ageing and Aged Care Challenges

Population ageing raises unprecedented challenges to policy makers on a global scale (Kendig, McDonald & Piggott 2016; Sanderson & Scherbov 2008; Bongaarts 2006; Vaupel 2002). Indeed, in the 21st century, ageing can be perceived as one of the main forces transforming both developed and developing societies (Rowland 2012; Sanderson & Scherbov 2007). Ageing is *the historical outcome of falling rates of fertility and mortality with fertility having the larger effect* (McDonald 2016, p. 65; 2014). In their key paper, Lutz, Sanderson and Scherbov (2008) reported that the *speed of ageing is likely to increase over the coming decades and to decelerate in most regions by mid-century* (2008 p. 716). This rapid shift in the age structure of population has wide-reaching effects on numerous systems, structures and processes in industrialized countries (Productivity Commission 2013; United Nations 2012; World Health Organization & National Institute of Ageing 2011). Societal ageing affects economic growth (Bloom et al 2010), sustainability of families (Herlofson & Hagestad 2011) and the ability of countries and communities to provide care to older people (Bittman et al 2007, Phillipson 2004). Current generations of aged people, due to poor planning for the pace of ageing, have only limited models of care related actions available to them, but their experiences will heavily influence the nature of future models (Laslett 1996). Care providers and government regulators are in constant pursuit of better information that will help them in making decisions.

Studies on population ageing and aged care revolve around a range of uncertainties. The focus of demographers, for a long time, has been on whether an increase in life expectancy leads to healthier lives or whether ageing-related disability will dominate the old age (Salomon et al 2012; Bongaarts 2006; Wilmoth 1997). The figures provided by the Australian Institute of Health and Welfare suggest that, in the period between 1998 and 2009, the years of life with disability have increased faster than years of life without disability (AIHW 2012c). Yet, the research evidence has been mixed on whether ageing can be mitigated by declines in disability in older cohorts (Robine & Saito 2009) and how the severity of disabling condition translates to a range of care needs (Majer et al 2013; Jagger et al 2007). The direction and dynamics of transitions between needs for assistance with daily activities and assistance with persons' behaviour has stayed largely underexplored. Another area of uncertainty is whether morbidity will compress (Fries 1980), expand (Gruenberg 1977), remain stable (Manton 1982), or could decrease in the

prevalence of some diseases that lead to more complex states of multi-morbidity and frailty (Fried et al 2001). It is worthy of mentioning, however, that throughout human history, longevity gains have come mostly from declining mortality rather than slowing senescence (Goldstein & Cassidy 2010; Sanderson & Scherbov 2008; Lutz, Sanderson & Scherbov 2008; Bongaarts 2006; Oeppen & Vaupel 2002).

Like much of the developed world, Australia's population is ageing because of sustained low fertility and increasing life expectancy (McDonald 2016, 2004; Hugo 2013; Booth 2010, 2009; Department of Health & Ageing 2010, 2008; Rowland 2003). *"Because both rates of fertility and mortality have fallen faster than was foreseen, the speed and extent of population ageing emerged as a new policy issue in the 1980s"* (McDonald 2004 p. 31). Demographic ageing has been fuelled in Australia by the post-war baby boom and supplemented by massive post-war immigration, but it has also been shaped by steadily increasing longevity (McDonald 2014). As John Piggott (2016 p. 47) stated, there are two distinct, but related forces that make population ageing an issue: *"the ageing of the baby boomer generation, and related policy challenges around retirement support, health care, aged care, and the management of intergenerational relationships; and the impacts of population dynamics and evolving changes in demographic structure, nationally, regionally and globally."* With life expectancies above 80 years (84.5 for females; 80.5 for males) (ABS 2016), elderly Australians, on average, can expect to live between 20 to 30 years beyond the traditional retirement age (Sanderson & Scherbov 2008; Kendig 2014). As the baby boomer¹ generation is moving towards older age (Hugo 2007; 2003 p. 109), and due to increased life expectancy, it is expected that the growth rate of the older population will surpass overall population growth (Swerissen & Duckett 2014).

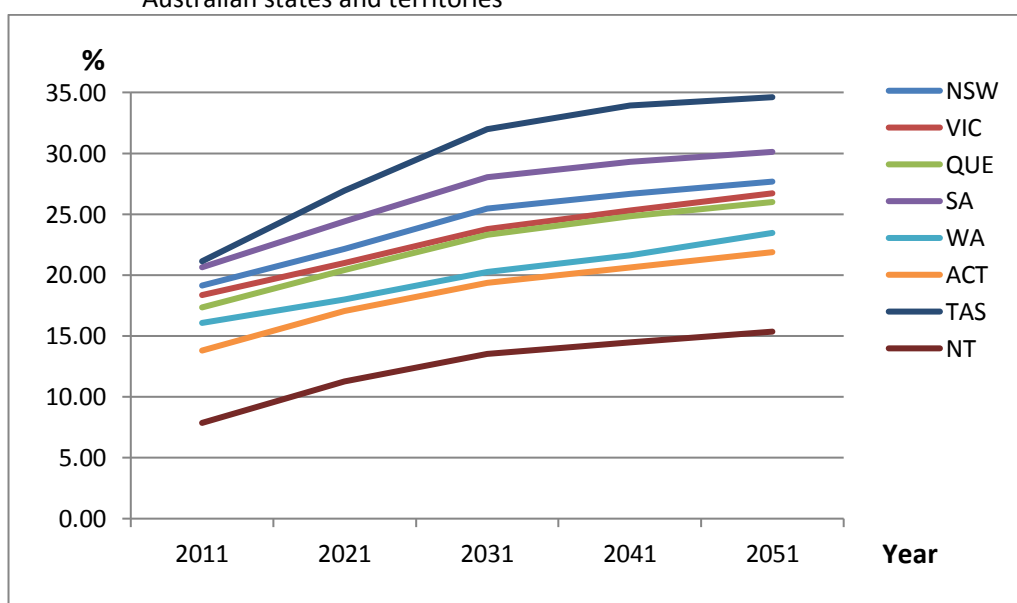
In all projection series (A, B & C) of the Australian Bureau of Statistics (2013), the age group older than 65 is expected to increase from 3.2 million (2012) to between 5.7 million and 5.8 million in 2031, and to between 9.0 million and 11.1 million in 2061. The share of those aged 65 and over is projected to increase from 14% (2012) to between 18.3% (Series A) and 19.4% (Series C) in 2031. Even more striking is the expected increase of the number of people aged 85 and over. The Australian Treasury (2015) anticipates this group to more than quadruple over the next few decades, reaching approximately 2.0 million people in 2055. The number of centenarians is also

¹ The Australian Bureau of Statistics (2012c) defines baby boomers as persons born in the period 1946-1966. Among the Australian generational cohorts, the baby boomers are commonly thought to be the most advantaged based on their rising educational and employment opportunities and the booming residential housing market through the 1980s and 1990s (Gong & Kendig 2016).

projected to exceed 40,000 in 2055. Despite small differences between the Australian states and territories (Figure 1.1), they share similar trends of structural ageing.

Recent reports on aged care in Australia suggest not only that one fifth of those aged 65+ will need care, but also that two thirds of women and half of men aged 65 and older will need formal (residential) aged care in their remaining lifetime, given the lifetime risk estimates (CEPAR 2014). Similarly, at least 40% of older persons who reached the age of 65 in New Zealand (Broad et al 2015), Finland (Martikainen et al 2014) and USA (Friedberg et al 2014) are expected to use residential aged care later in life due to the increased need for assistance with daily activities. Regardless of the place or method of delivery of care, the shortage of carers poses a serious threat to the Australian aged care system (Hugo 2007), especially in the light of growing expectations about the quality of aged care voiced by elderly Australians themselves (Taylor 2016). With continuing strong labour demand in other service industries, it might become more difficult to recruit professional staff such as specialised nurses, carers and those with skills in end-of-life care (Productivity Commission 2011; Hugo 2003). Furthermore, Australians are nowadays more likely to die in residential aged care or in hospitals than they were 100 years ago (Higginson et al 2013). For example, Broad et al (2013) reported that only about 14 per cent of Australians die at home, compared to 54 per cent in hospitals and 32 per cent in nursing home facilities. Similar distributions of deaths in terms of location have been observed in other countries such as Belgium (Van Rensbergen et al 2006), England (Grundy et al 2004), Switzerland (Fischer et al 2004) and Sweden (Axelsson & Christensen 2003).

Figure 1.1 Population aged 65 and over as a percentage of the total population of the Australian states and territories



Source: Census 2011 (ABS 2011); Projection Series B (ABS 2013)

Undoubtedly, a combination of increased life expectancy and changes in the disability conditions will affect the volume and cost of aged care (Borowski & McDonald 2007). However, an increase in the demand for aged care, due to an accelerated ageing process, does not reveal the structure of future care needs nor processes taking place within aged care. Disability-free life expectancy in Australia has increased over the last decade, but so have the expected years with a disability and with severe functional limitations (CEPAR 2014, p. 8). An internal dynamic of the aged care system is largely underexplored. For example, more information is needed on how rapidly older Australians progress from the general population towards various aged care arrangements. This progression has been observed only at its end points or from the cross-sectional perspective – as a comparison of the share of older Australian population outside of aged care with those who already use aged care services. However, the aged care trajectories of older Australians are more complex and aged care itself is not a one-stage process. To fully unravel these trajectories and to provide a realistic picture of the aged care experience of older people in Australia, we first need to enquire into the organizational structure of the Australian aged care sector. This will be beneficial for at least two reasons: (1) it will inform us on the existing legislation that outlines possible aged care trajectories and, (2) it will give us a broad view of data collection and storing procedures. Understanding and harnessing the power of available data sources and utilization of appropriate methodological approaches are necessary to reach conclusions on the present dynamics of this complex system.

Before delving deeper into this matter, this study first aims to address the reasoning behind modelling of the residential aged care system. The planning process will be briefly discussed in terms of the main idea of this study, followed by the fundamental concepts of modelling and a brief overview of some of the existing attempts to model aged care in Australia.

1.2 Reasoning behind Modelling

1.2.1 Planning

The first time that I presented the concept of modelling of the residential aged care system to an academic community, proposing conventional statistical modelling and microsimulation, a few researchers reacted with a degree of scepticism. One of the questions that deeply etched in my memory for a long time was *why would we build statistical models when it is possible to collect information through field surveys in residential care?* Surveys of the elderly could indeed be an appropriate method for some purposes and would, of course, complement quantitative

methods by revealing potentially unobserved details. However, qualitative surveys would not be powerful enough to describe the present dynamics, and would not give us the necessary details for prediction of future outcomes in the residential aged care system of a large country such as Australia. The complexity of Australian residential aged care and its nature (variety of stakeholders, multi-stage process, and complex regulation framework) require researchers to utilize the power of extensive data sources to understand the dynamics and structure of the system.²

The second reason for scepticism about my initial proposal was well-grounded. It related to the feasibility of combining statistical modelling of the residential aged care system using a full-scale micro-simulation within the scope of one (student) Ph.D. project. Limited funding, tight deadlines and other unforeseen issues, particularly that related to data collection and cleaning, posed a serious threat. A reasonable alternative in given circumstances was to model the Australian residential aged care system statistically, to explore its underlying mechanisms and driving forces, aiming to derive parameters that explain the internal dynamics of the system and, if possible, to prepare a path for the projection of aged care needs. I have followed this alternative path hoping that it will provide a new perspective on residential aged care and build a solid basis for further research extensions that extend beyond the scope of a single Ph.D. thesis.

Having said that, a question that arises is: *what drives the system of aged care or, in other words, what constitutes the system's internal dynamics?* Many older persons, at some stage in their life, request access to available aged care services. Broadly speaking, understanding the system means identifying *older people who are more likely to use aged care services?* There are a few other equally important questions. For example, *who are those older persons who are 'directed' towards residential care? When do people 'decide' to start using aged care services? What is the probability they will reach nursing homes? What happens inside residential care in terms of people's functional abilities, care needs and diseases? How long older Australians who enter aged care will stay inside such care?*

1.2.2 From Modelling to a Projection

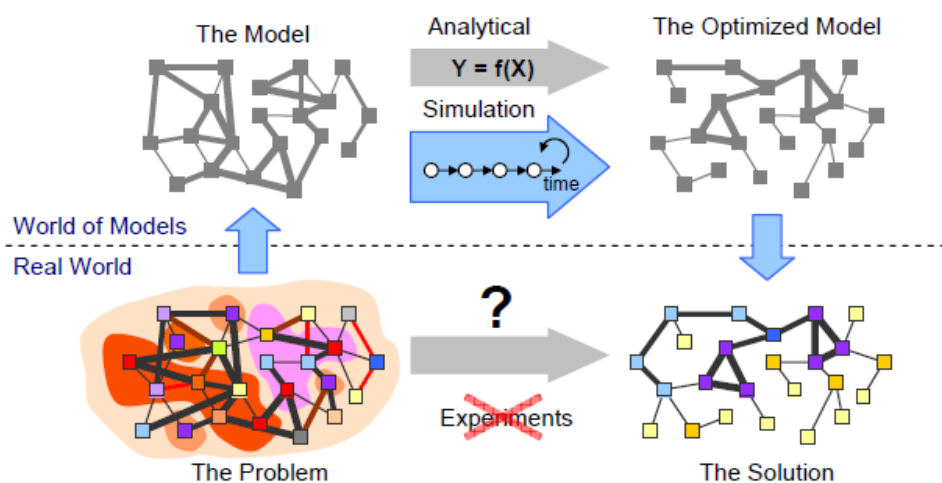
Given the above, we come closer to the nature of the research problem and, therefore, can give a better answer to one of the fundamental questions: *Why do we need modelling?* If we can

² Methodological issues are addressed in 1.6 Research Gaps.

replicate the decisions from the viewpoint of individual (and family) characteristics associated with a person, then we can gain insights into the mechanisms underlying decision-making and extend such explanation to give it some predictive power. Providing explanations to complex system patterns, as frequently extolled to be the main reason for building models (Miller & Page 2007; Gilbert & Troitzsch 2005; Epstein & Axtell 1996), cannot be the only rationale. Conventional statistical modelling can also shed light on how individual decision-making is related to the ways in which residential care operate. Another, at least equally important reason is the predictive power of such models (Epstein 2008). If properly extracted, the parameters from the residential care system, such as odds ratios, coefficients, transition probabilities, life expectancy estimates and others, can be utilized to predict the future needs of the system.

In a nutshell, statistical modelling is a mathematical method of solving and describing problems that may often occur in the real world. Borschev and Filippov (2004) underscored that modelling is useful when prototyping or experimenting with real-world systems (i.e. residential care) becomes infeasible or inconceivable (i.e. through survey or experiment). A shift from some real-world situations to the corresponding model involves the process of abstraction or idealization. In situations where results depend only on a range of included parameters, analytical or static models may be sufficient (Morand et al 2010). Such situations, however, do not occur frequently which implies a need for the introduction of simulation models (Epstein 2008; 2007; 1999). A common feature of such simulation models is the implementation of rules that describe change in the system, from an initial state to the outcome over discrete or continuous time (Willekens 2012).

Figure 1.2 From the real-world problems to the optimized models



Source: Borschev & Filippov (2004 p. 2).

Residential aged care is a complex population system. Given adequate data, such a system can be statistically modelled or simulated, helping us to understand the underlying forces that drive the system. Resulting models can give probabilities of a person's entry to, progression within and exit from the system. This information, such as rates and parameters, can be used to better understand pathways of care trajectories, and to realistic projections of the aged care system. Because projection of the demand for residential care is considered throughout this thesis as one of the rationales for modelling, it is useful to review this rationale briefly here.³

1.2.3 Why do we need Modelling?

Broadly speaking, the two main reasons for modelling are understanding of the complex system and prediction. Clearly, it is difficult to predict how complex system such as residential aged care will develop in the future, how many persons will enter the system and how long people will stay within the system. Standardised reports on residential care based on descriptive measures, such as the statistical overviews periodically published by the Australian Institute of Health and Welfare (AIHW) and the Department of Health (DoH), give a valuable glimpse on each segment of the care system (i.e. home and community care, residential care, temporary discharges to hospitals etc.), but such reports do not reveal the underlying driving forces in the aged care system. One obvious reason for this is the cross-sectional nature of aggregate reports that only reveal individual parts of the care services, rather than the pathways of people through the system. It has been suggested that more advanced statistical techniques are required to fully understand specific processes happening within the residential care system (Liu 1996).

Literature shows that classification modelling methods, such as logistic regression have been most widely used in aged care research (Gaugler et al 2003). For example, logistic regression is used to model the association between personal characteristics of older persons and the probability of a specific care event (i.e. entry to care, recommended long-term care setting etc.) (Gaugler et al 2007). As the dependent variables in these models are binary, logistic regression is usually fitted by the maximum likelihood method. The selection of predictor variables to be used in these logistic models is informed by the literature about the factors associated with aged care events. Models that measure time to an aged care event and factors that are associated with this event mostly rely on Cox proportional hazard models (Martikainen et al 2009; Miller & Weissert 2000).

³ More detailed discussion about possible approaches to model and project Australian aged care is given in Chapter 8 (see 8.3.2 Projection techniques).

As previously noted, modelling can help us in identifying factors relevant to aged care events. If we focus strictly on pathways of care trajectories, statistical models can provide information about the characteristics of persons who undertake aged care events, and on the likelihood of such events. In situations where statistical models harness the power of big data (i.e. data on an entire population who has undergone a specific event over a long period) to measure a specific process, it can be expected that such models may approximate the dynamics of the process with reasonable accuracy. Modelling of residential care has the potential to provide accurate information about the dynamics and structure of the aged care system to all stakeholders, including users of aged care, their families, Government and care providers. Such a modelling framework can act as an interface, capturing the experience of those older persons who have already taken care related actions, and providing a picture of the care processes for those who plan to follow a similar aged care pathway.

Finally, rich information about the dynamics and structure of the aged care system, gathered through modelling of aged care events, opens a path to implementing advanced research methodology. For example, multi-state projection and simulation models could be constructed using big data on aged care that would provide a convenient framework for handling a wide variety of aged care situations characterized by multiple events and longitudinal data. This could be used to deliver valuable piece of information, not only from an individual perspective (aged care users), but also in the broader policy context.

1.2.4 Existing Models of Ageing and Aged Care in Australia

Social modelling and microsimulation were considered as potentially useful in contributing to Australian public policy (Brown & Harding 2002). However, the existing models of ageing or aged care have not extensively relied on 'big' administrative data. Instead, these models relied on cross-sectional and longitudinal surveys. For example, Nepal et al (2011) used SDAC (*'Survey of Disability, Aging and Carers'*) data on disability levels of Australians living in the community, and in nursing homes, to estimate future levels of demand for residential care. This simulation model predicted that between 2006 and 2051, the numbers of older people needing low-level residential care will double and those requiring high-level residential care will more than triple. Other research efforts focused on mapping of the ageing trajectories with and without increasing morbidity. Brown et al (2011) described the DYNOPTASIM microsimulation project, using selected variables from the datasets of nine different Australian longitudinal studies of ageing. Only the first wave of each longitudinal study was used, giving 50,652 initial records.

Weights were used to make the pooled dataset representative of the Australian population aged 45 years and older in 1996. Cumpston (2014) used SDAC data, together with 123 disease models, to project numbers of persons in residential care. As with the other two models listed above, no use was made of Aged Care Funding Instrument (ACFI) data on admissions to residential care, residents and exits. Similarly, the current Australian models have not utilized Aged Care Assessment Program (ACAP) data on applications for aged care arrangements. Currently, these two unlinked data sets are the most comprehensive sources of information on Australian aged care. Throughout this study, ACFI and ACAP data will be discussed in more detail.

Heretofore, the term '*residential aged care*' has been mentioned multiple times, but I have not dedicated attention to the definition of this care arrangement. In the following section, care terminology will be described with the intention of giving readers more understanding of the Australian aged care system. The internal structure of the care system will be explained, focusing on the residential care segment of the system. Care pathways that lead to residential care will be discussed as well as the surrounding context, including public policy and financial aspects of this type of aged care.

1.3 Residential Aged Care

1.3.1 Terminology

Residential aged care is a complex system and a substantial subset of the current Australian aged care system. This section provides the main definitions required to understand the terminology and examine the literature and data pertaining to residential aged care. However, it is necessary to keep in mind that Australian aged care is undergoing intensive transformation that may cause changes in the system's organizational structure over the following years. The reforms of aged care – in particular, using community and home care services to complement and supplement residential care (ACFA 2016), will be discussed in more detail in Chapter 3.

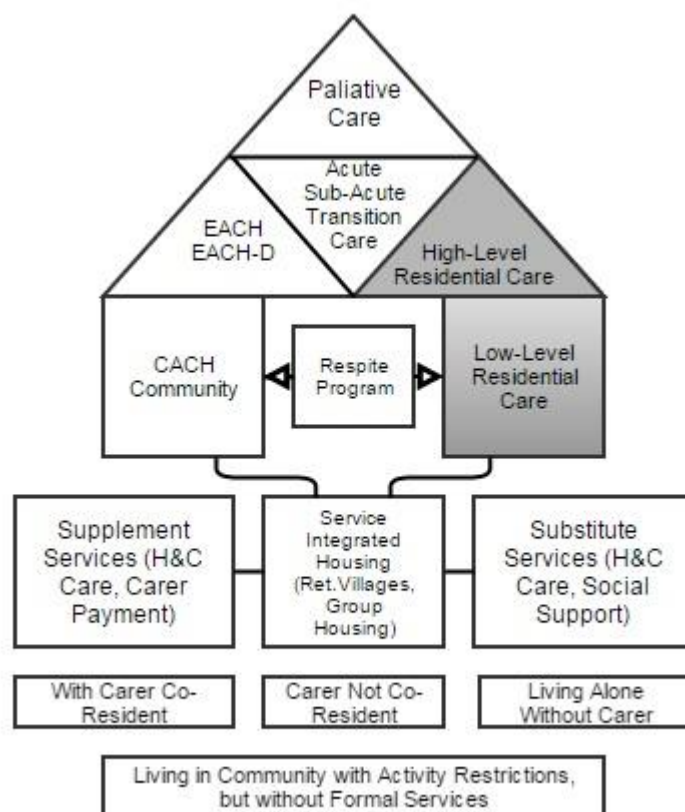
Residential aged care can be defined as "*providing accommodation and care services to aged people who are no longer able to support themselves or be supported by others in their own homes*" (AIHW 2007 p. 101). The Aged Care Act 1997 (41/3) notes that it "*does not include any of the following: (a) care provided to a person in the person's private home; (b) care provided in a hospital or a psychiatric facility; (c) care provided in a facility that primarily provides care to people who are not frail and aged*" (Australian Government 1997). There are four key points

related to residential aged care: (1) it is distinct from health care because it excludes accidents or sickness giving rise to acute care needs; (2) it is distinct from care provided to younger persons who might be in need of assistance and thus also receive "long-term care" (LTC); (3) it includes the assistance that aged people need in order to carry out the activities of daily living, and (4) it includes targeted strategies provided in care facilities. Furthermore, residential aged care belongs to so called "targeted strategies" that are different from "mainstream strategies" which include other forms of support such as health services, income and housing support (Department of Health and Ageing 2010 p. 8).

The definitions of residential care slightly vary between different countries. In their systematic review of residential aged care based on a comprehensive literature research, Arendts and Howard (2010) defined RACF (*'residential aged care facilities'*) as facilities that couple permanent living with the provision of various facility-specific nursing care services, in addition to other personal care services (Arendts & Howard 2010 p. 308). The authors included nursing homes, extended care facilities and skilled nursing facilities in the RACF group, but excluded facilities such as low care, assisted living and homes for the elderly. Other international studies used broadly similar definitions of residential (nursing) care. For example, in a US study, Chou et al (2003) defined a nursing home as a high-care facility catering to more dependent elderly persons who require a high level of assistance with their care needs (i.e. assistance with feeding, toileting, bathing, ambulation, dressing etc.) and nursing care. Regardless of the country, residential care facilities regularly require highly qualified staff who have received formal care training (such as registered nurses etc.).

As already noted, permanent residential care in Australia is a strictly defined segment of the aged care sector. The organizational structure of Australian aged care is shown in Figure 1.4. This schema shows different types of programs, facilities and living arrangements in respect to the different services that older person may receive. From 1 July 2014, the distinction between high care and low care has been removed in permanent residential aged care. The Department of Social Services reported that this formal change resulted in flexible, simple and more transparent arrangements in permanent residential aged care, reducing red tape for consumers and providers without compromising levels of care provided to residents (DSS 2014d).

Figure 1.4 Aged care system in Australia



Source: Productivity Commission, 2011.

Residential aged care services in Australia are delivered by various providers across a range of sectors. There are currently 972 residential aged care providers (ACFA 2016). The Australian Institute of Health and Welfare (AIHW 2012 p. 19) reported that these care providers include *‘private, government (local and state government) and not-for-profit (comprising religious, community-based or charitable) organizations*. The latest reports (AIHW 2016b) show that the not-for-profit organizations accounted for nearly 60% of operational places in mid-2014. This was distributed among religious (26%), charitable (17%) and community-based (14%) care providers. Private businesses owned 37% whereas government accounted for only about 5% of the remaining operational places. In recent years (2015 – 2016), the percentage of operational aged care places offered by private businesses has increased rapidly, the share of not-for-profit places increased only slightly while government-owned organisations have supplied fewer places.

This research is concerned with the residential aged care system in Australia. It looks specifically at the permanent residential care provided to *people aged 65 and older*. As already suggested, the term *residential* indicates not only a setting (structure), but also the means (or type) of care provision. In other words, such care is *formal* and thus provided in specialised facilities by

professional care workers, either in the form of low or high-level care. In contrast to this, care provided by families or friends within different environments is referred to as *informal* care.

In this study, the term '*residential aged care*' has been used interchangeably with other terms such as '*nursing home*', '*permanent residential care*', '*residential care facility*', '*formal aged care*' and '*institutional aged care*'. Similarly, '*entry to residential aged care*' has been used interchangeably with other terms such as '*nursing home placement*', '*nursing home admission*' and '*institutionalization*'.

1.3.2 The Path to Residential Aged Care: How does it work?

Understanding the process of entry to residential aged care is important for the data selection process and for modelling. At certain points within the life cycle, aged individuals make decisions (i.e. applying for assessment for residential aged care, applying for an admission). In brief, there are at least four crucial times when decision making, either by older persons themselves, or by their families, is involved:

- (1) Decision to apply for an assessment;
- (2) Decision to apply for admission following a positive assessment;
- (3) Decision to enter residential care after admission is allowed;
- (4) Decision to exit residential care (separation).

Australian aged care is a highly regulated sector. The access to each type of care is controlled by the Government through the Aged Care Assessment Program (ACAP). Besides home and community care, this regulation applies to residential care. An essential *first* step on a path to residential aged care is an ACAT assessment (known as ACAS in Victoria). Aged Care Assessment Teams (ACAT), consisting of health care professionals, conduct comprehensive assessments of the care (assistance) needs of older people to determine eligibility (*under the Aged Care Act 1997*) for entry into residential aged care (Department of Human Services 2017; Australian Government 2014). However, not all applications for residential aged care are approved which means that various alternative arrangements, such as home care, respite care, transition care or short-term restorative care might also be recommended. The results of approvals stay valid from the date an ACAT delegate signs the assessment form. A person may be approved to receive more than one type of care. Data on these assessments are kept within the national data clearinghouse and it is referred to as the ACAP data form. Data related issues will be discussed in more detail in Chapter 2.2.

A *second* step, following positive assessment, is finding an adequate aged care home and making the decision whether to apply for admission or not. Even though financial matters are not in the focus of this study, it is worth mentioning that, even in cases where older people in need of care are not able to pay for the accommodation or care services, they still get the recommended care. Residential care homes receive full Government assistance in cases where aspiring residents are assessed to be below the 'minimum permissible asset value' (Australian Government 2014), but they are not obliged to accept applications, either because of a lack of available places or inability to provide the required care services. The *third* step, after the admission to a nursing home is approved, is the decision whether to enter residential care or not. Over the last few years the percentage of approvals which resulted in admissions to residential care was relatively stable, at roughly 50 per cent. Data on entry to residential care, or more precisely, data on applications and application outcomes are stored in the ACAP form. Supplied by the Australian Institute of Health and Welfare (AIHW 2013a), these data were essential for modelling of applications and approvals for residential aged care in Chapter 5. However, linked data indicating that an older person who has been given residential care approval has actually entered a nursing home, were missing. This missing link between ACAP data and ACFI data (Aged Care Funding Instrument) will be discussed in the following chapters.

Time delay between an approval for and an admission to aged care depends on various reasons. The most recent data by the Australian Institute of Health and Welfare show that the average time between approval and entry into care for residential care was 84 days, compared with 73 days for home care (AIHW 2017). Availability of places in care homes affects the timing of entry, but it might not have a dominant role. Other factors, such as an aged person's choice to stay at home if possible, organizing the sale of assets or availability of informal care can be more important (AIHW 2015). Older people may, in some cases, deliberately postpone their entry to a nursing home aiming to get a needed level of care in a location of their choice. For example, people may aim to stay close to their family or relatives, but the facility in close proximity to the person's family could be inaccessible. Some evidence suggests that waiting time can also be related to the severity of the health condition (SCRGSP 2014; Box 13.10). A family of an older person may also decide to start giving necessary care or to hire an informal carer in situations where the person is diagnosed with a terminal illness. Dying at home, instead of in a care facility may be a preference for many older people (Broad et al 2013). In their key piece, Mittelman et al (1996) found that family intervention has an important role in delaying nursing home placement of older persons with Alzheimer's disease. Good informal care was found to be an

important determinant that can prevent and delay nursing home admission (Thygesen et al 2009 p. 20).

In the period, 2012-2013, around 18% of people entered residential care within a week of being approved by an ACAT team, 44% did so within a month, and 70% within 3 months (SCRGSP 2014 Table 13 A.66). Detailed information on the structure and the dynamics of the residential aged care system in Australia is available in Chapter 3.

1.3.3 Inside Residential Care

Once older people have entered permanent residential aged care, a tool called the Aged Care Funding Instrument (ACFI) is used to appraise their dependency or care need across three domains: ADL (activities of daily living), behaviour (BEH) and complex health care (CHC). Residents are appraised and classified as having either a *Nil, Low, Medium or High* need for care in each of the three domains (AIHW 2012a). The results in each domain determine the level and costs of care required, and together with some other mental (behavioural) and medical diagnoses, are used to classify the care needs of each resident as either low care or high care. The ACFI appraisal can be applied multiple times whenever a resident's needs change or in cases of temporary or longer-term separations from the nursing home. Even though the ACFI appraisals need to follow strictly defined guidelines (Department of Social Services 2014e; Department of Health 2016), the final decision is made by the nursing home businesses themselves and submitted to Government in the form of Aged Care Online Claims.

Box 1.1 The Aged Care Funding Instrument (ACFI)

An ACFI assessment contains information on:

- 3 mental or behavioural diagnoses;
- 3 medical diagnoses (other);
- 5 questions on the need for assistance with the ADL: nutrition, mobility, personal hygiene, toileting and continence;
- 5 questions on the need for assistance with the BEH: cognitive skills, wandering, verbal behaviour, physical behaviour and depression;
- 2 questions on the need for assistance with CHC

The need for assistance in each category is rated from lowest (A) to highest (D) and then added to categorise the needs as *Nil, Low, Medium or High*.

Source: Department of Social Services, 2014.

Boxes 1.1 and 1.2 are excerpts from the ACFI appraisal procedure guidelines (appraisal pack). These details are important for the interpretation of modelling results and understanding of

changes in a person's assistance needs inside the aged care facility (Chapter 7). Box 1.2 is particularly important as the complex health care component appears to be the domain most susceptible to 'suspicious claims' or inflation of claim scores by the providers. This issue is discussed in more detail in later sections and chapters.

The last step (the final event) of the process examined in this research is exit or separation from residential care. This occurs when a resident leaves a residential facility with no likelihood of return. The main reasons recorded for separation from permanent residential care are death, transfer to hospital (i.e. periods of 'hospital leave' are not counted as a separation), moving to another residential aged care facility, or returning to family or home (AIHW 2015f).

Box 1.2 Example of complex health care (ACFI) procedures for care residents

An example is taken from the 'ACFI-12' CHC set of questions.

- [1] Blood pressure measurement for diagnosed hyper/ hypotension is a usual care need? (Yes or No)
- [2] Blood glucose measurement for the monitoring of a diagnosed medical condition e.g. diabetes, is a usual care need? (Yes or No)
- [3] Pain management involving therapeutic massage or application of heat packs, involving at least 20 minutes of one on one staff time in total (Yes or No)
- [4] Complex pain management and practice undertaken by an allied health professional or registered nurse. This will involve therapeutic massage and/ or pain management involving technical equipment specifically designed for pain management (at least 20 minutes of one on one staff time)? (Yes or No)
- [5] Complex skin integrity management for residents with compromised skin integrity who are usually confined to bed and/ or chair and cannot self-ambulate, including repositioning at least 4 times per day? (Yes or No)
- [6] Management of special feeding undertaken by a registered nurse, on a one-to-one basis, for people with severe dysphagia, excluding tube feeding? (Yes or No)
- [7] Catheter care program (ongoing); excludes temporary catheters e.g. short term post-surgery catheters? (Yes or No)
- [8] Administration of suppositories or enemas for bowel management is a usual care need, with the minimum required frequency 'at least weekly'? (Yes or No)
- [9] Management of arthritic joints and oedema related to arthritis by the application of tubular and/or other elasticised support bandages? (Yes or No)

...

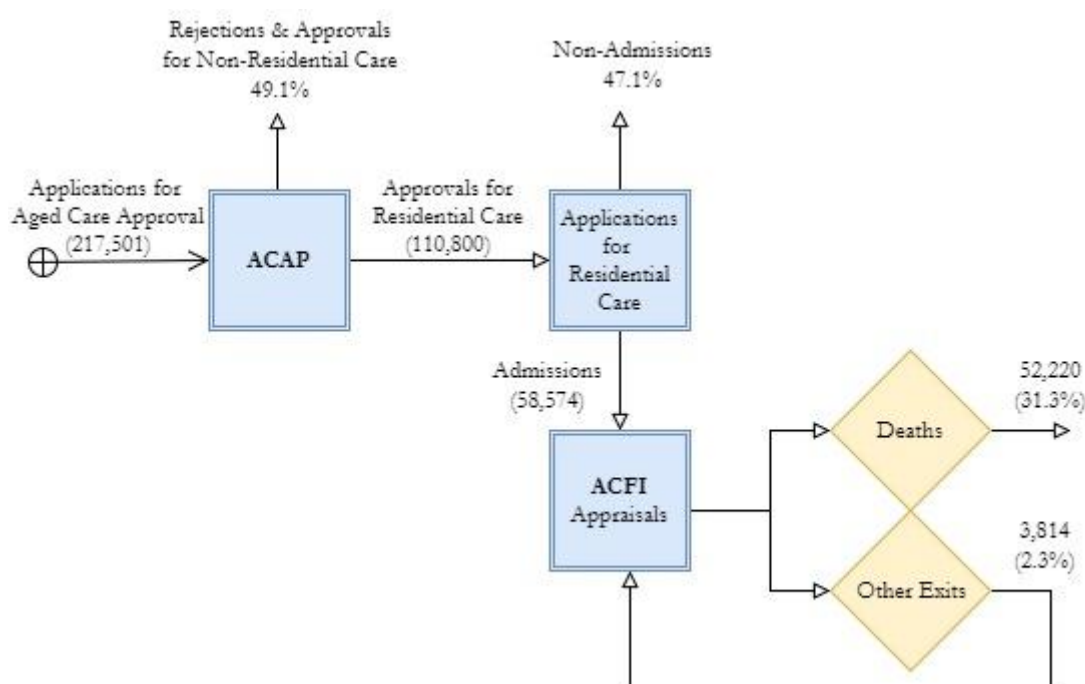
Each of these questions has a specific (different) score. The providers may or may not provide medical evidence for each of the complex health care conditions.

Source: Department of Health, 2016.

Figure 1.5 shows a conceptual model of residential aged care trajectories in Australia, including numbers of older people in each stage of the process during the period 2011-2012. During this

period 217,501 persons were recorded as applying⁴ under the Aged Care Application Process (ACAP) for some form of aged care. In the same year 110,800 persons were recorded as having received an approval for residential care, suggesting that about 49.1% of applicants for care are approved for non-residential care, or rejected for any form of care, or withdraw their applications. The numbers of applicants for care and approvals for residential care were derived from the analysis of a unit record file of ACAP applicants for the period 2010-2013 (AIHW 2013a) supplied by the Australian Institute of Health and Welfare (AIHW) in late 2015.

Figure 1.5 A scheme of Australia's aged care system in the period 2011-2012



Source: ACAP data for applications, rejections and approvals (AIHW 2013a) and ACFI cubes on admissions and exits (AIHW 2013b)

During the period 2011-2012, there were 58,574 persons recorded as admitted to permanent residential care, suggesting that about 47.1% of persons with approvals for residential care do not receive such care. Some persons defer admission for a variety of reasons, and others may die before they can enter. In the mentioned period, there were 52,220 exits from residential care where death was recorded as the cause. This figure means that nearly one third (31.3%) of the total persons being recorded in residential care at 30 June 2012 die during one calendar year. There were 3,814 other exits from care, or 2.3% which includes movements from one to another nursing home facility. The admission, exit and resident figures are from the ACFI data cubes of the Australian Institute of Health and Welfare (AIHW 2013b).

⁴ A person can apply or be referred for the ACAP assessment multiple times in one year.

1.3.4 A Glimpse into the Costs of Residential Aged Care

Aged care is an indispensable element of the Australian Government's policy agenda (Australian Government 2013; Productivity Commission 2011). A series of reforms have been progressively implemented over the last ten years to make care more affordable and sustainable (Department of Health 2017). Even though most of the reforms favour a notion of older people remaining at home and '*ageing in place*', the traditional image of aged care is still associated with residential care. However, this institutional type of aged care has had substantial financial implications since its wider implementation in the 1960s and 1970s. Currently, work is underway to examine alternative arrangements that could deliver sustainable residential care (ibid. 2017). Despite ongoing reforms, for many older Australians the best way to receive adequate help and support can be by living in a nursing home (Australian Government 2017).

Even though financial aspects are not in the focus of this research, it is important to be aware of the potential consequences of increased numbers of older people in need of care and of possible changes in the proportions of older persons under different care arrangements. Such changes could occur in a natural way, for example, through changes in disability or disease patterns, but can be also caused by irresponsible actions on behalf of care providers or assessors. A joint media release by the former Minister for Health Susan Ley and the former Assistant Minister for Health Ken Wyatt stated that "*as many as one-in-eight of 20,000 ACFI claims audited during the period 2014-2015 were deemed to be incorrect or false*" (Ley & Wyatt 2016 p. 1). Because of such actions "*a stronger compliance regime, including tougher new fines, and better-targeting or funding will be introduced to protect the integrity of Australia's residential aged care sector and thousands of providers delivering older Australians high quality care every day*" (ibid. p. 1). This example clearly shows that Australian aged care policies may benefit by having more precise information on underlying mechanisms of the residential aged care system. Undoubtedly, to get a clearer picture of the aged care system, it is necessary to examine its dynamics and structure deeply. As previously underscored, part of the solution is having appropriate data to inform decision makers.

Perhaps the best way to get a sense of the financial implications of residential care is to examine the ACFI subsidy rates. The ACFI is the classification instrument used to measure personal assistance (care) needs and to allocate subsidies to residential aged care services (Department of Human Services 2017). During their stay in nursing home facilities, older persons, at least once, get such an assessment. More information on these assessments, in the context of data,

is provided in Chapter 2. The daily ACFI subsidy rates in Table 1.1 are from the Department of Social Services (DSS 2015). The highest daily subsidy rate, just below \$110.00, is allocated to people who scored *High* in the “*need for assistance with the activities of daily living*” (ADL). On the other side, the lowest daily subsidy, \$8.25 is paid for permanent care residents who were appraised *Low* in the behavioural domain (*‘need for assistance with behaviour’*). These rates are intended to be used to distribute available funds, rather than to meet the actual costs of care. The proportions of residents at each ACFI level shown in Table 1.2 are from the Australian Institute of Health and Welfare (2016d).

Table 1.1 ACFI daily subsidies 1/7/15 - 30/6/16 (Australian \$)

Level	ADL	BEH	CHC
Nil	0.00	0.00	0.00
Low	36.11	8.25	16.25
Medium	78.62	17.10	46.27
High	108.92	35.66	66.82

Source: DSS 2015 & DHS 2017.

Table 1.2 Proportions of residents at each ACFI level at 30/6/12

Level	ADL	BEH	CHC
Nil	0.024	0.076	0.088
Low	0.231	0.160	0.283
Medium	0.304	0.239	0.327
High	0.441	0.526	0.302
Total	1.000	1.000	1.000

Source: AIHW 2016d.

There were 176,967 persons in permanent residential aged care at 30 June 2015 (AIHW 2016d). At the average daily subsidy per resident of \$144 estimated from Tables 1.1 and 1.2, the total cost of ACFI-based subsidies in the period 2015-2016 is about \$9.2 billion. Given the high cost of these subsidies, it is desirable that the ACFI scheme is carefully constructed, and that reasonable precautions are taken to ensure that claims are valid. Later, in Chapters 4 and 7, it is demonstrated that the ACFI domain values are good predictors of the probability of exit from residential care.

The total allocation of funding in the Australian aged care sector in 2016 reached nearly \$20 billion. The Aged Care Funding Authority (ACFA), an independent statutory committee charged with the role of providing independent and transparent advice to the Government on the sustainability and viability of the aged care sector, reported that “*the Australian Government*

expended \$15.2 billion and consumers contributed around \$4.5 billion, excluding refundable accommodation deposits “(ACFA 2016, p. 13).

1.3.5 Financial Implications of Residential Care in the International Context

Even though organization and funding of permanent institutional care differs between countries (AIHW 2010b; Ronald et al 2008; Ribbe et al 1997) making comparisons less generalizable, many developed countries have recently promoted or implemented reforms of de-institutionalisation and community-based care for the elderly (Swartz 2013; OECD 2006; Johri et al 2003). Evidence from international studies points out that the sustainability of the financing of long-term care services and other assistance for the elderly is an urgent matter among OECD countries (Colombo et al 2011; OECD 2010; Hollander & Chappell 2007; Van den Berg & Ferreri-Carbonell 2007). Some studies have demonstrated that residential care is more expensive than home and community care (Kok et al 2014), even if informal caregiver time is valued at the replacement wage (Chappell et al 2004). However, in one of his earlier pieces, Weissert argued that it is difficult to make home or community-based services more cost effective because these types of care are just an addition to residential care (Weissert 1985). Similarly, the US study by Segall and Chappell (2000) suggested that, in insurance-based systems such as those in the United States, implementation of paid community and home care services may just shift the costs from residential care to informal care, without necessarily reducing costs.

In summary, international evidence on public costs of non-institutional care arrangements is not conclusive. Although home and community care may be a cost-saving alternative, the costs of informal care are usually not included in a cost-saving equation. Evidently, many developed countries are not prepared for the rising numbers of older persons in their populations. The situation in Australia may be slightly different from some other countries which have experienced the Global Financial Crisis in the period following 2008. It can be speculated that greater financial wealth of older Australians (i.e. baby boomer cohorts), mostly accumulated by increase in the value of their property portfolio, may be re-directed to finance advanced home care packages. Despite this possibility, planning of sustainable and feasible residential care will most likely stay a priority for the Australian Government.

1.4 Decisions and Events: What are the Triggers?

Before going deeper into the statement of the problem and research gaps, it is important to point out some terminological details that will be important throughout the thesis. Box 1.3 underscores a conceptual distinction between "*decisions*" and "*events*". The distinction between the two substantially predetermines the methodological approach, choice of data and modelling tools. The decision, in its essence, is a complex process that is difficult to measure in an accurate way from the data sources on aged care currently available in Australia. On the other hand, it is possible to register events related to residential care (i.e. assessments, entries or exits) as well as the circumstances (and potential determinants) present at the time of the event. When it comes to the choice of a method for modelling or validation, the events are preferably modelled using conventional statistical tools, while the decision implies the use of agent-based modelling and it is often grounded in behavioural theories such as the *Theory of Reasoned Action* (Fishbein & Ajzen 1975) or the *Theory of Planned Behaviour* (Ajzen 1991). These two theories include the construct of behavioural intention which serves as a proximal antecedent to action, but they relate strictly to individuals making decisions about themselves. In the case of aged care related decisions, other individuals are often involved and the theories would be much more complex. Therefore, it is noteworthy that all statistical and modelling techniques used in this research are related to events, not the decisions.

Box 1.3 Decision vs. Event

DECISION is an individual (or group) action usually based on the information whose main parts stay *largely unobserved*. The decision to act or not act is usually the result of an *assessment of the likelihood* of specific outcomes associated with the act along with the *subjective values assigned* to those outcomes (Fishbein & Ajzen 1975)

Modeling Method: **Agent-Based Modeling**

EVENT is the observed outcome of a stochastic process (Willekens 2012). It can be observed and *objectively measured or registered*.

Modeling Methods: **Classification techniques, Static or dynamic (micro)simulation, Event history analysis** etc.

Source: Author, October 2014.

In the following few paragraphs, I will briefly discuss the major events or triggers that may affect an aged person's progress through the residential care system. This is necessary at the beginning as it helps in formulating the research questions and problems, and introduces the concept of the aged care trajectory. However, these few paragraphs will only give a glimpse of the potential factors associated with an individual's progression through the aged care system. More detailed theoretical background, conceptual models of entry to, progression through and exit from care, as well as the hypotheses, will be discussed in Chapter 4 (see 4.4 Conceptual Models and Hypotheses). The first part of Chapter 4 is the foundation for modelling of the aged care process

conducted in later chapters. The selection of variables for modelling is largely driven by the theoretical underpinnings of aged care pathways.

The context of the major *events* related to older peoples' 'movement' towards residential aged care is highly complex and the *decision* to move into care is often difficult. Remaining at their own home instead of moving to permanent residential care or living with children has been the preference of most older people (Young et al 2015; Caplan 2014; Swerissen & Duckett 2014; Dow et al 2013; De Almeida Mello et al 2012; Nolan et al 2009; Thygesen et al 2009; Peace & Holland 2001, p. 8; Hellström & Hallberg 2001; Keysor et al 1999; Benjamin 1999). Rapid ageing and current prevalence of age-related disability (ABS 2016b), however, means that staying at home would place an extra strain on intensive community aged care (OECD 2010; Hugo 2003; Segall & Chappell 2000). In Australia, as suggested by Hugo (2007), an expansion of community and home care would lead to a significant shortage of aged-care workers. Domestic informal carers are unlikely to meet all the demand, which might further increase Australia's reliance on international migration (Hugo 2009 p. 189). In their recent paper focusing on the provision of community aged care, Taylor and Donoghue (2015) proposed the empowerment of social enterprise and '*direct payments*' as a sustainable way to generate improvements in the community aged care system. It is estimated that in 2015 informal carers provided around 1.3 billion hours of community and home care which would cost almost \$60 billion if paid aged care workers were to do this work (Access Economics 2015).

Regardless of whether a decision to move into permanent residential care is made by the elderly person themselves or by their kin, the transition is almost always associated with a recognizable pattern of surrounding circumstances. Most existing research shows that having an informal carer (i.e. spouse, child, kin) is protective against nursing home placement (Petriwskij et al 2014; Hiedemann et al 2013; Byrne et al 2009; Kersting 2001a; Pickard et al 2000; Andersen 1995; Andersen et al 1983). In contrast, some US studies have found that receiving informal care, increases the risk of being admitted to a nursing home (Miller & Weissert 2000). Decisions between receiving informal care or being institutionalized are likely to be modified through the effects of carer relationships and co-residence. In their key analysis, Gaugler and colleagues argue that the associations between nursing home placement, family assistance and informal care are very complex and therefore require detailed measures on the type, source and quality of informal care provision (Gaugler et al 2000).

In addition to the effects of caregiving on residential care admission, other factors may also play an important role. For example, caregiving stressors (such as feelings of being overwhelmed by

caregiving duties), impaired subjective health and wellbeing or depression may also be linked to earlier entry to residential care (Gaugler et al 2000; Whitlatch et al 1999; Lieberman & Kramer 1991). A growing body of research has reported that high stress experienced by family caregivers may have a critical role in a decision to expedite institutionalization of older persons (Müller et al 2017; AIHW 2012b, p. 21; Navaie-Waliser et al 2002; Gaugler et al 2000; McFall & Miller 1992). In a qualitative study, Ryan and Scullion (2010) found evidence that family carers tend to report inadequate support from health care professionals and this affects their decision to place an older person into institutional care. Interestingly, some earlier studies suggested that caregiver stress could be a more important predictor of earlier institutionalization than older peoples' functional needs (Dunkin & Anderson-Haley 1998). Taken together, these factors may also affect the long-term care recommendations made by ACAT teams in Australia when assessing older persons' eligibility for permanent residential care.

The literature also shows that divorce and widowhood decrease the provision of informal care by family (Furstenberg, Hoffman & Shrestha 1995) and consequently may trigger the decision to move to residential care. However, this relationship is more pronounced for the divorced elderly who, as opposed to widowed, are less likely to co-reside with their adult children and, therefore, receive fewer hours of informal care (Pezzin & Schone 1999). Australian baby boomers who are now progressing toward older ages have been more exposed to the risk of being divorced or widowed. An increase in marital dissolution has been well documented in Australia, especially since the Second World War (Gong & Kendig 2016). In a recent US study, Ryan and colleagues have found that baby boomers are more likely to be without a spouse due to divorce (Ryan et al 2012). Nevertheless, the family remains the most important provider of informal care for the elderly in Australia (Piggott, 2016; Walker 1997). Having a healthy spouse is surely among the most significant prerequisites that enable frail elders to remain in the community (Schaie & Uhlenberg 2007; Liang et al 2005). The role of wider social networks (i.e. friends, neighbours), whether as a replacement for informal care due to the absence of family caregivers, or as a decision-making factor, has not been well examined in international literature (Walters & Bartlett 2009). There is, however, evidence from Australia suggesting that social networks can slightly enhance survival of the elderly (Giles et al 2005).

As previously underscored, there is an uncertainty in Australia about potential impacts of future intergenerational relationships on the provision of informal care (Piggott 2016). Indeed, it has been well documented in many industrialized countries that recent reductions in family size and the growing number of childless families decrease the possibility of informal care provision (Hale, Barrett & Gauld 2010; Gutiérrez et al 2010; Allen & Perkins 1995). Although these

processes may not have a big impact in Australia at present, there are several important demographic processes that may seriously affect future informal care provision. Firstly, there is a convergence in survival prospects between males and females, leading to increase in male life expectancy (ABS 2015). Related to this convergence, Australian demographic studies are projecting a significant increase in the number of men living alone (Temple 2007) and lower average number of children born by future cohorts of older persons (McDonald 2000a; 2000b). Furthermore, compared to the past, many adult children are living further distances from their parents, with implications for the provision of care (Joseph & Hallman 1998). It is also noteworthy that approximately one third of caregivers in Australia are older than 60 (AIHW 2004), with the average age of primary caregivers being 55 years (Carers Australia 2017). There is also a trend for increased workforce participation amongst women in this age group. These demographic processes, taken together, suggest that future informal care in Australia may be very different to what is observed today.

In a country of immigration such as Australia, the potential effects of ethnicity on residential care placement should also be discussed. The share of Australia's overseas-born population has increased from around 10% immediately after the Second World War to about 28% in 2013. This rapid increase has been driven largely by immigration from non-English speaking countries. In the same period, the share of persons born in the main overseas English-speaking countries has remained stable at about 9% (AIHW 2013d). Recent reports suggest that overseas-born Australians are less likely to use permanent residential care facilities. For example, in mid-2015 only about 18% of permanent care residents were born in non-English speaking countries and less than 10% reported that their preferred language spoken at home was not English (AIHW 2016b). A majority of those permanent care residents who did not speak English at home were the first generation migrants of Southern and Eastern European ethnic background (67%). The rest of them were older persons from Asia (15%), Northern Europe (10%) and other regions (8%). The structure of permanent aged care residents by ethnicity suggests that older persons coming from countries with different linguistic, cultural or ethnic characteristics, may potentially display different behaviour when it comes to care decision making. The Australian longitudinal study conducted by Kendig et al (2010 p. 347), however, showed that among the socio-demographic variables, only age and marital status remained significant within the multivariate block model, and only age remained significant for the final model. Ethnic background or language spoken at home did not show any statistically significant effect on entry to residential care. Other studies, however, such as the one by Jorm et al (2010) showed that overseas-born people and those speaking languages other than English at home were significantly less likely to use home and community care services.

Nonetheless, some disability conditions may, more than any other group of factors, determine a pathway to a permanent residential care leaving no alternatives (Kendig et al 2010; Gaugler et al 2007; Bharucha et al 2004; Keysor et al 1999). The relationship between the severity of disabling conditions and the future demand for care is within the scope of research on ageing in Australia. Recent studies suggest that some activities, such as bathing and eating, could be good predictors of residential aged care admission (Cumpston & Jukic 2017; Jukic & Cumpston 2017; Fong et al 2012). However, more evidence is missing on how disability changes the propensity of admission to nursing homes for older people. Entry to residential care in many cases follows a critical event such as a serious fall injury or a hospital admission (Ritchey & Studenski 2012; Schaller et al 2012; Leibson et al 2002; Tinetti & Williams 1997; Wolinsky et al 1992; Kiel et al 1991). This happens mainly because such events usually lead to decline in the physical and social functions of the elderly (Tinetti et al 1988). A qualitative survey by Stillwell and Kerslake (2004), although conducted on a small sample, suggested that such an eventuality preceded entry to care in more than three-quarters of cases.

A substantial body of evidence, has pointed out that specific degenerative, multiple and chronic conditions such as dementia⁵ (Cumpston 2011; Luppia et al 2008; Bharucha et al 2004; Heyman et al 1997), depression (CIHI 2010; Gaugler et al 2009; Davison et al 2007) or some less common, such as Huntingtons disease (Fisher et al 2012; Wheelock et al 2003), are highly associated with an earlier admission to permanent residential care. The ineffectiveness of treatment of illnesses, such as hearing or vision loss, osteoarthritis and Parkinson's disease, is also expected to increase care demand (Begg, Vos et al 2007). A longitudinal study from Australia, for example, showed that the primary reasons for placement into residential care facility were dementia (44%), stroke (16%) and coronary heart disease (14%), but some other conditions, such as incontinence, impaired respiratory function and depression were also important (McCallum et al 2005). However, the links between diseases, disabilities and entries to care are complex. *A state of disability, regardless of the definition, is not synonymous with poor health and needing care* (CEPAR 2014 p. 6).

Attention in this study will also be paid to functional needs of older persons. A growing body of research has indicated that needs for assistance with daily activities, behaviour or complex care are highly associated with the movement along the aged care trajectory. The US studies by

⁵ Based on projections of population growth and ageing, the prevalence of dementia in Australia is expected to increase from 322,000 persons (2013) to 900,000 (2050). In 2010, dementia was the 3rd leading cause of death in Australia, accounting for 6% of deaths that year (AIHW 2012b, p. 1)

Gaugler and his colleagues showed that impairment in the activities of daily living (ADL) proved to be a significant predictor of admission to a nursing home (Gaugler et al 2009; 2007). Similar results were obtained in Australian studies (Kendig et al 2010). It is, however, worth reiterating that countries differ markedly in the legislative procedures to determine eligibility for care admission (Swartz 2013; Tamiya et al 2011; Damiani et al 2011; Doyle & Timonen 2007) and that the ACAP assessments are the prerequisite of care admission in Australia, even in cases where hospital patients need to be transferred to residential care (Whitehead et al 2001; Aged Care Act 1997).

To understand what drives the system of aged care in Australia, all the above-mentioned factors will be analysed in more detail. In Chapter 4, the associations of these factors with an older person's progression on a 'typical' residential care pathway will be scrutinized, both in the international and Australian contexts. For that purpose, I will use a modified Andersen behavioural framework for a typical health service utilization (Andersen 1968). This widely-recognized model has been adapted to create a solid theoretical foundation for modelling of residential care trajectories of older Australians. In some instances, however, the selection of variables for modelling is affected by data constraints. Data related issues are discussed in Chapter 2.

1.5 Research Gaps

The link between population ageing and aged care has been actively researched across various disciplines, both in Australia and abroad. Demographers have examined the relationship between the demand for and the supply of aged care in the light of population ageing (Hugo 2007; 2003; Lee 1994; Rowland 1984), while economists, actuaries and other specialists mainly looked at the financial impacts of an increased demand for aged care services (Karlsson et al 2012; Costa-Font & Courbage 2012; Spielauer 2007; Wise 1997; Manton, Corder & Stallard 1997). In many existing studies, however, the association between ageing and aged care has been perceived exclusively from the macro-perspective. In other words, the lack of balance between the demand side and the provision side of aged care was in the focus (Soldo & Stephen et al 1992). Justifiably, the most frequent question on the research agenda was "*Who is going to care?*" (Percival & Kelly 2004; Knickman & Snell 2002). The individual (micro) perspective, on the other hand, has been more frequently used in health sciences, public health research and family studies. Researchers in these disciplines have focused mainly on the analysis of the influence of disability conditions and family structure on the link between the elderly and their carers (Wolf et al 1996; Soldo & Freedman 1994; Stephen et al 1992).

Modellers and simulation specialists have also attempted to operationalize their assumptions in various simulation models. Although many studies have included interactions between disability and older peoples' needs for assistance, not many of these models have become widely used by governments. Besides the few Australian models that have been mentioned above (see section 1.2.4), there are examples of international attempts to model aged care. For example, the MOSART simulation model (Fredriksen & Stolen 2007) accounted for a limited set of health-related behaviours, disabilities and moving in and out of aged care institutions. In a similar way, the 'LifePaths' simulation (Statistics Canada 2011) covered certain aspects of health, disability and institutionalization of aged people. Other Australian models like DYNAMOD2 (Abello et al 2002) and APPSIM (Percival 2007) mainly made use of disability levels whereas the SAGE model in the UK (Evandrou et al 2003) included family structure, but has never routinely operated (Cumpston 2011). Finally, a group of models from the UK, derived under the 'Care Life Cycle' (CLC) project, have used the complexity science approach to model a complex interaction between health and social care context and demographic processes (Silverman et al 2013).

A preliminary review of the potential triggers and determinants of aged care related events and the insights gathered on the interdependency between ageing, residential care and broader aged care policies have led us to the following research gaps:

(1) Gap in Understanding of the Residential Aged Care Process

First, even though contemporary literature on ageing has emphasized the practical importance of modelling long-term demand for aged care in Australia, most research undertakings have relied solely on the macro-perspective, trying to approximate a crude inflow of older persons from the general population into residential care. In contrast, the micro-perspective of aged care demand has not been sufficiently represented. Yet, a micro level approach has the potential to provide better insights on the main aged care events (i.e. applications, approvals, admission, exits). In addition, a microanalytical approach gives a clearer picture of the transitions between different levels of individuals' assistance needs (i.e. change in the severity of needs for care, measured by the ACFI appraisals within residential care). Furthermore, interactions and associations between determinants that influence care related events (i.e. the joint influence of family structure, living arrangements and disabilities) have also stayed largely underexplored. Several key studies have analysed the utilisation of aged care services prior to death, entry into aged care and the role of disease in explaining entry to care and usage of services (Joenperä et al 2015; Karmel et al 2012; AIHW 2009). To date, however, there have been no micro-level studies quantifying and

modelling complex associations between sociodemographic characteristics of older Australians, their disability and disease patterns, and the joint influence of these factors on the probability of experiencing aged care events.

Second, a comprehensive view, which follows older persons from the moment of application to aged care until exit from such care, has not yet been adopted. This view would open tremendous opportunities for investigation of the pathways into care and provide a better understanding of processes that happen inside residential care facilities. At each point on a care trajectory, for instance, a person's condition may change, which then alters both the direction of the aged care pathway and time spent in a specific state (i.e. a substantial lag may exist between an approval for residential care and an actual entry). The modelling strategies adopted in this study allow an examination of residential aged care trajectories.

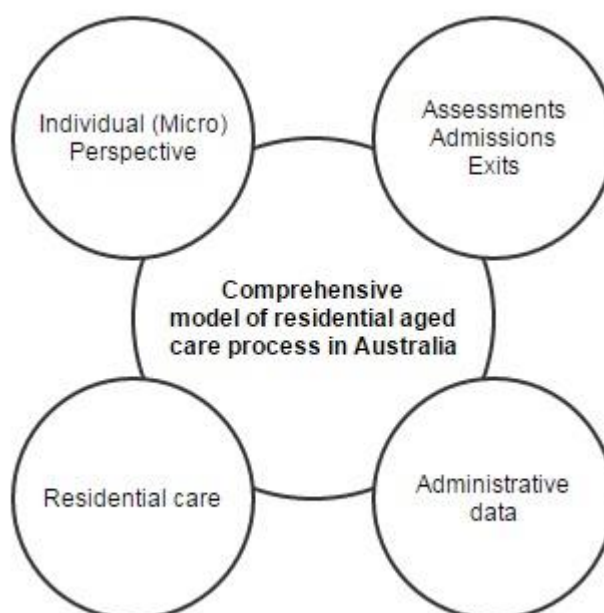
Third, even though some aged care studies have adopted modelling approaches, they have not been focused on residential aged care. As one of the most complex and most sensitive parts of the overall aged care system in Australia, residential care deserves our special attention. Finally, considering these shortcomings, it is possible to claim that a comprehensive model of the residential aged care system in Australia, based on the individual or micro-perspective of care events, is clearly missing. Such an approach may lay a foundation for the development of a full-scale projection model of the residential aged care system.

(2) Gap in Data Usage

Attempts to examine and model aged care, disability levels, or family structure have largely relied on survey data, with administrative data only occasionally been used, mostly for validation purposes. Large and comprehensive data sets which enable researchers to 'follow' an older person from the moment of application for residential care until the exit have not been extensively used. The availability of large quantities of data from the *National Aged Care Data Clearinghouse* (AIHW 2016a; 2015e; 2013a; 2013b) has made it possible to conduct a detailed research project that might be of interest not only in Australia, but also to other countries experiencing ageing. In the key study, Karmel and her colleagues demonstrated that, to some extent, certain linkages between the Australian administrative records of persons applying for care and persons receiving aged care could be established (Karmel, Powierski & Anderson 2014). However, data linkage procedures are extremely costly and time-consuming and as such not entirely feasible under the budget limits of a PhD project. Therefore, in some instances, as a proxy to a full-scale data linkage, procedures of merging and statistical matching of both the

administrative unit records data and surveys, have been used in this thesis. For example, by matching data on assessments on one side and data on admissions and exits on the other, it is possible to examine residential aged care trajectories from an individual perspective. Furthermore, recently obtained longitudinal ACFI data (AIHW 2016a) enable a detailed analysis and understanding of how aged peoples' disability levels change within residential care, and what are the prevailing conditions (disability status) of exit or separation. Comparison of the results (i.e. transition rates between care needs, exit rates etc.) obtained through statistical matching of the administrative data sets and surveys, with the results derived from the analyses of longitudinal data, provide the opportunity to validate the results of this thesis and to make recommendations about further procedures. As data collection and model building can be very costly, early information on its potential value is important.

Figure 1.6 A scheme of the research gaps



Source: Author, February 2015.

As already underscored in the previous sections, the aged care system in Australia is complex, with its financial implications being an important and sensitive issue for Australian public policy. The previously mentioned media release saying that *"the claims by some in the aged care sector that an increase in "frailty" in older Australians was to blame for the unexpected increase in ACFI claims was not consistent with Government data on claims for other ACFI-funded services"* (Ley & Wyatt 2016) underscores the importance of Australian aged care data. If properly collected, analysed and interpreted, such data can be utilized by many aged care stakeholders both in the public and private sector. There are three main reasons why these 'big' data are very useful:

- (1) the ongoing nature of administrative data collection;
- (2) the high statistical power due to many independent observations;
- (3) the high level of consistency and accuracy of observations across Australia.

A detailed study of the emerging data, their uses and accuracy, as conducted in this research, should be able to contribute to the understanding of aged care in Australia.

1.6 Statement of the Problem

Heretofore, I have raised several important issues including: (1) the dominant research discourse on ageing and aged care in Australia and internationally; (2) the reasoning behind modelling, better utilisation of potential data sources and aged care predictions; (3) the pathways of care in Australian residential care viewed from the individual perspective of older persons, including dominant factors that influence aged care events; (4) a synthesis of the research gaps related to modelling of residential care. All the above give rise to the fundamental question: *What is the practical problem this research wants to examine?*

The answer to that question requires acknowledgment of the following facts:

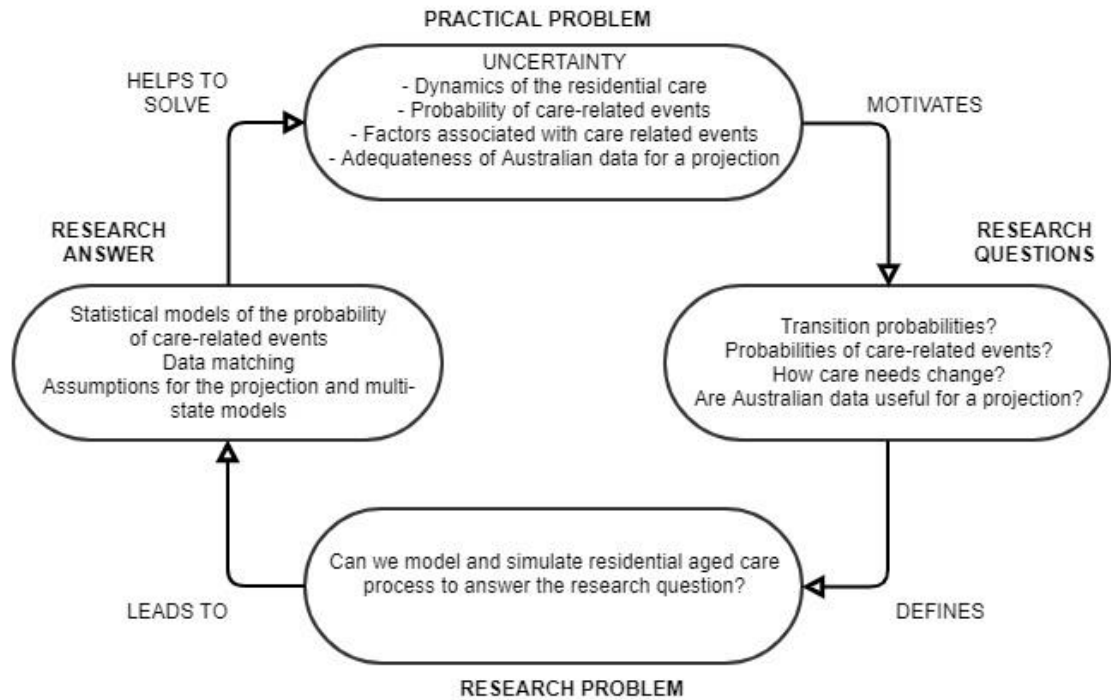
- *Structural ageing may change the dynamics of influx of older persons to residential aged care, especially when the baby-boomers progress towards very old ages;*
- *Future disability patterns and pathways associated with these patterns are uncertain;*
- *Any residential aged care trajectory (applications, assessments, admissions, exits) is a series of interrelated events and actions;*
- *The future dynamics and financing of the residential aged care system in Australia are uncertain;*
- *Research evidence has supported claims that sets of conditions (determinants) influence individual actions related to care, above all, the level of disability and availability of carers;*
- *The influence of surrounding conditions (factors) on the individual care-related actions is uncertain and requires further exploration;*
- *Aged care data in Australia have not been utilized adequately or made accessible to researchers, despite repeated recommendations of the Productivity Commission (2011; 2013)*

Having recognized these facts, an answer to the previous question imposes itself. *The practical problem*, in its essence, is that aged care policy planners in Australia do not have sufficient insights on the present or the future dynamics of residential aged care. Considerable uncertainty surrounds the probability of aged care events and factors associated with these events. Similarly, the likelihoods of certain disabling conditions and functional needs being developed in residential care facilities remain unknown. Moreover, the patterns of exit or separation from nursing homes likely depend on the direction and speed of the development of older persons' assistance needs inside residential care. Broadly speaking, an indispensable part of the same problem is whether policy decisions are based on compelling evidence derived from a variety of adequate sources.

Critical appraisal of the literature revealed the methodological and knowledge gaps that need to be addressed in this study. Evidently, there is a lack of attention to the individual perspective and surrounding circumstances of aged care events and actions. In practice, this means that future increase in the number of older persons in Australia does not necessarily imply a proportional increase of older Australians in residential or other care settings. In a similar way, an increase of the residential aged care population does not presuppose a proportional increase in the number of exits from or deaths within care. For example, there might be an increase in a proportion of long-stayers over some period, with a relatively stable pattern of separation, followed by a jump in the force of mortality when a specific cohort of long stayers reached very old ages. As already pointed out, changes in the care needs of permanent care residents are an even more sensitive issue, as these changes directly determine the total value of subsidies for aged care beds.

Finally, by answering all the constituting parts of the research problem (Figure 1.7), I will explore whether statistical modelling of aged care data gives sufficient information for the construction of a projection model of residential care. Ideally, a projection model of persons in aged care, or a model of people in need of such care, should be part of a representative model of the whole Australian population. Such a model would need to be able to simulate disease development, and to replicate the development of functional needs of older Australians measured by the ACFI instrument. The prerequisite of such a modelling framework is having adequate data suitable for the extraction of necessary transition probabilities.

Figure 1.7 Synthesis of the research framework



Source: Author, February 2015.

A precisely defined practical problem is a prerequisite for setting up the eligible and clearly targeted *research questions* (Chapter 1.7). Such questions consequently define and reveal the true nature of the *research problem*, which is different from the *practical problem* described above. As opposed to the practical problem, the research problem is defined by the research questions asked. At its core, it is the problem of modelling the residential care events and actions using a statistical framework and a probabilistic approach. An indispensable component of the research problem, as defined in this thesis, is the examination of Australian aged care data to determine whether they can be used to derive assumptions for a projection model of residential aged care. Figure 1.7 clarifies the relationship between these terms.

A desired *research answer* or an output of the modelling is getting a better understanding of the entire residential aged care process from an individual perspective by providing probabilities and recognizing the pathways of care and patterns of care related events and actions. Establishing matching, merging and linkage between different parts of the Australian aged care data base will provide new insights into the compatibility and usefulness of these data. More importantly, the research answer will contain the assumptions for a projection model of residential aged care. In the end, such assumptions (state transitions, probabilities of aged care events, life expectancy estimates etc.) will be useful for future use in a projection or a multi-state model of aged care. From a utilization standpoint, modelling and projections of residential

aged care should serve a twofold purpose. Firstly, they contribute to our understanding of a complex care system, and secondly, they inform aged care decision and policy makers about the dynamics and structure of this system. As defined, this study has the potential to lay the foundation for the development of more complex prediction tools which may assist future policies on aged care in Australia. Potential prediction and simulation methods will be further discussed in the last chapter of this study.

1.7 Research Questions and Aims

Identified gaps and the problem statement lead us to the following research questions:

- (1) What are the probabilities of residential aged care events (i.e. applications, approvals, admissions, exits) and which determinants (factors) are significant in the residential aged care pathways of older Australians?*
- (2) How common are different care needs within residential aged care and how do they change with age and time spent within care?*
- (3) Can aged care data provide sufficient information for statistical models and projections of the residential aged care system in Australia?*

In summary, the research aims of this study can be paraphrased as a pursuit to identify the factors that have a significant effect on the following residential aged care events: (1) application for an aged care assessment; (2) approval for residential care; (3) entry to residential aged care, given approval, and (4) exit from residential care. Based on the associated individual conditions (determinants), the intention of this study is to calculate the probabilities of these aged care events. Construction of the statistical models should contribute to the understanding of a residential aged care trajectories from the perspective of older individuals. The prevalence of care needs and the transitions between different levels of care needs within residential care will also be examined, especially with respect to age and time spent within care given specific combinations of care assistance needs (care related life expectancy; chapter 7). These insights are particularly relevant from the financial perspective of aged care policies. Using the administrative, cross-sectional and longitudinal data, and relevant information from the SDAC survey data, this study also seeks to verify whether it is possible to provide sufficient details for construction of a projection model of the residential aged care system in Australia. Statistical models presented in this research provide valuable insights into underlying patterns and

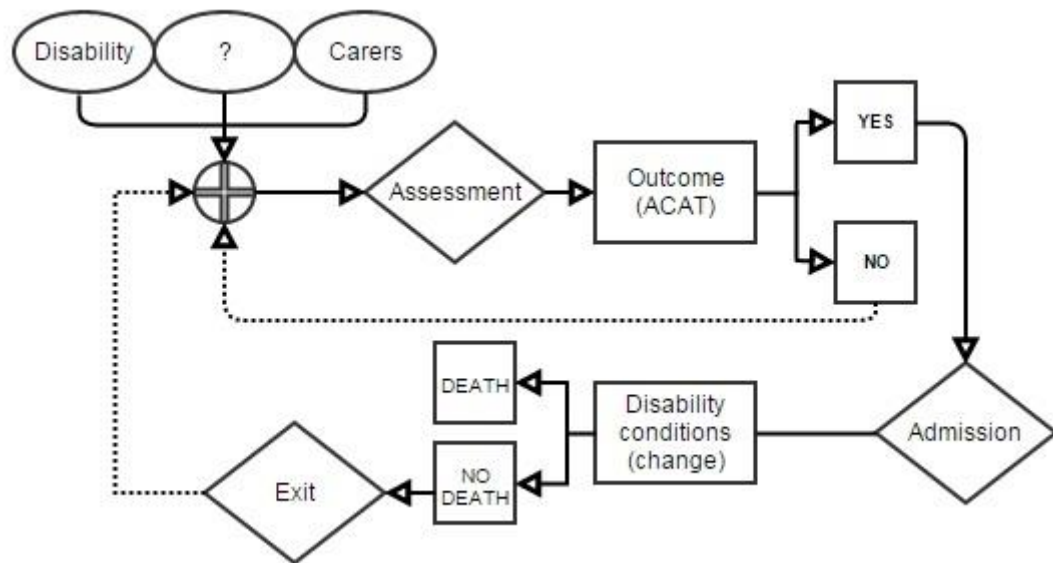
mechanisms of the examined process, and thus could serve other researchers and policy makers in the field of aged care.

1.8 Research Scope

The scope of this research includes modelling of residential aged care in Australia, starting with the mandatory applications and aged care assessments and ending with deaths and other forms of exits from residential care, perceived from the individual perspectives of older Australians (Figure 1.8). Though it falls within demography of ageing and aged care, this work is focused on a narrow and strictly defined part of a wider aged care framework - the care delivered under institutional arrangements in residential aged care facilities. Specific attention has been put on older individuals who, at a certain point in their life course, take a series of actions towards residential care, including applications, assessments, admissions and exits. The outcomes of such registered actions or events are then analysed using conventional statistical modelling and finally, the evidence obtained from the modelling has been examined in the context of potential uses of this information in a future prediction model of residential aged care.

Because this study focuses upon understanding of residential care rather than on prediction and projection of the aged care system, a lot of attention will be devoted to the gaps that need to be filled in current data on residential aged care. This again implies a need to examine extensively all the available data sources that contain information on residential care, to describe the parameters and determinants available in these sources and to test the value of these data in statistical models of the pathways towards institutional care. Limitations of certain statistical methodologies used in this study and the problems with collection, management and organization of care data in Australian institutions that hold these data will also be addressed.

Figure 1.8 Residential aged care pathway (trajectory) in Australia (general framework)



Source: Author, March 2015.

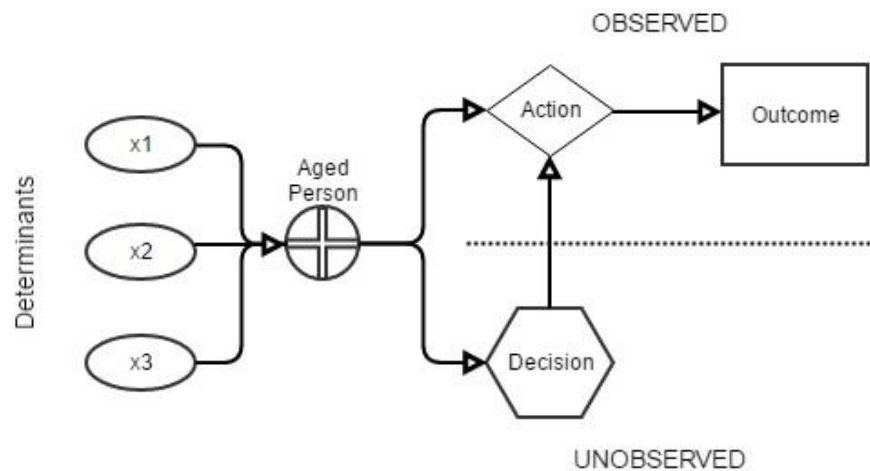
From the technical perspective, the domain of this study includes conventional classification techniques, such as logistic or multivariate linear regressions, multi state models, life expectancy estimation and some other techniques that will be described in later chapters. Furthermore, this study also focuses on the practical uses of some statistical techniques that may be considered '*less conventional*', but proved to be useful in mitigating data shortcomings and inconsistencies. This particularly relates to techniques of data manipulation, such as using summaries to prepare a binary logistic regression between unlinked data sets containing a common set of variables. In the absence of more reliable and connected data sources, these techniques could help us to get a better understanding of the aged care system and to underscore deficiencies in the current data. Similarly, some statistical techniques that may be considered '*less precise*' still have a value in the way that they point to the missing parameters that are necessary for construction of more precise models. Finally, the results of these procedures give a valuable feedback that is beneficial for future efforts of data collection practitioners, data custodians and aged care policy planners.

The models of residential aged care pathways have been derived exclusively from the contextual parameters surrounding aged care events. The observed and registered actions taken by older persons were extracted from the administrative and survey data on aged care (Chapter 2). The selection of relevant predictors of residential aged care events and their inclusion in the scope of this study has been guided by the findings in the contemporary Australian and international literature on older persons' care institutionalization. However, this implies that this study has relied on the assumption that the mentioned research evidence has, in fact, correctly identified

the most important determinants of residential care events. Even though, most of these factors are found in the data examined by this study, some other possibly relevant determinants might not have been available. In other words, the scope of this study, in terms of data, has been limited by the available information. Specific data items that are available in the national database including information on the ethnicity, indigenous status, location, and some other conditions that may identify an older individual have not been included in the data files provided to me.

In terms of the core activities surrounding modelling of residential care, the following are within the scope of this study: (1) Data interpretation and manipulation; (2) Statistical modelling and estimation; (3) Data visualization, and (4) Reporting and interpreting the results. Therefore, this study is limited by the capabilities of the proposed methods. Unlike the previously mentioned agent based framework (ABM) which focuses on decision-making, the statistical models adopted in this study have been derived exclusively from the observed and registered aged care events (Figure 1.9). Limitations that arise from data and methods, however, will be addressed in more detail in Chapter 2.

Figure 1.9 Conventional vs. Agent-based Modelling



Source: Author, March 2015.

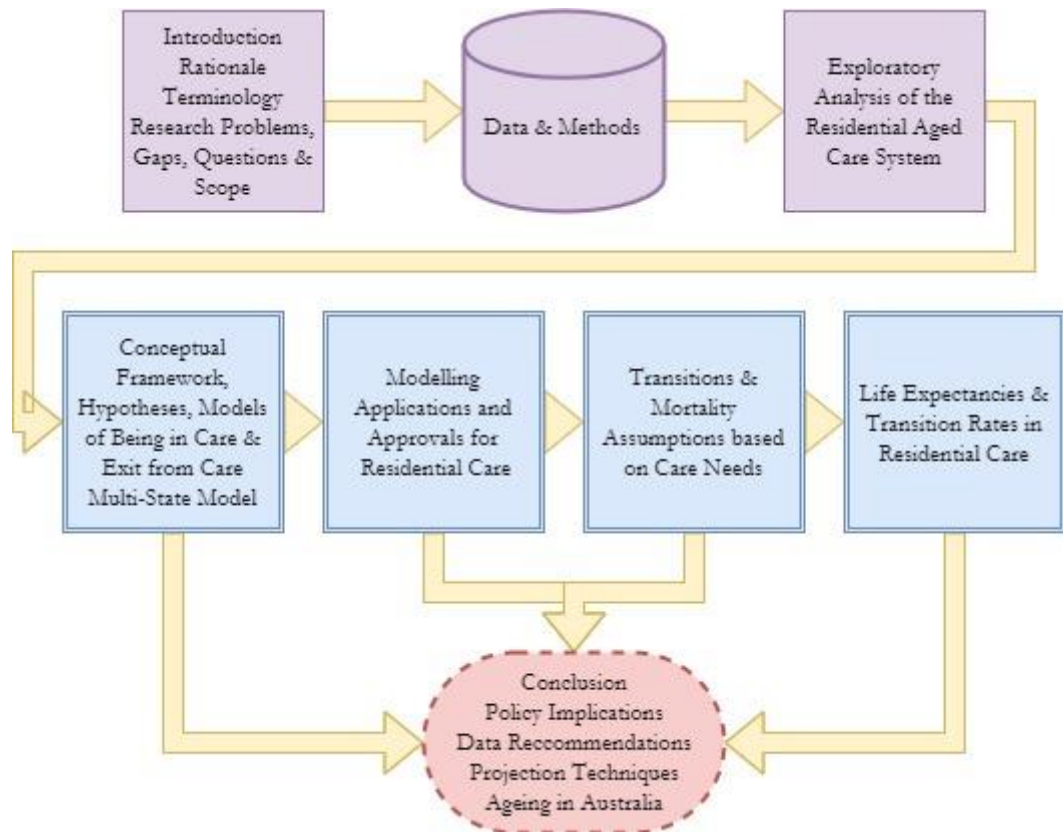
One of the most relevant parameters under which this research operates is *age*. Throughout the manuscript, the term *elderly* is used interchangeably with the other terms, such as *older people*, *older persons*, *older Australians*, or *aged persons*, relating to those 65 years and older as the main subjects or action takers on a residential aged care trajectory. It is noteworthy that persons younger than 65, under special conditions, can be admitted to residential aged care. However, this rarely happens in practice.

Finally, this study assumes that underlying mechanisms of residential aged care pathways, seen as interactions between a set of contextual parameters (factors) and the outcomes (events), at the level modelled herein, are generalizable to other developed countries. Nevertheless, these residential care pathways are likely to vary between countries. This variation can be explained by differences in the regulation of aged care financing, or by different legislative procedures of assessment and admission to residential care.

Projecting residential care demand in Australia is beyond the scope of this study. However, some potentially useful projection and simulation methodologies will be analysed in the last chapter. Furthermore, it is not the intention of this study to establish statistical linkages between fragmented Australian data on aged care. For example, studies that link care assessment data to service use data for community care, home care and residential care (Karmel et al 2012; 2010) are costly and, given the current structure of Australian care data, these studies are only feasible for a smaller cohort of older people. Even though the home and community care programs are fundamental parts of the Australian aged care system, these segments were also beyond the scope of this study and, therefore, they will not be modelled. Yet, on many occasions both home and community care will be examined because of its increasing importance in the Australian aged care policy agenda.

1.9 Structure of the Remainder

Figure 1.10 Structure of the thesis (chapters and research steps)



Source: Author, March 2017.

Chapter 2 introduces the reader to the Australian residential aged care data and looks at each individual data source from the perspective of data quality, data limitations, confidentiality and other relevant issues that may affect the results of modelling. Furthermore, this chapter outlines the methodological framework employed in this research, briefly explaining each research step. In addition, the second chapter reinforces the research aims by adding further explanations to each of the three critical steps: modelling of the residential care system, examining changes in older persons' care needs and scrutinizing data on residential aged care for possible use in a projection model. Chapter 3 sets the context on how the Australian aged care system has worked over the last decade. Special attention is given to the historical changes in aged care policies in Australia that strengthened the policy agenda of the substitution of residential aged care with community and home care alternatives. Perceiving the residential care system from the macro-perspective, this chapter reveals the areas of stability and the areas of change in the aged care system. Furthermore, the third chapter gives an overview of residents' characteristics, serving as a stepping stone towards the micro-level analysis and modelling of residential care

events. The aggregate numbers presented in this chapter, including information on the use of residential care services, the turnover of permanent care residents, the expected length of stay, geographical differences and the prevailing needs for assistance at a specific age for each gender, serve as reliable reference points. These aggregate figures can be compared with the results of statistical modelling to show whether modelling of entry to residential care gives plausible results.

Chapter 4 is the key chapter of this study for two reasons. Firstly, it provides the theoretical basis that informs variable selection in modelling of residential care processes. This foundation is later used as a conceptual framework to support modelling decisions in other chapters. Secondly, this chapter displays models of the probability of being in residential aged care and the likelihood of exit from such care. It demonstrates how models of exit from care can be derived using matching between resident and exit data. The probabilistic models shown in this chapter may not be as robust as some other models shown in this study or elsewhere, but they serve as a guide to the determinants (variables) likely to be useful in modelling and simulating admission and exit probabilities. When data sources are limited, modelling techniques such as these may be useful. Another methodological exercise shown in this chapter is the multi-state model of transitions between ACFI care needs levels, based on ACFI data cubes on admissions, residents and exits from residential care.

Chapter 5 examines the process of entry to residential aged care as a multi-stage process. Three probabilistic models are shown in this chapter: the probability of making an application for care assessment, the probability of approval for residential care and the probability of taking up the residential care following the approval. The most *robust*⁶ of these models – the model of the likelihood of being approved for residential aged care – is derived from a large administrative data base from the Aged Care Assessment Program (ACAP), whereas the other two models are constructed as a combination of unlinked data sources. The main intention of this chapter is to approximate the entire process of residential aged care entry (application – approval – admission), meaning that the models derived by combining the unlinked data sets, although less accurate, are still useful as they point to the problems with the aged care data collection and management system in Australia. This chapter also illustrates novel techniques to make use of unlinked data sets by deriving compatible assistance codes from different data sets.

⁶ Based on properties testing shown in Appendix 5.8.

Chapter 6 broadens our understanding of an individual's journey from the general population to residential aged care, by combining two data sets that capture different points on this trajectory towards residential care. This chapter demonstrates how two data sets can be combined, firstly, by deriving translational bases⁷ that connect these sources and finally, by imposing the mortality model derived from one data set, to another data set. Specifically, Chapter 6 displays the fitted prevalence models of care assistance needs and estimates the mortality rates associated with each combination of care assistance needs. Mortality rates are estimated for both data sets (SDAC and ACFI) and are used in combination with the fitted SDAC prevalence models to provide transition assumptions for each of the SDAC care needs levels. The insights from this chapter, such as transition probabilities or mortality assumptions may be useful in a projection model of the demand for residential care in Australia.

Chapter 7 examines the functional decline of older Australians in nursing homes, showing how longitudinal ACFI data could be used to directly estimate transition rates between different care needs and how to calculate the life expectancies for each combination of care needs. Moreover, this chapter gives the key evidence on changes in the ACFI system dynamics that have occurred in the period between 2008 and 2015. It also interprets these changes in the light of the effects of the recent reforms in aged care policies in Australia. Specifically, this chapter contributes to our understanding of the *real* dynamics inside the residential care system, distinguishing such dynamics (i.e. measured as life expectancy) from the continuous upward drifts in ACFI appraisal outcomes measured by the providers.

Finally, Chapter 8 discusses policy and the theoretical importance of the findings and suggests how existing aged care data can be used for future analysis. A large part of this chapter is dedicated to discussion of potential methods for projection of the aged care system. Furthermore, the gaps in the current data system are identified and discussed. These gaps include incompleteness, inconsistencies, linkage problems and inaccessibility of data. Chapter 8 summarizes the findings of the study and puts them in the context and perspective of demographic ageing of the Australian population. It provides a concise summary and recommendations for further research.

Figure 1.10 gives an overview of the structure of this manuscript with all the chapters and the key research steps.

⁷ The translation bases between the ACFI and SDAC levels are derived based on their correlations (see section 6.3.2 *Allocation rules to create ACFI needs from SDAC needs*).

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2. Data and Methods

2.1. Data Overview

The Australian aged care system is highly regulated and substantially funded by the Government. Large volumes of data on aged care regularly collected in the system are potentially valuable for statistical modelling, simulation or projection. These administrative data are comprehensive, reliable and ongoing, with a substantial number of unit records, giving high statistical power. Unfortunately, linkage systems between separate segments of residential aged care data have not yet been fully implemented and the access systems are costly and incomplete (Cumpston & Jukic 2017). Better access to data on aged care should allow the development of a multi-purpose projection model of residential aged care demand. Even though Australia has a national policy of releasing more public-sector data for research (Productivity Commission 2015), practical implementation of this policy is still on hold.

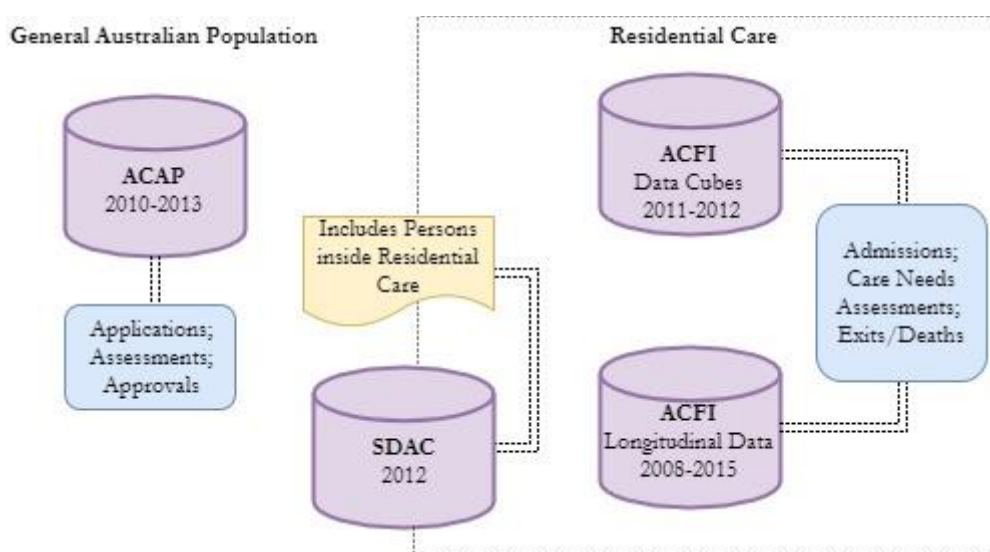
Modelling methods used in this research rely on the limited data publicly available, and on data obtained from the National Aged Care Data Clearinghouse (NACDC) of the Australian Institute of Health and Welfare (AIHW) and from the Australian Bureau of Statistics (ABS). As previously outlined, the two largest administrative unit record files used for modelling of the residential care system (ACAP and ACFI⁸), are not linked. This *missing* link has been partially *reconstructed* in this study using novel methods of analysis. The primary purpose of these methods was to show the potential value of the full (linked) data and to suggest ways in which the available aged care data can be used to plan projection models of entry into residential aged care, and of progression through such care.

The administrative data on aged care in Australia can be broadly divided into two parts – each of them pertaining to a different phase of the residential care trajectory. The first part comes from the Aged Care Assessment Program (ACAP) and contains all information on the assessments and their outcomes, such as program approvals or recommendations. These data are collected when older individuals apply for one of the aged care programs (Department of Social Services 2015a). The second part is based on the Aged Care Funding Instrument (ACFI) used to assess the health and physical condition of persons in residential care. Comprehensive data routinely acquired from these systems are stored in the National Aged Care Data

⁸ Longitudinal ACFI data (for more information see 2.3.3).

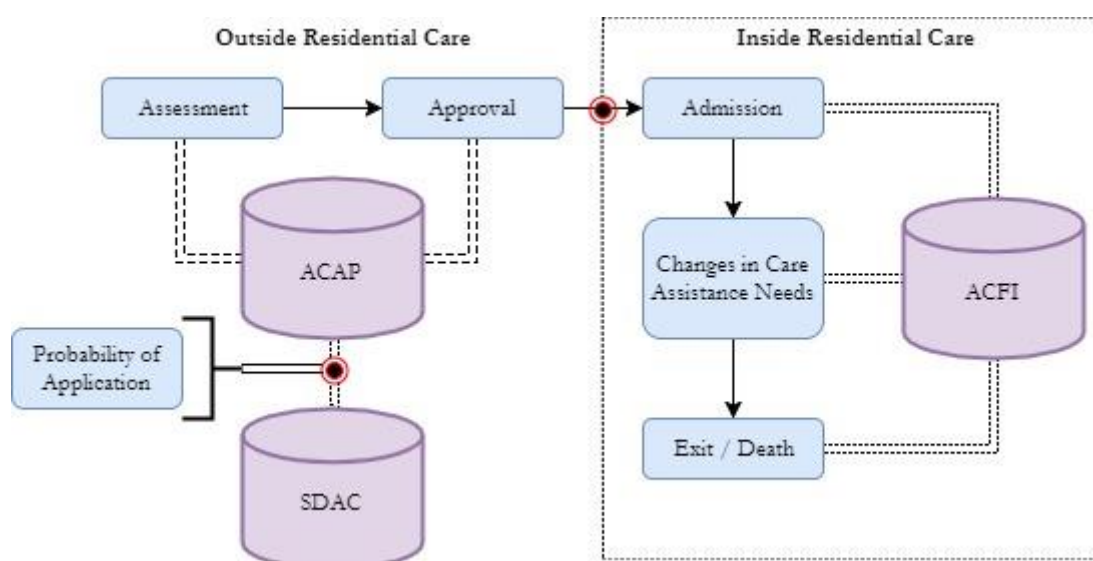
Clearinghouse (NACDC) of the Australian Institute of Health and Welfare (AIHW 2015e), allowing detailed modelling of the processes of applying for an approval for aged care, receiving such an approval, entering aged care, exiting from such care, and changes in the needs for care assistance (Figures 2.1 and 2.2). The conceptual model of the Australian residential aged care system (Figure 1.3) shows the volume of flows between the mentioned aged care programs in the period 2011-2012.

Figure 2.1 Data sets on aged care used in this research



Source: Author, August 2017.

Figure 2.2 Data sets on aged care in the context of residential aged care trajectory



†The encircled black dots denote the spots on residential care trajectory where data is unlinked.

Source: Author, August 2017.

It is noteworthy that this study identifies the points on the residential care pathway where the existing aged care data are unlinked or incompatible (Figure 2.2) and, therefore, do not allow models of residential care to be easily derived. In such cases, as shown in later chapters, data sets had to be prepared for modelling by applying procedures of matching and merging. The ACAP data, for instance, include details of the households, health conditions and activity limitations of each applicant, in broadly comparable form to those recorded in the Survey of Disability, Ageing and Carers 2012. A comparison of these two data sources allows modelling of the probability of an application being made, whereas a separate analysis of the ACAP unit records allows models of the probability of an older applicant being granted residential approval, and of the time for this to occur.

ACFI assessments are completed within 8 weeks on entry to residential care, and whenever a resident's health changes sufficiently to suggest a different level of government funding may be appropriate. Longitudinal ACFI data (Figures 2.1 and 2.2) are particularly useful as they allow a survival analysis and direct estimation of the transition rates between different levels of care needs, necessary for a projection model of residential care. The recorded ACFI data include the main health conditions, and assessments of nutrition, mobility, personal hygiene, toileting, continence, cognitive skills, behavioural needs, medication and complex health care. Comparing ACFI records at entry with ACAP assessments allows models of entry likelihood and delay. Also, the ACFI data boxes may be a useful data source in the absence of the full ACFI longitudinal file. The use of such boxes (or the ACFI data cubes) in combination with other data sources is also demonstrated in Chapters 4, 5 and 6. Analysis of the rich ACAP and ACFI data, as shown in the following chapters, may improve care for older Australians, and may perhaps also be helpful to other countries.

Data manipulation procedures undertaken in this study, such as those described in the previous two paragraphs aim at addressing one of the main research questions of this study – assessing the quality of aged care data for a projection model of the demand for residential care in Australia. The following sections of Chapter 2 (2.2 – 2.6) give the details on each data set used in this research. However, due to the complexity of data manipulation and modelling procedures, some additional information on data (i.e. derived variables, transformations etc.) and methods will be given in each of the main chapters (Chapters 4-7).

2.2. ACAP Data

As stated in Chapter 1, ACAP is a nationally consistent assessment program that provides a unique opportunity to analyse the relationships between an older person's sociodemographic, health, disability and other characteristics, and a recommendation for residential aged care. This data set records person's care needs and social circumstances, including availability of a carer, at the time of care assessment, and up to ten health conditions affecting needs for assistance, including whether a person was approved for a residential care long-term setting (Department of Social Services 2015a). The recommendations of the ACAT teams are important as one of the inputs for understanding Australia's aged care reforms currently underway. Indeed, the ACAT recommendations are the key requirement to determine a person's eligibility for entry to care, these assessment outcomes cannot be perceived as the only factor of actual entry to nursing home. Other factors, such as availability of vacancies and acceptance of the older person by the aged care providers also play an important role. The aim of this section of Chapter 2 is to provide more information on the volume and the content of ACAP data used for modelling of approvals for residential care.

The ACAP system provides high-quality administrative data derived from ACAT assessments with more than 100,000 applications for entry into residential aged care each year. In the period 2011-2012, for example, 217,501 ACAT assessments were completed, covering residential care, respite care, community based care services and transition care. Nearly half of the total applications (49.1%) were rejected or resulted in non-residential care approvals. The total number of the approvals for residential care in the same period was 110,800. Almost half of these approvals (47.1%) did not enter residential care for various reasons (Figure 1.5).

This analysis uses a de-identified ACAP file 'R1415_1146' with all Aged Care Assessment Program referrals received by Aged Care Assessment Teams from 1 July 2010 to 30 June 2013 (Australian Institute of Health and Welfare 2013a). Prior to the analyses, the data's accuracy, completeness and appropriateness was carefully evaluated for this research purpose. Due to confidentiality considerations, several variables from ACAP assessment files (i.e. personal identifiers, address etc.) have been omitted from this data supply. In addition, date of birth has been replaced with age, which has been provided in five-year age groupings for each record in the file, commencing with "under 50" and continuing in increments to "100+".

The supplied ACAP file in the period between 01 July 2010 and 30 June 2013 contains more than 750,000 personal unit records. Features of particular interest for this research are person's age, sex, carer availability, carer co-residency, health conditions, measures of needs for assistance, state of residence and recommended long-term care setting. Box 2.1 lists the main variables in the ACAP data set. These variables were found to be of great importance for person's progression towards residential care (more details in sections 1.4 and 4.4.1). Other relevant variables, such as reason for ending the assessment or time of referral were also used for exploratory analysis and statistical modelling (a comprehensive variable list is available in Appendix 1).

Box 2.1 Main variables in ACAP Data Set

Age	Older person's age in 5 year bands.
Assessment ID	Unique identifier of ACAP assessment.
Assessment Date	The first face-to-face assessment date.
Carer Availability	Whether someone has been identified as providing regular and sustained care and assistance to the person.
Carer Co-residency	Whether or not the carer lives with the person for whom they care.
Health Conditions	Health conditions being a diagnosed disease or disorder that has an impact on the person's need for assistance with activities of daily living and social participation. This condition is one of up to ten health conditions which may be reported for the person. In the original format it is recorded as a 4-digit code for each condition based on the ICD-10-AM classification and comparable to the ABS 4-digit code used for the Survey of Disability, Ageing and Carers.
Needs for Assistance	11 measures of older persons' needs for assistance with the activities of daily living (more detailed description in the text below).
Sex	Biological sex of the person (M, F, Unknown).
State	Australian state in which the person lives.
Referral Date	The date on which the referral for an assessment is received.
Resid. Care Approval	Approved or Not approved (High care, Low Care).

Source: AIHW 2013a.

Measures of needs for assistance with daily activities can be perceived as the most critical piece of information in the ACAP data as these indicators play a strong role in assessor recommendations about entry to permanent aged care (Department of Social Services 2015a). These ACAP needs are, in fact, measures of the functional status of older Australians, specifically referring to their needs for assistance as follows:

- ❖ **Move:** maintaining or changing body position, carrying, moving and manipulation of objects, getting in or out of bed or a chair.
- ❖ **Moving:** walking and related activities.

- ❖ **Communication:** understanding others or making oneself understood by others.
- ❖ **Health:** taking medication or administering injections, dressing wounds, using medical machinery, manipulating muscles or limbs, taking care of feet.
- ❖ **Self-care:** daily tasks such as eating, showering or bathing, dressing, toileting and managing incontinence.
- ❖ **Transport:** using public transport, getting to and from places away from home or driving.
- ❖ **Social:** Shopping, banking, participating in recreational, cultural or religious activities, attending day centres, managing finances and writing letters.
- ❖ **Domestic:** household chores such as washing, ironing, cleaning and formal linen services.
- ❖ **Meals:** including the delivery of prepared meals, help with meal preparation and managing basic nutrition.
- ❖ **Home:** home maintenance and gardening.
- ❖ **Other:** needs assistance with other tasks not stated above.

As already underscored, the missing link in the analysis of residential care pathways is between ACAP and ACFI unit records. The information on take-up of residential care, following the ACAT assessments (ACAP data), should in theory be linked to the permanent admissions data (ACFI) using a unique combination of letters selected from the care recipient's information (person's ID, date of birth, sex). This linkage procedure would enable investigation of an entire ACAP-ACFI National Minimum Data Set (NMDS)⁹ and, therefore, an examination of full residential aged care trajectories for each person applied, approved and admitted to nursing home. With the current state of data on aged care, the linkage is expensive and cumbersome. For example, the assessments stored in the AIHW ACFI source system (SPARC) can have multiple records associated to a single ACAP assessment. This confusing situation is because the individual records have been generated for a different aspect of the assessment, usually at different times.

The absence of ideally linked data, confidentiality concerns and high costs of formal linkage procedures (Karmel et al 2014; 2012) determined the methodological approach in this research. Consequently, these limitations have led to the implementation of alternative methods to “*bridge the gap*” between ACAP and ACFI data. An example of this procedure is shown in Chapter

⁹ The Aged Care Assessment Programme National Minimum Data Set NMDS (V 2) is an important source of information for the ACAP and the aged care system generally. It contains data on assessments by ACATs, as set out in the ACAP Data Dictionary (Department of Social Services 2015a).

5.5.3. The utilisation of ACAP data is further discussed in Chapter 5 where most of the ACAP analysis is done.

2.3. ACFI Data

2.3.1 ACFI System

The Aged Care Funding Instrument is a resource allocation tool focused on the main domains that discriminate assistance needs among aged care residents (Department of Health 2016). The ACFI data used in this study come from the National Aged Care Clearinghouse (AIHW) and are largely based on the appraisals¹⁰ undertaken within eight weeks after entry to residential aged care. However, personal ACFI records are extended and updated whenever a care resident's condition changes sufficiently to suggest a different level of government subsidy is adequate (Department of Social Services 2014a). Because the ACFI unit record files (see 2.3.3) include all care residents *followed* from the moment of their admission to residential care until exit from such care, it is possible to examine residents' needs for assistance, changes in disability conditions, incidence of diseases, and other individual characteristics relevant to this study.

The main variables reported across different segments of the ACFI system are given in Box 2.2, whereas a comprehensive list is provided in Appendix 1. This broad list of variables suggests that at least two aspects of the ACFI system can be modelled. Firstly, it is possible to examine changes in care needs, or more precisely, changes in the individual disability and disease conditions of residents. Analyses of these indicators provides the transition probabilities between different ACFI care needs levels, ideally needed for aged care projections. Even though in different segments of the ACFI system, persons' assistance needs are represented with different variables (*ACFI Category, Assessment Category, ACFI Level* etc.), these indicators are comparable and all of them measure the same levels of the ADL, BEH and CHC care domains (*Nil, Low, Medium* and *High*). In practical terms, this means that each person in the residential aged care system, at each time, can have 1 out of 64 possible combinations of care assistance needs. Secondly, information given on the time spent in residential care arrangement, measured as a difference between entry to and exit from aged care (including re-assessments episodes), enables survival

¹⁰ A reappraisal can be undertaken in a few circumstances where there has been a substantial change in care needs or when a care resident experienced an extended hospital stay (AIHW 2011a).

analysis and approximation of individual life expectancy associated with different assistance needs (see 2.3.3 ACFI longitudinal data).

In accordance with the aims of this research, analytical approaches, such as those stated above, have a potential to broaden our understanding of aged care dynamics in Australia. For example, probabilities of aged care events in nursing homes, such as different modes of exit from these facilities, can be derived. The probability of exit can be modelled as an outcome of various personal circumstances (care needs, diseases, sociodemographic and other factors) at the time when such an exit occurs. A clear understanding of how long older Australians are expected to stay in care is especially relevant from a policy perspective as this measure helps in estimating the costs of permanent care and availability of beds. In the current form, longitudinal ACFI unit records can provide information necessary for projections of residential care demand, such as transition rates between different levels of care needs, mortality estimates, probabilities of disease development and other measures.

Box 2.2 Main variables in the ACFI system

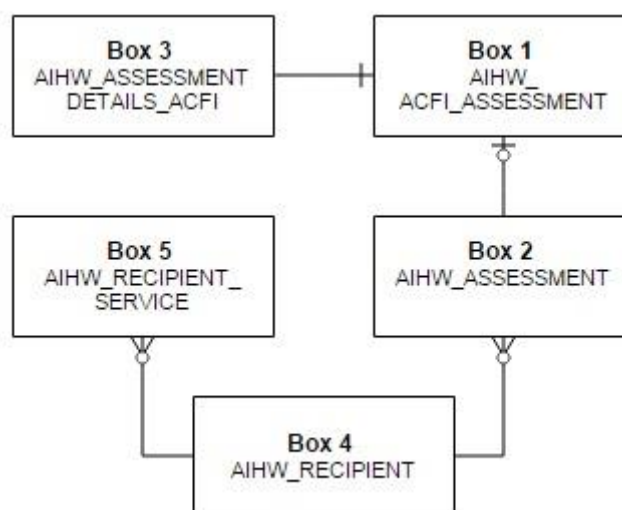
Age	Care recipient's age in 5 year bands.
Sex	Biological sex of the care recipient (M, F, Unknown).
Assessment ID	A unique identifier of ACFI appraisal. The assessment ID can be linked with the ACAP and other boxes that contain the information on aged person's stay in residential care.
Carer Availability	Specifies whether a residential care recipient has a carer available.
Care Needs	A care recipient's needs for assistance in 3 different domains (ADL, BEH & CHC), and other subdomains. The ACFI categories, levels and scores, as separate variables, also belong to care needs.
Discharge Reason	Whether a care recipient has died, moved to other residential care facility (or hospital), or returned home.
Death	Indicates whether the recipient is known to be deceased.
Entry & Exit Date	Length of stay in residential aged care.
Marital Status	Specifies marital status of care recipient.
State	The Australian state or territory in which a care recipient lives.

Source: Author, July 2015.

Most of the ACFI variables used in this research come from the five boxes (Figure 2.3) of the National Aged Care Data Clearinghouse (NACDC) (AIHW 2015e). The assessment ID numbers, recipient codes unique to each patient, and other numerical identifications (i.e. SPARC system) where available, have a great potential to link the ACFI system boxes with ACAP data. Another

important goal of this study is to suggest how to reform data management in aged care. The first linkage ever completed that involved ACAP-ACFI data, as previously mentioned, was constructed under the “*Pathways in Aged Care*” (PIAC) project. This expensive and research intensive cohort study (Karmel et al 2012) gave insights into the care pathways and transitions of older aged care users in Australia. The study resulted in a database (cohort of 105,000 persons) that linked aged care assessment data with aged care usage and death records. With the implementation of new unified rules of data coding within the aged care system in Australia, these separated segments of the system could be permanently linked (unified). Such administrative interventions would open new analytical possibilities leading to better understanding of the system in its entirety, which would consequently lead to more appropriate aged care policies.

Figure 2.3 ACFI Data Structure (AIHW Clearing House)



Source: AIHW 2015e.

2.3.2 ACFI Data Cubes

The Australian Institute of Health and Welfare (AIHW) provided on-line access to data cubes for admissions to residential aged care, residents and for exits (AIHW 2013b). Even though the ACFI cubes included useful data relating to residential care, they were constrained to the period from 2009 to 2012. Yet, this was very useful because the last data year reported in the cubes (2011-2012) corresponded to the time contained in other sources extensively used in this study such as SDAC and ACAP. In the absence of direct linkages between the ACAP and ACFI individual unit records, the ACFI data cubes were heavily used in this research. The data cube for admissions in 2011-12 had 58,574 admissions, subdivided by sex, age group, state and four-level ACFI ratings for assistance with daily living (ADL), behaviour (BEH) and complex health care (CHC). Of these,

1308 had no ACFI ratings, presumable because they had not been in residence long enough for ratings to be completed. The data cube for exits in 2011-12 had data on 56,799 exits, 849 without ACFI rating. The data cube for residents at 30 June 2012 had data on 166,876 residents, 816 without ACFI ratings. No more recent data cubes were available.

In Chapter 4 the ACFI data cubes were used to derive matching data between resident and exit summaries, and in a multi-state projection of care needs combinations. In Chapter 5, the ACFI cube admissions were used in combination with the ACAP approvals to derive models of the probability of entry into residential aged care given approval. In Chapter 6, the cubes were used in a combination with the SDAC survey data to fit individual mortality rates based on the ACFI needs variables from the cubes, and to create the allocation rules (derive ACFI needs from SDAC needs). Indirectly, through these procedures, the ACFI data cubes provided the opportunity to derive transition and recovery rates for SDAC assistance needs levels.

Data from the ACFI cubes 2011-12 were very useful for this study, but it would have been more useful if these data were also available for later periods. For example, much better estimates of transition and mortality rates would have been possible given the information for the years following 2012. However, after the 2011-12 release the National Aged Care Data Clearinghouse (NACDC) discontinued the release of any new data cubes on residential care. It can be speculated that this was due to lack of flexibility and some confidentiality concerns. The AIHW is currently investigating new technologies to automate some of the confidentialisation methods and to give more options to data users (Cumpston 2016).

2.3.3 ACFI Longitudinal Data

Supplied by the Australian Institute of Health and Welfare (AIHW 2016a) under “*R1516_1729 release code*”, the longitudinal ACFI data base on permanent aged care residents included 1.05 million unit records. The file contained details, for each permanent aged care resident, of every ACFI assessment made in the period from the introduction of ACFI system on 20 March 2008 through to 30 June 2015. For exits from 1 July 2009, information was recorded on the mode of exit. The practical significance of such a long-time span (more than 7 years) is that these data provide a detailed picture of the within-residential aged care dynamics because the length of

time covered in the data is much longer than the average length of stay (LOS) in residential aged care.¹¹

For each ACFI assessment, a rating of A, B, C or D was provided for each of 12 variables: nutrition, mobility, hygiene, toileting, continence, cognition, wandering, verbal behaviour, physical behaviour, depression, medications and complex health care. Using the procedures at the end of the ACFI User Guide (Department of Health 2013), the following values were derived:

- A value of *Nil, Low, Medium* or *High* for Activities of Daily Living (ADL) from the first five of the above variables;
- A value of *Nil, Low, Medium* or *High* for Behaviour (BEH) from the second five of the above variables;
- A value of *Nil, Low, Medium* or *High* for Complex Health Care (ADL) from the last two of the above variables.

Each assessment record had a person identifier, so it is possible to trace persons with repeated assessments. Exits from residential care were also recorded, with death being the most common cause of exit (92.2% of all exits) in the period from 2011 to 2012 (AIHW 2013b). To help preserve confidentiality, dates of birth were only given as calendar years, and dates of death as calendar months. In addition, each assessment record had a start and end date, given as calendar months. For example, a person could have an assessment, a reassessment, an exit from residential care, a re-entry to residential care with a third assessment, and then death. Data in this form enabled a detailed analysis of changes in assistance needs and an accurate estimation of mortality rates inside residential care. These longitudinal ACFI records became available only recently in the later stages of this study but they were indispensable for the direct derivation of the life expectancy in residential care facilities.

Beyond the information on activities of daily living (ADL), behaviour supplement (BEH) and complex health care supplement (CHC), in some cases, other data such as a medical diagnosis can be relevant to the calculation of ACFI outcomes (Department of Health 2013). Two supplementary questions (Q13 – Q14) record a range of medical conditions that a resident may suffer from. These questions relate to a diagnosed and documented disease or disorder excluding the mental and behavioural disorders recorded in the mental and behavioural

¹¹ The average total length of stay in permanent residential aged care during 2013–14 was 34.5 months at last separation (AIHW 2016c)

diagnosis (recorded in the first 12 questions). Box 2.3 lists the main variables used in the analyses, with a more comprehensive list being appended (Appendix 1).

Box 2.3 Main variables in the ACFI “R1516_1729” file

Admission Date	Month and year of an admission to residential care.
Assessment Reason	Specifies the reason for the assessment in residential care.
Client ID	Unique client identifier.
Discharge Date	Month and year of a discharge from residential care.
Discharge Reason	Specifies the reason that the recipient was discharged from the service.
Q01 – Q12	Questions used to determine care needs and calculate ACFI ratings in different domains of care needs (activities of daily living, behavioural needs & complex health care). These questions include: Q1 Nutrition: eating and readiness to eat; Q2 Mobility: transfers and locomotion; Q3 Personal hygiene: dressing, undressing, washing, drying, grooming; Q4 Toileting: use of toilet and toilet completion; Q5 Continence: urinary and faecal; Q6 Cognitive skills impairment: none, mild, moderate or severe; Q7 Wandering: trying to get to inappropriate places; Q8 Verbal: refusal of care, disruption, inappropriate language; Q9 Physical behaviour: threatening or inappropriate physical conduct; Q10 Depression: measured by a Cornell Scale for Depression (CSD); Q11 Medication: administering of medications; Q12 Complex health care (see Box 1.2 in Chapter 1).
Q13_C1 – Q14_C3	The ICD health codes for the Medical Diagnosis in ACFI based on the health codes used for the Aged Care Assistance Program (ACAP).
Reassessment Reason	Specifies the reason for the assessment.
Sex	Biological sex of the person (M, F).
Year of Birth	Used to calculate the person’s chronological age.
Source: AIHW 2016a .	

2.4. SDAC Data

The Survey of Disability, Ageing and Carers (SDAC)¹² is a national survey conducted by the Australian Bureau of Statistics¹³. This survey gathers information about people with disability, aged persons and their carers (ABS 2012a). It is perceived to be the most important source of national data on health and functioning of the elderly, including those in residential care

¹² Data used in this research come from the SDAC 2012 (Confidentialised Unit Record File; Re-issue 1).

¹³ In a current format the SDAC is conducted every 3 years. Previous surveys have been conducted in 2015, 2012, 2009, 2003, 1993, 1998 and 1981.

accommodation. Among the main advantages of SDAC is a relatively high level of sampling of households with elderly residents. This provides reliable information on aged care and disability situation in the general Australian population (AIHW 2012b). It is also noteworthy that SDAC does not reflect the actual usage of care services, but rather self-assessment disability status. Some of the shortcomings of the survey are overcome in this study by combining ACAP and SDAC (Chapter 5). Box 2.4 shows variables extracted from the 2012 version of SDAC survey that have been used in this study.

Box 2.4 Main variables in SDAC Data (2012)

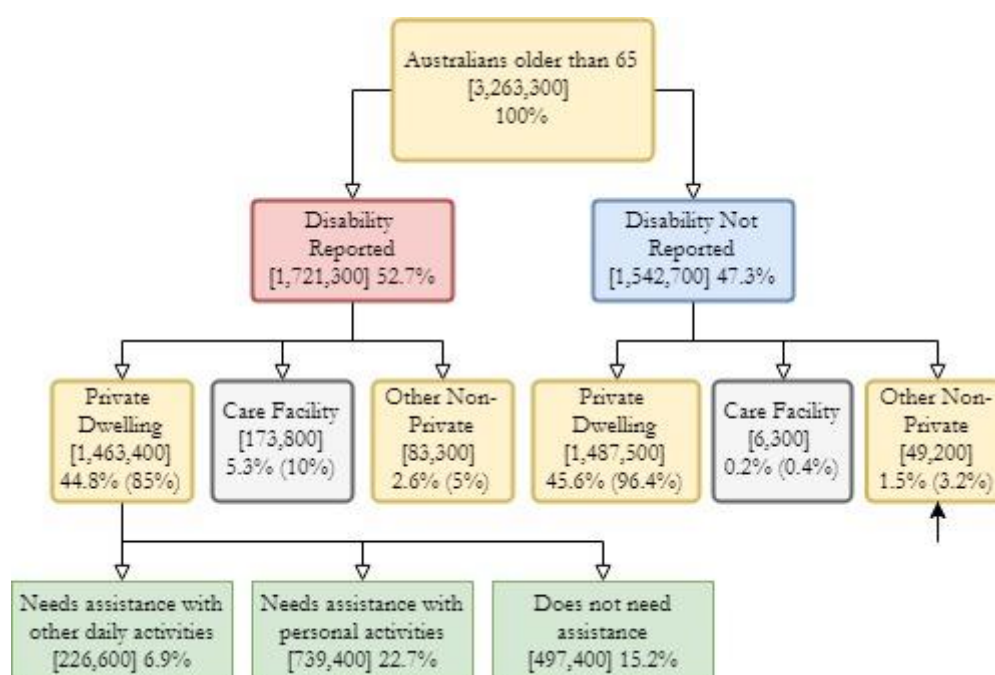
Age	The person's age in 5 year bands.
Carer Availability	Whether someone has been identified as providing regular and sustained care and assistance to the person.
Carer Co-residency	Whether or not carer lives with the person for whom they care.
Conditions	Conditions producing main disabilities.
Disability Status	Whether the person has a disability and/or a long-term health condition.
Disability Types	Specifies exact disabilities or their combinations.
Main Conditions	Code for each health conditions. Broadly comparable with the codes used for ACAP.
Sex	Biological sex of the person (M, F).
State	State or territory of usual residence.
Recipient ID	Or household ID number.

Source: [ABS 2012a](#).

As opposed to an unweighted ACAP unit record file, SDAC consists of weighted records. By the assignment of weights to each person, representing the probability of an individual being selected in the sample, it is possible to infer more accurate results for the entire population. Thus, weighted tabulations of persons in private dwellings are set using combinations of relevant variables. It is noteworthy that the robustness of the survey data in 2012 version is enhanced compared to previous rounds. Firstly, the sample size was increased compared to the 2009 survey and, secondly, the scope was extended to include primary carers identified by the care recipient, and not only by another person in the dwelling (ABS 2012b). Furthermore, the SDAC survey is subject to strict technical controls at all stages of data collection and editing, including a careful design of the questionnaire and reduction of errors. Finally, SDAC has been extensively used by modellers, policy analysts and other researchers in Australia. This is helpful as reassurance of this study's outcomes.

The Survey of Disability, Ageing and Carers (SDAC) was carried out by the Australian Bureau of Statistics in 1993, 1998, 2003, 2009, 2012 and 2015 (recently released), with the results available in unit record form. As already mentioned, this study relies on the results of the 2012 SDAC survey (released in November 2013). Almost until the end of this study, the 2012 version was the latest available SDAC release. Furthermore, this version of the SDAC survey is comparable with the other data sources used in this study (ACAP and ACFI) as they cover approximately the same period. The 2012 SDAC survey gave unit records for 77,570 persons and 122,382 disability conditions (Australian Bureau of Statistics 2014). Of the 77,570 person records, 10,362 were for persons in permanent residential care. The person records are weighted, allowing nationally representative totals to be estimated (Figure 2.4). Data manipulation procedures related to SDAC survey data, including derivation of the compatible SDAC needs for assistance codes, allowances for sampling variability and other techniques are described in more detail in each corresponding chapter.

Figure 2.4 Older Australians (by disability, living arrangement and need for assistance)



† These SDAC estimates have been rounded to the nearest 100 persons (rounding and perturbation may have affected the sum of sub-totals that may not equal totals).

‡ Other non-private dwellings comprise non-private dwellings apart from care accommodation, such as caravan parks and retirement villages.

§ 'Personal activities' comprise self-care, communication, mobility, cognitive or emotional tasks and health care.

¶ 'Other everyday activities' comprise reading and writing activities, transport, housework chores, meal preparation and property maintenance.

Source: ABS 2012b.

Figure 2.4 gives the estimates for older Australians subdivided by disability status, living arrangements and the SDAC needs for assistance with daily activities. Of the total population of older persons with disability, most remained in private dwellings (44.8 %), whereas just above 5% (173,800) lived in a care facility. It can also be seen that most older people who reported a disability and lived in private dwellings required some sort of assistance with daily activities. Expectedly, among those who lived in an aged care facility, the number who reported a disability was much higher than the number of people without disability, 173,800 and 6,300, respectively.

2.5. Data Problems and Limitations

Data sources on Australian aged care (i.e. ACAP, ACFI, SDAC) feature extensive and valuable information. However, there are currently no comprehensive data exclusively designed to ‘capture’ the entire residential aged care process. The National Aged Care Alliance (NACA 2015, p. 3) stated as a goal that *“every older person in Australia is able to live well, with dignity and independence, as part of their community and in a place of their choosing, with a choice of appropriate and affordable support and care services when they need them”*. To measure progress towards this goal, however, improvements are required in the recording and availability of administrative data. Reliance on several not entirely compatible data sources creates problems and sets limitations consequently affecting the ability to model, simulate or forecast the Australian system of aged care with precision. Data constraints listed in this chapter mainly relate to the following issues: *consistency* (i.e. in design and sequence of reporting), *comparability*, *reliability*, *missing information* and *the access restrictions*.

Consistency of data between various sources expands their research potential. Although ACAP, ACFI and SDAC have high standards of reporting, some limitations related to their joint use need to be acknowledged. Firstly, the term *“residential aged care home”* (RACH) in ACAP and ACFI is more restricted compared to the term *“cared accommodation”* in SDAC. Secondly, the disability categories are not completely standardized, but are broadly *comparable* between the data sets. In some cases, such as between ACFI and ACAP, the care needs are standardized and comparable. For example, the health code for the medical diagnosis in the longitudinal ACFI is based on the health codes used for the aged care assistance program (ACAP). The disease conditions in all data sets are coded according to the International Classification of Diseases (ICD-10)¹⁴. Where disability conditions are used in this study, new (transitional) variables will be calculated from the existing variables to bridge the gap between different data sets. Given the

¹⁴ World Health Organization, 2015.

present level of comparability between ACAP and ACFI data, follow-up of a person who went through an ACAP assessment and later entered residential aged care is technically possible, but very costly. An example of such efforts was the examination of *patterns in use in aged care* (PIAC study) using the AIHW data that was previously mentioned.

An additional problem stems from an imprecise *sequence of reporting* of the main events inside residential care. Reporting of the deceased residents might be inaccurate, as it is mainly derived from a recipient service discharge code representing death. Consideration of the values of a single variable from ACFI (Dead_Ind) may lead to the wrong conclusion. For instance, the value "N" does not imply that the recipient is not deceased as this value can mean that the most recent record of the person in care was "N" and that he/she died outside residential care. That is why the value of this variable should be in concordance with the "Deceased Date" variable. A degree of caution is needed in the analysis because this rule is not satisfied in all cases.¹⁵ In ambiguous situations, relevant variables are extracted from the tables with more accurate (up-to-date) information. For example, if the AIHW assessment data table contains more recent information than the AIHW recipient table, then the former table is used and *vice versa*. It is important to point out how tedious is the process of identifying persons entering and leaving residential care facilities. This required making references to the recipient, recipient service, service, provider and service type groups (labels). Also, it is noteworthy that the ACFI appraisals do not have to be completed until the end of the 8th week in care residence which may introduce some bias.

Reliability of data stems from the quality of reporting. It comes to light during the analysis of diseases such as dementia. Reliance on self-reporting is problematic in cases of dementia because a person's cognitive function can be impaired. The stigma associated with the disease may result in a person's reluctance to identify the condition (AIHW 2012b, p. 20). Therefore, self-reporting may lead to underestimation of less severe cases of dementia in the SDAC data. Also, some other sorts of underreporting may be present. For example, the ACAP national minimum data set captures information about people receiving a comprehensive assessment. Hence, information about those that received other sorts of assistance from a member of an ACAT may be omitted. However, the great advantage of using the ACAP and ACFI data is the rigorous process of data editing provided by the Australian Institute of Health and Welfare, including an explanation of many potential data problems. To some extent, reliability problems are caused by inappropriate implementation of the care assessment programs (ACAP and ACFI).

¹⁵ For example, if a recipient dies in hospital after 28 days of hospital leave the value of variable *Dead_Ind* may remain unknown, or if a recipient dies on leave after 28 days it will not be known (AIHW 2014).

For instance, the ACFI scores for different care domains within residential care may be unreasonably inflated by the assessors themselves. This coincides with the recent report that a *“concerning number of incorrect claims and unaccounted-for growth in spending in complex health care are creeping into the system”* (Ley & Wyatt 2016, p. 1). Such actions increase the costs that final users pay for their care arrangements and lead to the rapid increase of government subventions in the aged care sector.

Missing information may also cause problems in the data interpretation and analysis. The Aged Care Assessment Program (ACAP) data could be extended to include more detail on individuals who require additional support. Although the ACAT assessments are needed for residential or respite care in an aged care home, as well as for home care packages and transition care, little or no data are currently recorded on: individuals living with cognitive impairment, those from culturally and linguistically diverse backgrounds (other than the country of birth and language spoken at home), people experiencing financial or social disadvantage, those at risk of becoming homeless, parents separated from their children and people of diverse sexual orientation. In some cases, indigenous status, as an identification variable, was deliberately dropped from the provided unit record files for confidentiality reasons. As many diverse groups are small percentages of our population, obtaining data on them by survey can be costly and uncertain. Administrative data, such as ACAT or residential care admissions, thus need to record individual differences. In addition, independent surveys of personal experiences are needed as well as the establishment of better linkage between ACAP and ACFI data.

Finally, *limited access* to data poses a problem for research on aged care. Subject to privacy concerns, all the administrative and survey data should be publicly available. This appears to have been the aim of the Productivity Commission (2011) in recommending a national clearinghouse for aged care data. Furthermore, as stated in the strategic objectives (NACA 2015, p. 4), *‘consumers and informal carers have access to information, advice and advocacy to support the exercise of choice, and to a service system that is easy to navigate, provides accurate and timely information about service availability and quality, and addresses the diversity of needs’*. For the purposes of this research, the AIHW has been very helpful in enabling access to specific segments of aged care data. However, the procedures of data request submission were prolonged and confusing. In some cases, the legal procedures for data provision were not clear enough or an ambiguity existed between the provider’s procedures (AIHW) and guidelines provided by the Department of Health. Unfortunately, the Productivity Commission’s 2011 recommendation, that the National Aged Care Data Clearinghouse (NACDC) should link databases and invest in de-identification of new data, has not yet been implemented.

Improvements in data availability can take determined effort, and a lot of time. The last chapter of the thesis discusses some of the improvements that could be made at a reasonable cost.

2.7 Confidentiality and Ethics

The research conforms to the highest ethical and confidentiality standards of the *National Statement on Ethical Conduct in Human Research* (NHMRC 2015). The *Human Research Ethics Committee* of the *Australian National University* (researcher's host institution at the time of data delivery) provided a special approval (under protocol 2015/433) to cover for all possible ethical concerns by the data providers. It is noteworthy that the secondary data used in this research had already required a consent obtained by the data providers from the original participants. Therefore, the analysis also complies with all the conditions specified by the data providers, the *Australian Bureau of Statistics* (for SDAC) and the *Australian Institute of Health and Welfare* (for ACAP and ACFI).

The data used for this research comes entirely from the secondary sources (Australian Bureau of Statistics and the AIHW National Aged Care Data Clearinghouse databanks). Parts of the data in the unit record form are used with special consideration and precaution. The administrative and personal identifiers are omitted to comply to the high standards of protection and to avoid breaches of confidentiality. The details which might have helped to identify an applicant or carer, such as names, addresses or date of birth, as well as unreliable items, like indigenous status, have been omitted. In their report, AIHW (2010 p. 1) stated that the major problem in many health-related data collections is the under-identification and under-reporting of Aboriginal and Torres Strait Islander people. The extent of underreporting might have been well above 10% in some cases (ibid. p. 2) and may have caused serious biases in the analyses, especially because Indigenous people make up only a small share of the total population. For example, on 30 June 2015, only a tiny minority of people in permanent care identified themselves as Aboriginal or Torres Strait Islander (1% of their total number in Australia), compared with 3% of Australians overall (AIHW 2016d).

In practical terms, personal details used in the analyses may only include sex (gender), age (in 5-year bands or as a year of birth) and state (territory) of residence. Specific system codes (SPARC), in theory, can be used by the data custodians to link the same entry records from different tables (boxes) of the clearinghouse. Such safety codes serve to prevent other unauthorised users from establishing the identity of an individual. Regardless of the low risk, the results of this study are stored and disclosed with special precautions.

2.8 Methodological Framework

The remainder of Chapter 2 gives an outline of methodologies employed in this research, with a focus on the logic and strategy of analytical approaches. The suggested methods of statistical modelling, estimation and data utilization stem from the research questions defined in Chapter 1. Therefore, the main aims are translated into a detailed recipe of operations, keeping in mind the type of available data, feasibility, costs and theoretical underpinnings. In this chapter, a brief explanation of the main methodological steps is provided. Each of the central research chapters (4-7) uses a slightly different approach due to data limitations and specific aims. Therefore, each chapter also contains its own methodological introduction and a brief theoretical framework together with the description of specific procedures for data preparation and processing. These detailed instructions provide sufficient information that allow other researchers to conduct the same analysis. If they were to collect and analyse data using the provided guidelines and follow other recommended procedures, they would reproduce the same results.

This study is designed to extend our understanding of pathways of residential care for older persons in Australia. As outlined before, the logic of the analytical approach is strictly conditional on the objectives arising from the research questions (see 1.7). From the perspective of methodology only, these aims could be broadly grouped into four sections: (1) Modelling the residential aged care process (trajectory, pathways), including an estimation of the probabilities of aged care events and focusing primarily on entries to and exits from residential aged care; (2) Examination of the dynamics of change in care needs within residential aged care, and (3) Analysis of the potential usefulness of Australian data for aged care modelling and for the construction of a projection model of residential aged care demand.

2.8.1 Modelling Residential Aged Care Process

The first section of the methodological framework covers modelling of the residential aged care process in Australia from an individual perspective. This process can be perceived as a person's pathway or a trajectory towards residential care. In this study, I will attempt to identify personal characteristics of older Australians associated with each aged care event on this trajectory. Therefore, this first section will include modelling of the assessment process (applications and approvals), entry into permanent residential aged care and separations or exits from such care. Statistical models presented in this study give estimates of the probabilities of these key aged

care events. Logistic regression in various forms was used to estimate odds ratios of these events and actions, and statistical associations between residential care events and older individuals' personal characteristics. In short, the following five steps (or uses to be made of data) have been set statistically to approximate the residential aged care process:

1. Comparing details of applications for permanent residential care (ACAP data) with similar details for the general population (SDAC data) provides logistic models of the probability of applying for approval for permanent residential care;
2. Comparing approvals (ACAP data) with applications made (ACAP data) provides models of the probability of applications for residential care succeeding;
3. Comparing admissions to residential care (ACFI data) with applications granted (ACAP data) will provide models of granted applications resulting in admissions;
4. Comparing aged care separations with residents (ACFI aggregate data) will provide models of aged care separations;
5. Using longitudinal ACFI data to directly estimate transitions between different care needs, life expectancies and exit rates.

In the *first stage* of the research, the logistic models of the probability of applying for approval for permanent residential aged care are constructed. Comparison of the details of two data sets: ACAP (data on applications) and SDAC 2012 (survey data) serve as the basis for modelling. The identification of broadly similar variables in SDAC and ACAP was necessary for the approximation and comparison of the data sets. However, prior to this first stage, the SDAC survey was separately analysed to identify which predictor variables are associated with a higher likelihood of being in residential care. This was possible as SDAC surveys both the population inside care facilities and those older people in the general population.

In the *second stage*, models of the probability of the successful applications are constructed through the comparison between granted applications (or approvals) for permanent residential care and applications made. The estimates in this stage should have a high degree of accuracy because they are derived from a single administrative unit record file (within ACAP comparison) that included the entire population of older Australians that applied for aged care assessment in the selected period.

In the *third stage*, the models of granted applications resulting in care admissions are created. The basis of such models is the comparison between admissions to care (ACFI data cubes) and applications made (ACAP data). As already outlined, there is no link between ACAP and ACFI data which makes modelling of this stage of care pathway very difficult. Consequently, due to a relatively low number of common variables between ACAP and ACFI data (basic sociodemographic indicators and location) and because of the absence of full information on take-up of permanent care for approved persons, it is reasonable to expect a lower level of accuracy of these statistical models.

In the *fourth stage*, the regression models of exit from residential aged care were derived using matching between resident and exit summaries (both taken from ACFI data cubes). The number of exits were divided by the number of aged care residents for each combination of factors (demographic variables and care needs levels). The force of exit was then estimated, by taking the logs of the estimates and fitting a linear regression model. As will be discussed in Chapter 5, these models are based on only a limited number of variables. More detailed models of exit from residential care, based on the longitudinal ACFI unit record files, will be derived in the next stage.

Finally, in the *fifth stage* of modelling, the aged care funding instrument (ACFI) longitudinal data was used to achieve the three objectives: (1) directly estimate the probabilities of transitions between different levels of assistance needs; (2) estimate the life expectancy in residential care for each type and combination of assistance needs; and (3) derive mortality estimates. These data, that cover the entire Australian population inside institutional aged care, enabled more detailed analysis of the effects of assistance needs on exit from residential care.

The methodological steps listed in this five section (stages) of modelling of residential aged care process are further discussed and demonstrated in Chapters 4, 5 and 7.

2.8.2 Modelling Care Needs in Residential Care

The second section, in terms of methodologies, focuses on the dynamics in residential aged care facilities, including changes in care needs levels. It is now a well-established proposition that these assistance needs are the most important indicators of an individual's health condition, and thus, good predictors of exit from aged care (see 4.4.2). Getting accurate insights on how quickly these needs for assistance change is important for government subsidies and for providers of care. Initially, in Chapter 4, this complex task was initiated using a relatively simple multi-state

model of transitions between assistance needs levels. This model was constructed using the available data on aged care entrants (admissions), data on residents and the estimates of exit rates from residential aged care. With a few adjustments (see 4.6), this multi-state model shows estimates of the transition probabilities between assistance needs levels (ADL, BEH and CHC domains) as well as the probabilities of exit from residential care. Furthermore, the transition assumptions were adjusted to match the initial ACFI data on admissions, residents and exits from this type of care.

A somewhat similar method of modelling of care needs, in this case using the multi-state approach (developmental tables or projection arrays), is employed in one of the later chapters (see 6.3.5 and 6.4.4). The smoothed SDAC needs prevalences, together with the approximate mortality rates derived from the ACFI data cubes (NACDC data) were used to estimate transition rates between 12 assistance needs levels. Optimization of the transition rates was conducted using six development tables, one for each physical care, behavioural care and complex health care, separately for each sex. These tables start with the prevalences of persons in each of the four levels for the domain at the initial age, and project forward a year at a time, using the admissions, deaths and transitions between the four levels during the year to calculate the prevalences at the start of the next year of age. As a different form of multi-state approach (analogue), two multi-state models were created, projecting for each sex the numbers of persons at each age with each of the 64 combinations of needs levels. Exit rates were based on a logistic model fitted to the most recent year of exits from care. The projections were made for 10 years, and transition parameters chosen to minimise the square of the differences between the numbers of persons at the start and end for each age and needs combination.

Finally, from the perspective of accuracy, the most reliable transition rates between individuals' assistance needs levels are those rates directly estimated from the longitudinal ACFI data. The direct estimation of the transition rates also helped in deriving the life expectancies for each combination of residents' needs for assistance (see 7.4.3). These parameters, ideally estimated from longitudinal data sources, are necessary for a projection or a microsimulation model (Li & O'Donoghue 2013). Unlike some other countries where the availability of aged and healthcare data is relatively limited (Cole et al 2015), Australia has rich administrative data sources with plenty of information on disability and health status of persons in care arrangements. Therefore, there is a solid foundation for construction of projection models of the demand for residential aged care beds. Yet, such quantitative models, as previously underscored, have been used rarely to approximate health transition and mortality after entry to residential care.

The steps listed in this section are further discussed and developed in Chapters 4, 6 and 7.

2.8.3 Examination of Australian Data

Are enough high quality aged care data available in Australia? Can these data allow construction of quantitative models of residential aged care pathways or enable projections of the demand for residential care? In this research, various quantitative methods will be used to examine the possible usefulness of the Australian aged care data for modelling of residential care trajectories or for projection of residential aged care demand. For example, the transition probabilities between different levels of care needs, derived from both cross-sectional and longitudinal data, are crucial pieces of information for modelling of individual aged care pathways and for deriving the optimal assumptions for the projection model. Together with mortality rates approximations derived from combined data sets, these transition probabilities between assistance needs (i.e. between SDAC care needs levels) are key in deriving the assumptions of persons who may enter or leave residential care.

For practical reasons, on some occasions in this thesis a multi-state methodology was used. Such a method served as good proxy to assess potential uses of aged data for a projection or micro-simulation. Both the multi-state approach and microsimulation use similar or the same assumptions and potentially give the same results. The advantage of multi-state projection models is that they do not suffer from random variations that are characteristic of microsimulation models (i.e. random generation of the events). In the absence of such random variations, it is easier to search for optimal assumptions that fit available data. Finally, some recommendations are given in the concluding chapter on the value and future use of the Australian aged care data. Based on the analyses conducted in this study, it is also suggested how data can be used in construction of a projection model of the Australian aged care system.

This analysis of the methodological framework has already revealed that Australian aged care data will be used in multiple ways throughout this study. The current state of these data, primarily in terms of fragmentation and inconsistency, led to the implementation of some “novel” methods that will be demonstrated in the later chapters of the thesis. However, before proceeding to the chapters that model residential care trajectory from the micro-perspective (4-7), it is necessary to get some insights about the dynamics of aged care from the macro or aggregate perspective. Such a view is especially important in the light of government policies aimed at rebalancing the aged care system more towards home and community based care.

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3. Dynamics of the Residential Aged Care System

Chapter 3 sets the context of how the residential aged care system in Australia has worked over the last years. The macro-level analysis of the aged care system presented in this chapter serves as a stepping stone towards the micro-level analysis and modelling of residential aged care process (Figure 1.10). Therefore, the main aim is to provide insights into some interesting subsets within the system (i.e. differences between states and territories) and within the population (i.e. between males and females, persons with short stays and those with longer stays, or between persons with lower and higher ACFI levels on admission), and to inform the more complex analysis and statistical modelling. Several important features of the system are briefly considered and the order in which the analyses are presented is purposeful:

1. The areas of change in the system

- Provision of services
- Geographic differences

2. Changes in residents

- Use of services
- Rates of admission

3. The areas of stability in the system

- Separations
- Length of Stay (LOS)
- Turnover
- Care needs of residents (ACFI)

Because of the soaring costs, uncertainties about the volume of inflow of new nursing home residents and prolonged duration of stay of some residents, the residential aged care system occupies a central place in the Australian aged care agenda. This is not unexpected as many other developed countries with strong trends of structural ageing face similar challenges (Swartz 2013). The features of the system stated above, therefore, need to be carefully considered. For example, *Section 4* of the Productivity Commission's *Aged Care "Living Longer Living Better" Act* (Australian Government 2013) underscores that the following key issues need to be addressed: (a) whether unmet demand for residential and home care places has been reduced, (b) whether the number and mix of places for residential care should continue to be controlled or (c) whether further steps could be taken to change key aged care services from a supply driven mode to a consumer demand driven model.

The timescale of the analysis in this chapter is set between 2001-02 and 2012-13. This period is essentially under the same policy settings, leading up to the *Productivity Commission* review, but before “*Living Longer, Living Better*” reforms were implemented (passed into law on 28 June 2013), and before the “*High and Low*” level care distinction in residential aged care was removed (Australian Parliament 2013). Furthermore, this period is relevant for the analysis undertaken in later chapters because most of data used in modelling of care pathways (SDAC, ACAP and ACFI) dates from this period. More recent figures are given where available.

3.1. The Areas of Change in the System

3.1.1 Provision of Services

Provision of residential aged care services is discussed first. The level of provision is important as it sets the limits of the system being analysed. These limits are internally controlled by the Australian Government. The Government allocates new aged care places every year in each state and territory to meet the demand, ‘*having regard to the national planning benchmark, population projections provided by the Australian Bureau of Statistics (ABS) and the level of current and future service provision*’ (AIHW 2012a p. 8.). The Government’s aim is to maintain a national target level of operational aged care places across the programs set by the *Aged Care Act* (Australian Government 1997; 2013). The target ratio is still 113 places per 1,000 persons aged 70 years and over (Department of Health and Ageing 2010; AIHW 2011b, 2012a), although this might not seem to be good practice now, given the fact that the large baby boom cohort is entering the young end of this age range.

The number of operational residential aged care places has been on the increase throughout the entire period from 2001 to 2013 (Figure 3.1.; Table 3.1)), reaching 189,761 at 30 June 2013. The increase continued in 2014, after the Productivity Commission’s reforms were introduced, with 192,834 places available in residential care at 30 June 2014. If all community services were added, the total number of aged care places in 2014 sums up to 263,788. The trend of increase in the number of operational home and community aged care places (with EACH/EACHD) is also visible in the same period, reaching 66,954 operational places at 30 June 2014.

Table 3.1 Number of operational residential aged care, CACP, EACH/EACHD and TCP places from 30/06 2001 to 30/06 2014

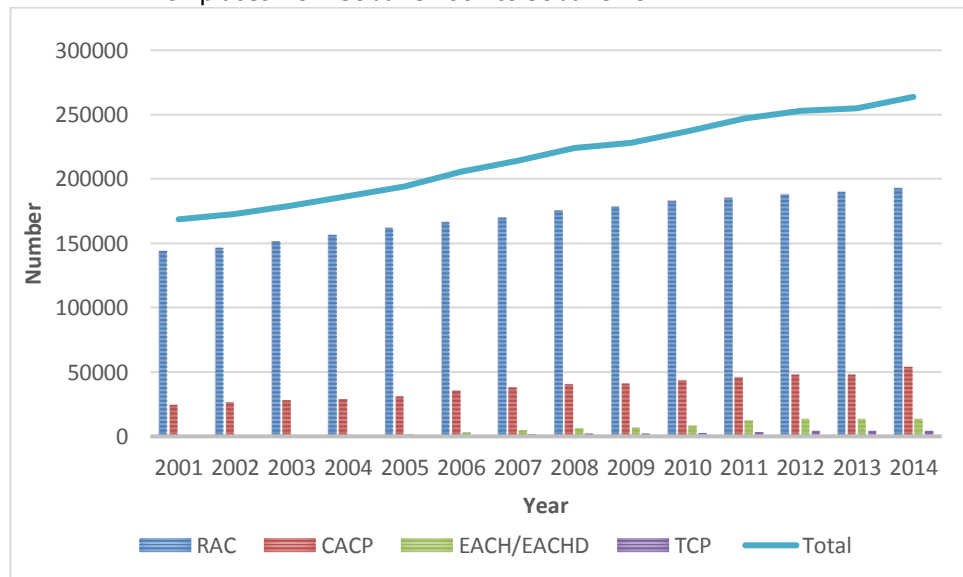
Year	RAC	CACP	EACH/EACHD	TCP	Total
2001	144013	24629	0	0	168642
2002	146268	26425	0	0	172693
2003	151181	27881	225	0	179287
2004	156580	29063	860	0	186503
2005	161765	30973	1673	0	194411
2006	166291	35383	3181	595	205450
2007	170071	37997	4573	1609	214250
2008	175472	40280	6240	1963	223955
2009	178290	40859	6514	2228	227891
2010	182850	43300	8167	2698	237015
2011	185482	45777	12145	3349	246753
2012	187941	47949	12936	4064	252890
2013	189761	48087	12971	4029	254848
2014	192834	53954	12964	4036	263788

† An operational place is one which is either occupied or available for the provision of aged care to an approved care recipient; EACH – Extended aged care at home package; EACHD – Extended aged care at home for dementia patients; CACP – Community aged care package; TCP – Transitional care place.

‡ Numbers for 2013 and 2014 vary between AIHW and DSS reports.

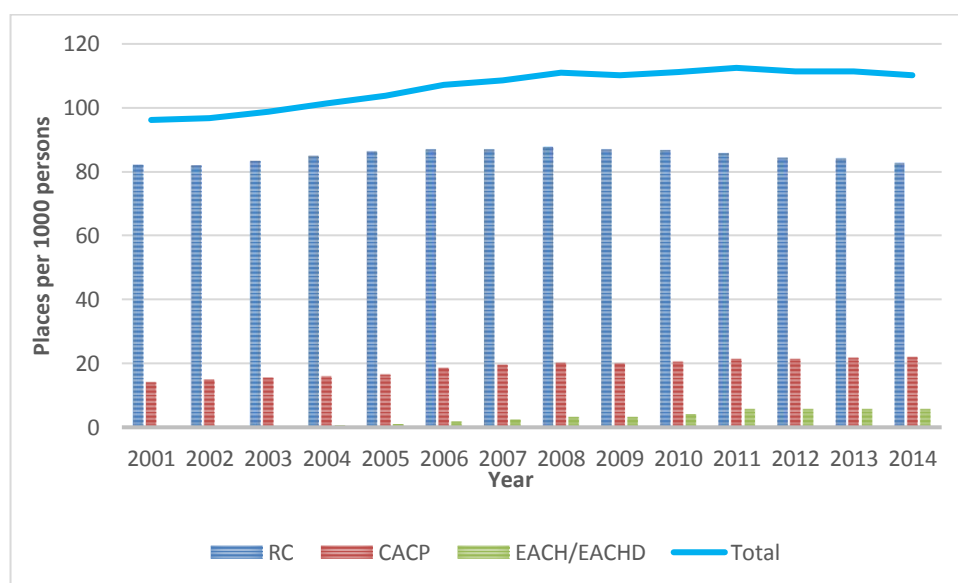
Sources: AIHW 2012a; DSS 2014c

Figure 3.1. Number of operational residential aged care, CACP, EACH/EACHD and TCP places from 30 June 2001 to 30 June 2014



Sources: AIHW 2012a; DSS 2014c

Figure 3.2. Aged care places per 1000 persons aged 70+, 30/06 2001 to 30/06 2014



Sources: AIHW 2012a; DSS 2014c; ABS 2013

The next aspect to look at is the provision of operational places in respect to the number of persons who are more likely to need aged care services. In its current form, the provision of residential aged care places is aligned with the distribution of the population aged 70 years and over. The estimated resident population suggests that there were 2,336,107 people aged 70 and over at 30 June 2014 (ABS 2014a). The provision ratio shows the number of places in different aged care settings available per 1,000 people aged 70 and over (Figure 3.2). On 30 June 2014, the provision ratio for residential aged care was 82.7, a slightly higher value compared with 30 June 2001 (82.2). A year later, on 30 June 2015, the ratio dropped to 81.1 (ACFA 2016). However, the provision ratio is lower than in 2008 when it peaked at 87.7 residential aged care places per 1,000 people aged 70 or more. During the same period, the number of operational places (or new beds) in residential aged care increased markedly (Figure 3.1.). The Aged Care Funding Authority (ACFA) is expecting that this trend will continue (ibid. 2016). At the same time, the ratio of operational places in community aged care arrangements per 1000 persons aged 70 and over increased prominently from 14.0 in 2001 to 21.2 in 2011, a rise of more than 50 per cent in a ten-year period (Figure 3.2.). To provide a potential explanation for the most recent changes in ratios between different types of aged care arrangements and to understand the current aged care policies, it is necessary to examine the historical processes and reforms in the Australian aged care system.

Aged Care Policies in Australia: An Overview

The focus of aged care policy has changed several times since the 1940s. These changes sometimes followed political shifts that altered the context of policy making. Although the Australian Government commenced funding of community care in 1956, aged care policy for the next two decades emphasized residential aged care (Henderson & Kaplan 2008). The absence of plausible assessment criteria for admission to nursing homes enabled many, in today's terms, 'inappropriate' admissions (Lefroy 2001). It is estimated that, by 1985, nearly 90% of overall aged care funding was directed to residential care (Howe & Kung 2003) which led to a fiscal crisis and prompted the 1985 Aged Care Reform (Henderson & Kaplan 2008). A series of targeted interventions, including tighter conditions of entry to nursing homes, were designed to deinstitutionalize the care of older Australians and shift aged care policies toward home and community care (Gibson 1998).

The most recent substitution¹⁶ of residential care with home and community care, therefore, is not just a 'coincidental' trend but the continuation of a policy that aims to get the residential care provision ratio down to 80 and the community care provision ratio up to 45, within a total ratio of 125 places per 1,000 persons aged 70+ by 2021-22 (Kendig & Duckett 2001; Howe 1999). Most of the decline in the provision ratio (15 beds per 1,000) was achieved by 1998, and in the early 2000s, was followed by a slight recovery. This tendency can be seen in one of the earlier reports which states that between 1985 and 1997, nursing care places per 1000 persons 70 years of age and older decreased from 67.2 to 47.8, while for hostels there was an increase from 32.3 to 41.7 (Steering Committee for the Review of Commonwealth and State Service Provision 1988). During that period, hostels included lower levels of residential aged care, whereas nursing homes accounted for high-level care. Although the distinction between low and high care has been repealed, the growth of community services at a greater rate than permanent aged care clearly shows the direction of aged care policies in Australia. The decline has been fuelled by a common perception that *"the investment in community care could be funded by necessary restrictions on the residential aged care sector"* (Kendig & Duckett 2001 p. 9).

Home and community care for older people has drastically expanded since the establishment of the consolidated Home and Community Care program (HACC) in the mid-1980s (McCallum 2015;

¹⁶ A substantial body of evidence has pointed out that many OECD countries are working to dramatically slow or halt the growth of residential aged care expenditure (Swartz 2013).

Dew & Griffin 2002; Gibson 1996; Healy 1990). More precisely, the HACC program was created in 1984, but was not started until 1985 when *the Home and Community Care Act* united a range of separately funded aged care programs aiming to prevent premature or inappropriate entry to nursing homes (Wells & Regan 2013; Productivity Commission 2013). Recently, this shift from residential care to community and home care has further accelerated because of the realisation that non-institutional aged care may be more effective and affordable compared with residential care (Henderson & Caplan 2008). Some researchers, however, found that this substitution of care arrangements does not necessarily guarantee lower costs of aged care (see Campbell et al 2016 in the paragraph below). However, this substitution of institutional care with home and community care arrangements is likely to continue because the non-institutional care settings were found to be preferred by older Australians and their families (Broad et al 2015; Dow et al 2013; Henderson & Caplan 2008).

Not surprisingly, the continuation of this substitution trend is also observed in the period from 2001 to 2014. For example, in 2004 the Department of Health and Ageing (DoHA) launched a new strategy for community care called “*The Way Forward*”, aiming to improve coordination and consistency across the aged care programs in Australia (DoHA 2004). Home and community services programs were initially focused on enabling older Australians who were healthier and more independent than those in nursing homes to stay at home. However, a range of modern and integrated aged care packages have been implemented to allow older Australians to remain in their homes even when their needs for care are equivalent to persons in nursing homes (AIHW 2011c). One example is the HC4 home package which is a long-term option for older people with complex care needs who decided (or their family decided) to stay at home. Compared to the HC2¹⁷ standard home package, the HC4 includes nursing care and provision of more hours of care per week which is necessary in cases of dementia or other complex conditions (DoHA 2013). Similarly, it is generally accepted that many in-hospital procedures can be replaced with modern medical therapeutics and diagnostics, allowing the concept of ‘Hospital in the Home’ (Caplan et al 2012).

Nonetheless, the extent to which some home and community care arrangements can substitute for permanent institutional care remains unknown. In some instances, high-intensity community aged care could be more expensive than residential care. One reason why non-institutional care

¹⁷ From July 2013, what was previously called Community Aged Care Package (CACP) has become Home Care Package 2 (HC2). The HC2 supports older Australians to stay at home with up to 14 hours of care per week (6 on average). This assistance includes basic daily activities, such as bathing, meal preparation, gardening and transportation (DoHA 2013).

does not necessarily limit residential aged care spending is that many people who could live on their own without going into residential care would be interested to get home and community care if it were available (Campbell et al 2016 p. 58; Weissert & Frederick 2013). However, in cases of very frail people with complex assistance needs, residential care might be more feasible unless low-cost labour is available or great burdens are placed on the family (Colombo et al 2011). To sum up, the findings in this chapter show that the policy of preventing inappropriate or premature entry to residential aged care has been present for a long time in the Australian aged care agenda (Campbell et al 2016), even though Australia is not an exception (Muir 2017; Genet et al 2013; OECD 2013; Mot et al 2012; Allen et al 2011).

Annual fluctuations in the ratio of aged care places per 1000 persons aged 70 or over (Figure 3.2) are not uncommon. The reasons are both internal and external. Bed approvals granted in the *Aged Care Approval Rounds* vary and new beds usually come on line 2-4 years later. On the other hand, various external factors such as the dynamics of the population (eg. larger cohorts of people reaching specific ages), changes in life expectancy or disability patterns can increase or decrease pressure on the aged care system. When considering the design of new aged care policies, it is crucial to anticipate future changes, for example, the entry of the baby boom cohort into residential aged care. However, it is possible to speculate that the baby boomers will have a downward effect on this ratio, at least in the short term.

Despite the Government's efforts to reduce the residential aged care provision ratio to 78 places by 2021-22, the structural ageing of the Australian population will likely prompt further increase in the number of residential places (ACFA 2016, p. 116). However, the effect of the baby boomer cohorts on the future provision of operational places in nursing homes is not so predictable. The baby boomers will live longer than generations before, and at the same time they will be more exposed to the risk of needing aged care at some time (Cullen 2007). Because of the current accumulation of material wealth, more people in these generations may be able to afford high-quality home care, but the increasing incidence of diseases such as dementia (Brodaty & Cumming 2010) could limit their choices and direct them to permanent aged care. For this reason, it is important to accurately measure life expectancies and transitions between different levels of assistance needs in the population.

3.1.2 Geographic Differences in Provision Ratios

Australia is a large continent with a relatively small and unevenly distributed population. Provision of residential aged care places, due to high costs, should be sensitive to the distribution

of its users. Therefore, if data enables, efforts to model residential care entry should include a consideration of geographic differences. Ideally, smaller geographical units, such as those at a level of postcode could be used to compare the demand and supply side of the aged care system. For the purposes of this study, such a detailed geographical information has not been supplied by the data providers due to confidentiality concerns. The Australian states and territories, although very large spatial units, may still be a statistically significant factor in the process of entry to residential aged care. The availability of aged care services, due to factors such as remoteness, might well affect the waiting time before a person is admitted to residential care or these factors may re-direct an older person towards community care arrangements.

Looking at the geographical distribution of older Australians aged 70 and above, we can see that a staggering 80% lived in just three states on 30 June 2014. Most of them, around 35%, lived in New South Wales, followed by Victoria (25%) and Queensland (20%).¹⁸ Only around 1% lived in the Australian Capital Territory and about a half per cent lived in the Northern Territory. The official statistical reports, such as those regularly published by the Australian Institute of Health and Welfare, show that the geographical distribution of the population aged 70 and over in Australia has remained relatively stable over time (AIHW 2012a).

The total number of operational places in residential aged care facilities follows the geographical distribution of older Australians. On 30 June 2014, approximately 35% of the total operational residential care beds were in New South Wales, followed by Victoria (26%) and Queensland (18%) (Table 3.2). The Australian Capital Territory (ACT) had just above 1% of the total residential aged care places and the Northern Territory only 0.34%. It can also be seen that those states and territories with large tracts of remote areas (Northern Territory, Western Australia, Queensland) had a higher share of care places allocated to home and community aged care. The Northern Territory, for instance, had 1.57% of the total Australian home and community care places, a figure almost 5 times higher compared to its share of the total residential care beds. Unlike New South Wales and Victoria, Queensland and Western Australia, with many indigenous people living in remote locations, had a larger share of the operational community and home care places compared with their share of residential care places. These trends reflect the Government's considerable efforts to provide *"tailored and culturally appropriate care close to the homes, families and communities of older Aboriginal and Torres Strait Islander people"* (AIHW 2012a p. 15).

¹⁸ Australian Bureau of Statistics projection for 2014 by states and territories (ABS 2013).

Table 3.2 Total number of all operational aged care places on 30 June 2014

State & Territory	Residential Care		Home & Community Care		Transitional Care		Total Aged Care	
	No.	%	No.	%	No.	%	No.	%
NSW	66,780	34.63	21,133	31.56	1,378	34.45	89,291	33.85
Vic	49,921	25.89	16,039	23.96	1,000	25.00	66,960	25.38
Qld	34,208	17.74	12,817	19.14	733	18.33	47,758	18.10
WA	16,238	8.42	7,784	11.63	346	8.65	24,368	9.24
SA	18,077	9.37	5,273	7.88	347	8.68	23,697	8.98
Tas	4,880	2.53	1,677	2.50	109	2.73	6,666	2.53
ACT	2,073	1.08	1,178	1.76	58	1.45	3,309	1.25
NT	657	0.34	1,053	1.57	29	0.73	1,739	0.66
Australia	192,834	100.0	66,954	100.0	4,000	100.0	263,788	100.0

Source: Department of Social Services 2014c.

Table 3.3 Provision ratios by state and territory on 30 June 2014

State & territory	Residential Care	Home & Community Care	Transitional Care	Total Aged Care
NSW	84.5	26.7	1.7	112.9
Vic	84.1	27.0	1.7	112.8
Qld	78.8	29.5	1.7	110.0
WA	74.4	35.7	1.6	111.6
SA	91.5	26.7	1.8	120.0
Tas	80.0	27.5	1.8	109.2
ACT	70.6	40.1	2.0	112.7
NT	76.4	122.5	3.4	202.2
Australia	82.6	28.7	1.7	113.0

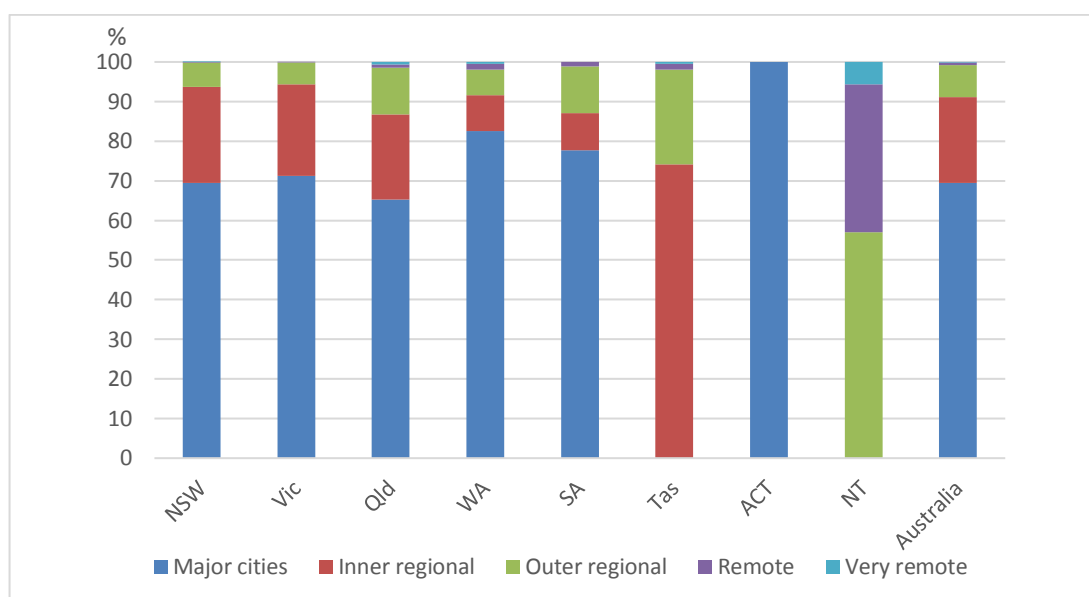
Source: Department of Social Services 2014c.

Because of the uneven spatial distribution of older Australians and some specific needs of remote communities (Bell & Cooper 2016; Department of Health & Ageing 2011), the provision ratios of operational aged care places vary markedly between the states and territories. On 30 June 2014, South Australia (91.5%) and New South Wales (84.5%) had the highest residential care provision ratios, whereas the Northern Territory (76.4), Western Australia (74.4) and the Australian Capital Territory (70.6) had the lowest (Table 3.3). The combined aged care ratio (all types of places) in the Northern Territory (202.2) was by far the highest compared to any other jurisdiction which is related to “*the higher provision of community care in remote and Indigenous communities*” (AIHW 2012a p. 15). For example, the provision ratio for the home and community care services on the national level was just 28.9, compared to an astonishing 122.5 in the Northern Territory.

In terms of remoteness on the national level, on 30 June 2014, approximately 70% of the total operational places in residential care were in the major Australian cities, just above 20% in the inner regional areas and roughly 10% in the outer regional areas (DSS 2014c). The remote and very remote areas of Australia had only about 1.4% of the total nursing home beds altogether. This is a very unfavourable level of care provision because, compared to the cities, older persons are overrepresented in remote regions (Bell & Cooper 2016). Moreover, the same remote tracts of rural territories make up a large share of Australia's most disadvantaged areas (Winterton & Warburton 2011; Alston 2007). Similarly, others have argued that the older residents of rural towns outside the regional centres may face more problematic futures in terms of healthcare and aged care service provision. For example, Argent and his colleagues suggested that following decades of demographic decline and public and private sector service withdrawal, many remote areas of Australia now lack anything but the most basic health and aged care services (Argent et al 2016 p. 152). These authors have also argued that the socioeconomic differentials between remote areas and cities (i.e. discrepancies between cities and rural areas in asset values, inability of rural residents to liquidate their housing assets etc.) may hinder mobility of older Australians towards the areas with adequate levels of aged care provision (ibid. 152).

Figure 3.3 shows the distribution of the operational residential aged care places across the states and territories, by remoteness. Evidently, the within-state distribution of nursing home beds by remoteness corresponds with their distribution by remoteness observed on the national level. Except for the Australian Capital Territory (ACT), which was classified as a major city, the share of residential care beds located in the major cities was the highest in Western Australia (83%), followed by South Australia (78%), Victoria (71%) and New South Wales (69%). The same figure also reveals that the city of Darwin in the Northern Territory was classified as an outer regional area whereas Tasmanian towns were included as inner regional areas.

Figure 3.3 Proportion of operational places in residential aged care by remoteness (States & Territories) on 30 June 2014



Source: Department of Social Services 2014c.

3.2. Changes in Residents

3.2.1 Patterns of Use of Residential Aged Care

Table 3.4 Permanent residents of residential care at 30 June, by age group, 2001–2007

	Number						
	2001	2002	2003	2004	2005	2006	2007
<65	5,948	5,984	6,073	6,240	6,483	6,562	6,467
65-9	4,237	4,317	4,389	4,439	4,613	4,705	4,840
70-4	9,368	8,999	8,783	8,720	8,503	8,344	8,298
75-9	18,450	18,286	18,457	18,454	18,614	18,591	18,005
80-4	28,599	29,633	31,198	32,912	33,593	33,436	32,945
85+	67,402	69,258	71,397	74,229	77,285	80,099	82,871
Tot.	136,005	138,479	142,300	146,998	151,096	153,743	155,433
	%						
	2001	2002	2003	2004	2005	2006	2007
<65	4.4	4.4	4.3	4.3	4.3	4.3	4.2
65-9	3.2	3.2	3.1	3.1	3.1	3.1	3.2
70-4	7.0	6.6	6.3	6.0	5.7	5.5	5.4
75-9	13.8	13.4	13.2	12.7	12.5	12.3	11.7
80-4	21.3	21.7	22.2	22.7	22.5	22.0	21.5
85+	50.3	50.7	50.9	51.2	51.8	52.8	54.0
Tot.	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: AIHW 2012a.

Table 3.5 Permanent residents of residential care at 30 June, by age group, 2008–2014

	Number						
	2008	2009	2010*	2011*	2012*	2013*	2014*
<65	6,606	6,509	6,482	6,385	6,190	6,217	6,287
65-9	4,951	5,194	5,274	5,493	5,712	6,083	6,247
70-4	8,626	8,756	9,136	9,359	9,599	9,672	10,155
75-9	17,764	17,294	17,090	16,912	16,908	17,059	17,466
80-4	33,228	33,102	33,142	33,066	32,507	31,770	31,837
85+	85,912	88,030	91,441	93,806	96,021	98,097	101,951
Tot.	159,095	160,894	162,565	165,021	166,937	168,898	173,944
	Percentage						
	2008	2009	2010*	2011*	2012*	2013*	2014*
<65	4.2	4.1	4.0	3.9	3.7	3.7	3.6
65-9	3.2	3.3	3.2	3.3	3.4	3.6	3.6
70-4	5.5	5.5	5.6	5.7	5.8	5.7	5.8
75-9	11.3	10.9	10.5	10.3	10.1	10.1	10.0
80-4	21.2	20.8	20.4	20.0	19.5	18.8	18.3
85+	54.7	55.4	56.3	56.9	57.5	58.1	58.6
Tot.	100.0	100.0	100.0	100.0	100.0	100.0	100.0

† Period 2010-2014 includes only permanent residential care residents (not respite care)

Source: AIHW 2012a; Department of Social Services 2014c.

The use of residential aged care services reflects the major demographic trends observed in the general population – the increasing life expectancy and greater presence of women in the older age groups. Tables 3.4 and 3.5 reveal these trends. It is noteworthy that data for the period from 2001 to 2009 included older Australians in *respite care*, whereas in the period from 2010 to 2014 only *permanent residential care* residents are included. Regardless of this methodological difference, the trends in use of residential care services are still reliable as only a small proportion of the total residents, about 2%, received respite care. This fast-flowing stream does not have a big impact on the dynamics of the system. As previously noted, the focus of this study is only permanent aged care residents.

In the last five recorded years, from 2010 to 2014, the total number of permanent residents in aged care increased by 6.9%, from 162,565 to 173,944. The largest increase in absolute and in relative terms has been recorded in the oldest age group (85+). The number of those older than 85 grew by 10,510, an increase of 6.5% in a 5-year period. In the future, this trend is likely to continue due to an increase in the total number of older persons (baby boomers). Considering previously mentioned aged care policies, it can be expected that bed provision will also increase, but very likely at a slower rate, until a ratio of 80 beds per 1,000 persons aged 70+ is achieved. Yet, as rates of use have fallen at in age groups (Tables 3.6 and 3.7), the increase in numbers of aged care residents is lower than it would have been otherwise. This is especially the case at ages from 80 years onwards where usage rates fell substantially between 2001 and 2014

Table 3.6. Usage rates for permanent aged care, by age group, 2001-2007, per 1,000 persons

	2001	2002	2003	2004	2005	2006	2007
<65	0.4	0.3	0.4	0.4	0.4	0.4	0.4
65-69	6.2	6.2	6.1	6.0	6.0	6.0	5.9
70-74	14.7	14.1	13.9	13.9	13.6	12.9	13.2
75-79	35.5	34.6	34.2	33.6	33.7	32.7	33.3
80-84	86.7	85.1	85	85.2	83.7	79.5	81.2
85+	254.1	250.2	249.2	248.8	245.3	240.3	237.0
TOTAL	6.9	7.0	7.1	7.2	7.3	7.3	7.4

Source: AIHW 2012a.

Table 3.7. Usage rates for permanent aged care, by age group, 2008-2014, per 1,000 persons

	2008	2009	2010	2011	2012	2013	2014
<65	0.4	0.3	0.3	0.3	0.3	0.3	0.3
65-69	6.0	6.0	5.8	5.8	5.3	5.5	5.6
70-74	13.0	12.8	12.9	12.8	12.5	12.3	12.2
75-79	32.3	31.5	31.0	30.2	29.7	28.8	28.6
80-84	78.5	76.8	75.5	74.4	72.5	70.9	71.1
85+	235.2	229.6	229.7	225.9	228.2	222.9	222.5
TOTAL	7.4	7.3	7.3	7.3	7.3	7.3	7.4

† The usage rates for 2012, 2013 and 2014 were calculated based on the estimated residents' population (ABS 2014a)

Source: AIHW 2012a; ABS 2013.

Despite the falls in usage rates in all age groups, because of the changing age composition within the population aged 70 and over, the usage rates for the total population aged 70 and over have been remarkably stable in the period 2001-2014 (Tables 3.6 and 3.7). Thus, while the usage rate at ages 85 years and over fell substantially over the period from 2001 to 2014, the share of this age group in the total population of residential aged care residents increased from 50.3% to 58.6% in the period 2001-2014 (Tables 3.4 and 3.5).

The Australian Institute of Health and Welfare reported that the fall in age-specific usage rates may be related to an increase in a provision of home and community care places (AIHW 2012a). Notwithstanding, the ageing of the population has meant that the number of people in residential aged care grew throughout the entire period from 2001 to 2014, and at the same time there was continuing increase in the provision of operational residential aged care places. Recent reports (AIHW 2017) suggest that the increase in the number of older Australians in residential aged care has continued.

3.2.2 Residents' Characteristics

Age and marital status are considered to be relevant factors in admission to residential care. In

terms of modelling, these determinants can also be good predictors of the decision to apply for an aged care assessment. Marital status, for example, may act as a surrogate for carer support. Because partners are leading carers¹⁹ in Australia (McDonald 2016), it can be assumed that those without partners may be more likely to make an earlier entry to residential care. Table 3.8 shows the structure of permanent residents by age and marital status.

Table 3.8 Permanent care residents by age, sex and marital status on 30 June 2014

Age Group	Male		Female		Marital Status	Male		Female	
	No.	%	No.	%		No.	%	No.	%
<65	3,417	6.3	2,870	2.4	Widowed	13,287	24.4	74,254	62.1
65-69	3,291	6.1	2,956	2.5	Married	24,371	44.8	26,854	22.5
70-74	4,912	9.0	5,243	4.4	Never M.	8,093	14.9	7,941	6.7
75-79	7,202	13.2	10,264	8.6	Divorced	5,892	10.8	7,876	6.6
80-84	10,836	19.2	21,001	17.6	Separated	2,117	3.9	1,566	1.3
85+	24,743	45.5	77,208	64.6	Unknown	641	1.2	1,052	0.9
Total	54,401	100.0	119,543	100.0	Total	54,401	100.0	119,543	100.0

† Married included those in *de facto* relationships.

Source: AIHW 2015f.

The large majority of all permanent residents in aged care at 30 June 2014 were females (69%) and a clear majority of those women, or nearly 65%, were 85 or older. In comparison, only about 45 per cent of males belonged to the same age group. Male residents were much younger than females, reflecting sex differences in the average age at admission (AIHW 2015f). Evidently, male residents, on average, enter residential aged care at younger ages. Care residents who were younger than 75 constituted 21.4% of the total number of males but just 9.3% of females. The largest group in residential care were very old women (85 and older) whose number exceeded 77,000 or almost 45 per cent of the total number of permanent aged care residents. There were just below 28,000 males in the same age group.

Males and females also differed markedly in terms of their marital status. Table 3.8 shows that the clear majority of females or almost two-thirds, were widowed, compared to just a quarter of males. Considering that most of the females in residential aged care belong to the oldest age group, it is possible to assume that the largest group in terms of age and marital status are widows who outlived their husbands. Their children are also older and less able to provide carer support. Interestingly, the largest share of men in residential care, nearly 45 per cent, were married. The question that arises is *why men in care are more likely to be married than women?* As indicated in Table 3.9, at admission, 70% of married men are aged 80 years and over and are

¹⁹ It is also worthy of mentioning that out of 2.7 million informal carers in Australia, 66% were females (ABS 2016b; ABS 2015).

likely to be beyond the ability of their spouse to provide informal care.

3.2.3 Admissions' Characteristics

Table 3.9 Admission into permanent residential aged care, by sex, age group and marital status between 2013 and 2014 (%)

Males							
Age group	Married	Widowed	Divorced	Separated	Never M.	Unknown	Total
<65	1.23	0.18	1.20	0.54	2.23	0.07	5.44
65-69	2.01	0.39	1.32	0.39	1.25	0.08	5.44
70-74	3.83	0.91	1.51	0.62	1.37	0.06	8.30
75-79	7.79	2.20	1.76	0.53	1.57	0.07	13.92
80-84	13.01	5.05	1.61	0.61	1.61	0.09	21.96
85+	23.70	16.67	1.80	0.59	2.00	0.19	44.95
Total	51.57	25.38	9.19	3.28	10.03	0.55	100.00
Females							
Age group	Married	Widowed	Divorced	Separated	Never M.	Unknown	Total
<65	0.83	0.27	0.55	0.21	0.74	0.06	2.67
65-69	1.01	0.58	0.71	0.15	0.39	0.03	2.87
70-74	2.05	1.69	0.89	0.20	0.41	0.02	5.27
75-79	3.98	4.69	1.12	0.23	0.57	0.04	10.63
80-84	6.49	11.91	1.35	0.25	0.79	0.10	20.88
85+	9.73	43.36	1.87	0.24	2.28	0.19	57.67
Total	24.11	62.50	6.49	1.28	5.17	0.45	100.00

† Married included those in *de facto* relationships.

Source: Produced by the author using AIHW 2015f.

The structure of aged care residents by age, sex and marital status reflects the characteristics of permanent residents at the time of admission. Table 3.9 shows that the most common groups of residents admitted to permanent aged care in the period 2013-14 were widowed women aged 85 years and over (19,583) and 80-84 (5,378). Widows aged 80 and over made up one third of all admissions in a one-year period. The largest group of admissions among males were married men aged 85 and over (6,924) who made one quarter of all male admissions. Although younger admissions, prior to the age of 75, made up only a small proportion of the total admissions, they were more common among males (25%) compared to females (11%). These patterns clearly have a lot to do with the fact that men are conventionally older than their wives and have higher mortality rates.

Admissions of older Australians to permanent residential aged care using the AIHW data cubes will be analysed in Chapter 5 whereas the potential factors that may be associated with a higher likelihood of admission will be examined in Chapter 4. The characteristics of residents at the time of their admission to permanent care is important in terms of modelling. One of the aims of this research is to determine the individual factors associated with the decision to apply for a

care assessment and later with the decision to enter residential aged care.

3.3. The Areas of Stability within the System

3.3.1 Separations

Our short review of the areas of stability in the system of residential aged care begins with the separations. A separation “occurs when a resident leaves residential aged care and has not re-entered the same or another service within 2 days” (AIHW 2011b p. 42). As this type of event may happen repeatedly, separations can be perceived in terms of their total number or as the last separation.

In the period between 2013 and 2014, a total of 69,392 residents separated from residential aged care. The main reason for the last separation from permanent residential care in this period was death (94.3%) followed by return to family or home (2.9%). Only a small share of all residents transferred to a hospital (1.5%) or to other care settings. When all separations were included (i.e. multiple transfers), the proportions were different with death being the main reason in almost 80 per cent of cases while transfers to other aged care facilities accounted for 12.7% of separations (Table 3.9). In some instances, a care resident has no choice but to move to a specific aged care facility that can provide the more advanced services that the person requires.

In comparison, the residents of respite care had different reasons for separation, reflecting the different purposes of these two care settings. A much higher proportion of respite residents, compared to the permanent, returned to family or home (61.1%), whereas only 2.5% died

Table 3.9 Separations from residential aged care, by discharge reason, type of separation and type of care in the period 2013-14 (%)

Reason	Permanent Care		Respite Care	
	All separations	Last separation	All separations	Last separation
Death	78.4	94.3	2.5	3.8
Hospital	1.9	1.5	5.3	3.9
Other aged care	12.7	0.6	18.5	25.7
Return to family	3.5	2.9	61.1	49.6
Other	3.6	0.7	12.5	16.9
Total (%)	100	100	100	100
Total (number)	69,392	57,651	64,852	42,858

Source: AIHW 2015f.

Males and females followed a similar pattern of separation from permanent residential care in the period, 2013-14. Death was the main reason for separation for nearly 78% of males and 79% of females (Table 3.10). Not unexpectedly, the age distribution of deaths was skewed towards the oldest ages. Almost 57% of the total male deaths happen among those older than 85. In contrast, the percentage of deaths in the oldest age group is much higher among females (72%). This reflects differences in the average age at admission, which is much higher for females, and the higher life expectancy of women. Transfers to other aged care homes were the second most common reason of separations from permanent aged care. The share of such transfers was 12% among males and 13% for females, with the majority happening in the oldest age group (85+).

Table 3.10 Separations from permanent residential aged care, by sex, age group and separation reason, 2013–14

Males												
Age	Death		Hospital		Care		Home		Other		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<65	613	2.9	59	9.5	185	5.7	100	9.4	106	10.3	1063	3.9
65-69	663	3.2	42	6.7	228	7.0	108	10.2	80	7.8	1121	4.2
70-74	1253	6.0	70	11.2	295	9.1	125	11.8	109	10.6	1852	6.9
75-79	2364	11.3	93	14.9	473	14.5	171	16.1	115	11.2	3216	12.0
80-84	4129	19.8	114	18.3	697	21.5	231	21.7	204	19.9	5375	20.0
85+	11872	56.8	246	39.4	1372	42.2	329	30.9	408	39.9	14227	53.0
Total	20894	100	624	100	3250	100	1064	100	1064	100	26854	100

Females												
Age	Death		Hospital		Care		Home		Other		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<65	451	1.3	37	5.5	145	2.6	100	7.5	59	4.0	792	1.9
65-69	516	1.5	30	4.4	180	3.2	83	6.2	39	2.6	848	2.0
70-74	1034	3.1	48	7.1	276	4.9	143	10.7	90	6.1	1591	3.7
75-79	2258	6.7	74	10.9	532	9.6	207	15.5	151	10.1	3222	7.6
80-84	4990	14.9	123	18.1	1092	19.7	257	19.2	256	17.3	6718	15.8
85+	24232	72.3	367	54.0	3329	59.9	550	41.0	889	59.9	29367	69.0
Total	33481	100	679	100	5554	100	1340	100	1484	100	42538	100

Source: AIHW 2015f.

The top causes of separation for permanent aged care residents have stayed remarkably stable over the years. Some of the earliest reports of the total residential aged care system (1988-89)²⁰ revealed roughly similar patterns as the most recent data (AIHW 2015f), with deaths accounting for 74.2% of separations, followed by transfers to different care settings (10.2%) and to hospitals (5.1%) (Department of Community Services and Health 1990, Choi & Lui 1998, AIHW 1998, Howe & Sarjeant 1999). Some of the differences reflect changes in the way separations and deaths are recorded. For example, in 1989-99, the ways in which person moved from low to high care are

²⁰ In 1988-89 the RACH system included nursing homes (high care) and former hostels (low care) combined (Department of Parliamentary Library 1993).

still being sorted out, and some of the moves to another facility were moves from low to high care. Subsequently, transfers between care homes were not counted as separations followed by an admission, but were counted as once-only admissions. There has also been a change in the way deaths in hospital are recorded. Such deaths are more often attributed back to residential care in the most recent data. When these changes are considered, the system looks very stable.

In summary, the residential aged care system might be in a 'steady state of equilibrium' with the residents who are admitted being a 'selected' group from the total population (i.e. older people with similar demographic or health features) and who simply replace those residents who leave. The outflows from residential care (and outcomes of these outflows such as deaths) may also be subject to 'external constraints' as much as being the result of 'internal factors' (i.e. events that happen in residential care facilities). The major external constraint is that there are few options to where people might die (i.e. at home, in a hospital, in a residential care or somewhere else). When it comes to hospitals, there are very few long-stay hospitals now in Australia, even if psychiatric hospitals are included, and there is a substantial flow of people from hospitals to residential aged care, even though most of those older Australians are near the end of their lives (Howe 2015). A data linkage study conducted by the AIHW (2013c) showed that the estimated discharges from hospitals to permanent residential care reached about 23,700 people during the period 2008-09. This figure made up only about 2.2% of total hospital discharges in the same period. In contrast, another study by the Australian Institute of Health and Welfare into the use of aged care services prior to death, found that a relatively large proportion of aged care clients stopped using care programs in the 3 months before death, with this percentage being highest in the youngest age group (aged 65-74): 17% compared with 10% among those who died aged at least 85 (AIHW 2015c p. 9).

3.3.2 Length of Stay (LOS)²¹

Length of stay determines the rate of turnover of the available residential aged care places, and affects the accessibility of beds during a time period (Liu 1996). Furthermore, length of stay provides 'feedback' on the utilisation of residential care and provides guidelines for policy decisions (Manton et al 1984). The length of stay of a separated resident is the time between

²¹ Here, only the total or completed length of stay (of a separated resident) will be considered. As defined by the Australian Institute of Health and Welfare (AIHW 2012a p. 39) "*if resident moves from one service to another in less than 2 days (transfer), then the admission date used in the measure is the earlier admission date, or the first admission considering all transfers.*"

the date of admission and the date of separation. For a current resident, it is the time between the date of admission and some specific date (i.e. at 30 June 2014). A methodological caveat is that a length of stay is an episodic measure. It means that both an admission and a separation can happen to each resident more than once. Interpretation of data, therefore, requires a degree of caution and the use of special methods. Length of stay measured as the *completed LOS of admissions* is in ideal circumstances an unbiased measure, but its use is not always practical due to the amount of time required for all members of the admission cohort to separate from care.

Completed length of stay is another feature of the residential aged care system that has been fairly stable over a long time. However, as the resident population is heterogeneous in terms of their demographic characteristics and care needs, available descriptive reports do not give a precise answer to the question *who are the long-stayers and who are the short-stayers?* Accurate predictions of future length of stay, especially in relation to disability, disease or needs levels of the care residents, have policy implications. Modelling of the development of assistance needs in residential care, derivation of the life expectancies based on these care needs and a longitudinal data analysis, can provide valuable answers.

Table 3.11 Completed LOS for permanent residents, by discharge reason, in the period 2013-14

Numbers						
	Death	Community	Hospital	Other RAC	Other	Total
< 1 month	3262	193	500	421	222	4598
1 – 3 m	4342	220	830	445	248	6085
3 – 6 m	4073	173	883	426	284	5839
9 – 12 m	5924	172	1294	431	350	8171
1 – 2 y	9124	176	1672	296	454	11722
2 – 5 y	16644	249	2417	298	636	20244
≥ 5 years	11006	120	1208	87	312	12733
Total	54375	1303	8804	2404	2506	69392
Percentages						
	Death	Community	Hospital	Other RAC	Other	Total
< 1 month	70.9	4.2	10.9	9.2	4.8	100.0
1 – 3 m	71.4	3.6	13.6	7.3	4.1	100.0
3 – 6 m	69.8	3.0	15.1	7.3	4.9	100.0
9 – 12 m	72.5	2.1	15.8	5.3	4.3	100.0
1 – 2 y	77.8	1.5	14.3	2.5	3.9	100.0
2 – 5 y	82.2	1.2	11.9	1.5	3.1	100.0
≥ 5 years	86.4	0.9	9.5	0.7	2.5	100.0
Total	78.4	1.9	12.7	3.5	3.6	100.0

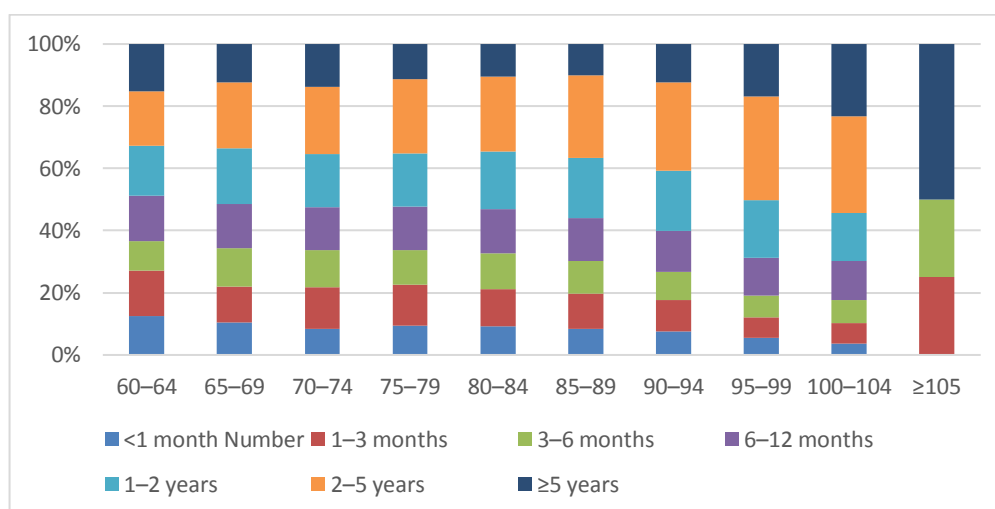
Source: AIHW 2015f.

For those residents who separated in the most recently recorded period (2013-14), more than one-third (35.6%) had stayed less than 1 year and 15.4% less than 3 months (AIHW 2015f). In

the period, 2010-11, these percentages were fairly consistent, 36.2% and 19% respectively (AIHW 2012a). A relatively high proportion of permanent residents had been in the nursing home for more than 5 years (18.3%) in the period 2013-14 (AIHW 2015f). For the period 2010-11 the share of long-stayers was slightly higher (21.4%). These figures look very similar to the trends observed over the period, 1988-89, in which nearly 20% of residents separated within 3 months and 16% stayed five years or more (DCSH 1990; Liu 1996).

Looking in more detail at Table 3.11, it can be seen that those residents who returned to the community stayed for a much shorter time in residential care compared to other groups. The percentage of residents who stayed less than 6 months in residential care and returned to the community was 45%. More than 15% returned to the community within the first month of being in care. Most of the residents who moved to a hospital were long-stayers. Of those, 27% stayed 2-5 years and almost 20% spent 1-2 years in nursing home before being discharged. In contrast, residents who moved to another nursing home have been mostly discharged within a year (71%). Such a high figure suggests that the adjustment to particular care requirements happens within the first year of admission.

Figure 3.4 Male separations from permanent residential care by age and LOS, 2013-14

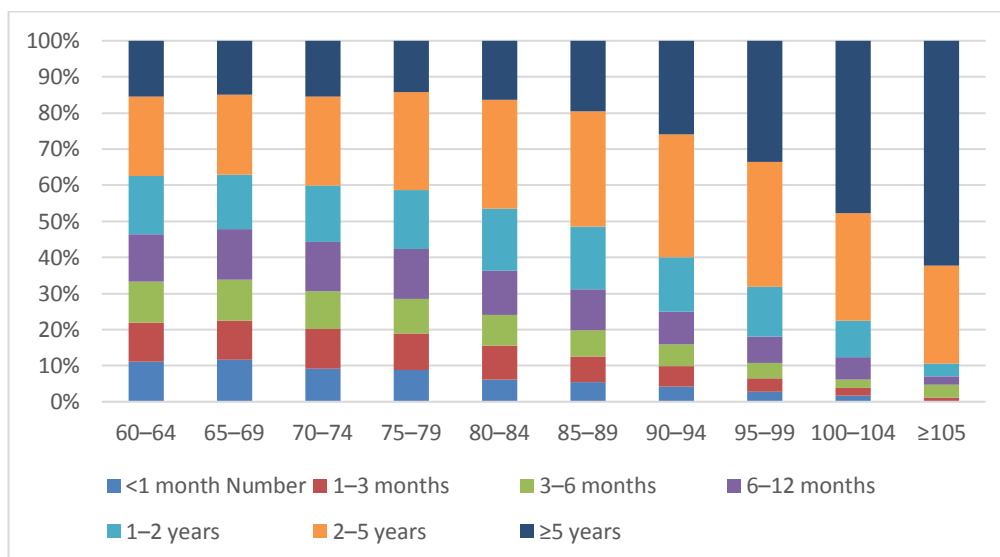


Source: AIHW 2015f.

Length of stay in residential care varies according to sex. It is a well-recognized fact that female residents stay longer in residential care than their male counterparts. Therefore, it is not unexpected that the oldest age groups of female residents (aged 95 years and older) have much higher shares of long-term stayers. Figures 3.4 and 3.5 show length of stay for males and females examined retrospectively, at separation. This measure of length of stay is most likely biased by variations in the volumes of all past admissions and their composition. Even though it necessarily over-represents short-term stayers resulting in an underestimation of the average length of stay,

differences by sex are obvious. Finally, sex differences were also visible in terms of the average length of stay. In the period 2013-14, the average length of stay was 39.0 months for females, 26.3 months for males and 34.1 months for the total population in residential care.

Figure 3.5 Female separations from permanent residential care by age and LOS, 2013-14



Source: AIHW 2015f.

3.3.3 Turnover

The turnover in the system of residential aged care is defined as a “*function of the number of admissions, length of stay and the overall growth or reduction in the type and number of places in the system*” (AIHW 2012a p. 42). In other words, the turnover measures the dynamics of use of residential aged care services by residents. Because all the determinants have been stable over the period between 2001 and 2014, the turnover showed very limited variations. Turnover rates for permanent care only slightly fluctuated around 0.33 (one-third of permanent places were associated with admissions in one year), whereas for respite care this value was much higher (fluctuating between 14.0 and 17.0). Such high rates indicate that respite places are used about 14 to 17 times a year.

3.3.4 Care Needs of Residents (ACFI)

Current residents as well as those newly admitted to residential aged care both receive the ACFI appraisals (Chapter 1.3.3, Box 1.1)²². Over time, certain variations in the ACFI appraisal outcomes

²² The ACFI replaced the Resident Classification Scale (RCS) on 20 March 2008 and is used to assess new and existing residents (AIHW 2011b, p. 54).

have been recorded (i.e. ACFIs vary according to age, reasons for separation, length of stay etc.). Small differences in the level of assistance needs have also been observed between existing and new residents. This section of Chapter 3 provides a brief overview of the trends in care needs perceived from an aggregate perspective. Understanding of these trends is directly pertinent to the research objectives of this study. For example, the summary statistics of ACFI scores for new admissions is a useful preparatory step for statistical modelling conducted in later chapters. These aggregates give an idea about the average characteristics of new residents and can be useful to cross-check the modelling outcomes. Consequently, models of the development of the ACFI care needs in residential care are a necessary step in the preparation of a projection model of the residential aged care system.

As mentioned earlier, the Aged Care Funding Instrument is a tool used to appraise the care needs of permanent residents in residential aged care facilities. Consistent with an increase in the total aged care population, the total number of ACFI appraisals has increased from 161,562 (30 June 2010) to 173,068 (30 June 2014). More importantly, a share of the *High-care* appraisal outcomes has also markedly increased from 71% (2009-10) to 83% (2013-14) (AIHW 2015b; 2015f). This strong upward drift in the share of high-care assessments at the time of admission has been well documented in earlier research reports (Andrews-Hall, Howe & Robinson 2007) as well as in more recent ones (Cumpston & Jukic 2017; Ley & Wyatt 2016). In Chapter 7, these ACFI appraisal outcomes will be more thoroughly analysed using the longitudinal ACFI data.

Distinction criteria between *High* and *Low* care, in terms of the overall ACFI outcomes, changed from 1 January 2010. *“Under the new definition, for a resident to be assessed as high care, they must have: a score of High in the activities of daily living (ADL) domain; or a score of High in the complex health care (CHC) domain; or a score of High in the behaviour (BEH) domain, together with a score above Nil in at least one of the ADL and CHC domains; or a score of Medium or High in at least two of the three domains. Otherwise a resident is classified as low care”* (AIHW 2012a p. 49).

Table 3.12 shows the distribution of the care need domain ratings within each ACFI-assessed care level (*High* or *Low*). The first ten most common combinations are shown for each level. By far the most common combination of ACFI outcomes among high care residents on 30 June 2014 was *High* in all three domains (25.3%), followed by *High* in ADL and BEH, with *Medium* in CHC (9.4%). These two combinations represented 21.1% and 7.9% of the total residential aged care population, respectively. The third most common care need combination within high-care group was *High* in BEH, with *Medium* in ADL and CHC. It made 6.8% of high-care residents and 5.6% of

the total permanent care residents.

Among low-care residents, the most frequent combinations were *Low* in ADL and CHC, with *Medium* in BEH (16.2%) and *Low* across all three domains (15.9%). However, each of these two combinations made up only about 2.7% of the total residential aged care population. The third most common combination within the low-care group was *Low* in the ADL and BEH domains, with *Medium* in the CHC domain, making up 12.9% of the low-care group and just above 2% of the total permanent resident population. The rarest combination of care assistance needs was *Medium* in ADL, *Nil* in BEH and *Low* in CHC, with only 0.5% of permanent care residents having such care needs. This is not surprising because most older Australians admitted to residential aged care require a certain degree of assistance with their behavioural needs.

Table 3.12 Distribution of care need domain ratings within ACFI-assessed care level (*High* or *Low* care), at 30 June 2014

ACFI Level	ADL	BEH	CHC	Number	% High	% (Total RAC)
High						
	High	High	High	36322	25.3	21.1
	High	High	Medium	13558	9.4	7.9
	Medium	High	Medium	9731	6.8	5.6
	High	Medium	High	9235	6.4	5.4
	Medium	High	High	9005	6.3	5.2
	Medium	High	Low	8813	6.1	5.1
	High	High	Low	6360	4.4	3.7
	Medium	Medium	High	4403	3.1	2.6
	Medium	Medium	Medium	4351	3.0	2.5
	High	Medium	Medium	4184	2.9	2.4
Low					% Low	
	Low	Medium	Low	4649	16.2	2.7
	Low	Low	Low	4577	15.9	2.7
	Low	Low	Medium	3722	12.9	2.2
	Medium	Low	Low	3247	11.3	1.9
	Low	Nil	Low	2158	7.5	1.3
	Low	Nil	Medium	1911	6.6	1.1
	Low	Low	Nil	1806	6.3	1.0
	Low	Medium	Nil	1666	5.8	1.0
	Low	Nil	Nil	1215	4.2	0.7
	Medium	Nil	Low	807	2.8	0.5

Source: AIHW 2015f.

It is also noteworthy that newly admitted residents had only slightly different ACFI appraisal outcomes compared with permanent residents, but the scoring trends have remained stable since the ACFI system was introduced. Over the period between 2008 and 2014, most of the new admissions needed some level of assistance with ADL with around one-third being

appraised as *High*, and more than a quarter as *Medium* (AIHW 2014b; 2015f). Only a small percentage of those residents (3-5%) had scored *Nil* or *Low* in ADL. Similar trends were observed for the BEH domain. On the other hand, newly admitted residents were less likely to require assistance in the CHC domain than with BEH or ADL, with only one-quarter (25%) appraised as *High* in the CHC domain, and more than 50% appraised as *Nil* or *Low*.

Care Needs, Age and Sex²³

An apparent regularity in distribution of the ACFI assistance needs across various age groups can be observed from available data. Similarly, regularity can be seen in respect to the sex of the resident. The most recent data (2013-14) reveal much lower age variation in care needs and a much higher share of the *high*-care outcomes, compared with data from the previous periods between 2008 and 2012. It is not clear whether Australian aged care residents are getting more dependent in terms of their care needs or whether this is due to 'inflated' ACFI claims by care providers or assessors as claimed in reports by the Minister for Health, Susan Ley, and the Assistant Minister for Health, Ken Wyatt.

To examine the differences, we compare two periods: 2010-11 and 2013-14. In both periods, the youngest and the oldest residents had the highest percentages of *High* appraisals in the ADL domain. In the period, 2010-11, the figures were 43% for residents younger than 65, and 47% for those older than 95. In 2013-14, these two groups kept the highest ADL scores, but the shares of *High* appraisals for the two age groups markedly increased to 50% and 55% respectively. Also, the percentage of *High* appraisals in the ADL domain increased in all other age groups in the period, 2013-14, compared with the earlier period. The variation in the share of high ADL appraisals became more apparent in the later period, with those in younger and older age groups having much higher ADL scores. Such age variation is expected because Australians entering aged care at younger ages usually enter with a much worse physical condition and, on average, these persons have higher assistance requirements. It is also expected that with an increase of age, the level of support with the activities of daily living (ADL) increases. Among all residents, females were more likely than males to have higher levels of ADL. This is the result of the much higher average age of female residents and their higher life expectancy. However, it is not clear why the observed overall increase in the ADL scores happened in a relatively short period.

²³ The data shows similar age pattern of ACFI scores for permanent and newly admitted residents in the period 2008-14 (AIHW 2012a; 2014b; 2015f).

The highest age variation in the ACFI appraisal outcomes in the period 2010-11 was recorded in the BEH domain. The percentage of permanent care residents appraised as *High* in terms of behavioural needs decreased rapidly with age. At the age of 65-69, almost 6 out of 10 of residents were appraised as *High* BEH steadily decreasing to roughly 40% at age 95 and over. A few years later, in the period 2013-14, the share of residents appraised as *High* in the BEH domain was 62% in the age range 65-69 and 49% for the oldest residents, aged 95 and over. This is a big increase compared to any of the previous years since the ACFI scores were introduced, but the trend of decrease of BEH scores with age stayed the same. Problems in the behavioural domain, such as dementia, depression or other degenerative, multiple or chronic conditions are good predictors of entry into permanent care, as demonstrated in Chapter 4.

Increase in the percentage of *High* appraisals between the two periods was the most evident in the CHC domain. In the period, 2010-11, the share of *High* scores showed only a small variation across age groups, ranging from 28% for those younger than 65 to 23% among those Australians older than 95. In the period, 2013-14, these figures were 40% and 43% respectively. This large rise seems unreasonable and suggests manipulations with the ACFI system in terms of artificial inflation of ACFI scores on behalf of providers (see sections 1.3.4 & 7.4.1). As opposed to the 2010-11 period in which the share of *high* appraisals in the CHC domain decreased with age, in 2013-14, the share increased with age. However, compared to ADL and BEH, the CHC domain scores show much lower variation by age. For most of older people admitted to residential care, problems in carrying out their daily activities and behavioural issues were more important than health conditions in their entry to care. Models of the probability of being in residential care and the probability of applying for care assessment, presented in the later chapters, are in line with these claims.

Table 3.13 shows the distribution of the care needs appraisal outcomes in each domain by age group and sex, at 30 June 2014. The figures confirm that females had higher shares of *High* appraisals in all domains (ADL, BEH & CHC) across almost all age groups. For example, in age group, 65-69, nearly 48% of females were appraised as *High* in the ADL domain, whereas roughly 42% of males had the same appraisal outcome. The differences between two sexes were more pronounced among the youngest and the oldest residents. In the BEH domain, for instance, more than 50% of females older than 95 have been appraised as *High* compared to only about 44% of males. The gap between females and males in terms of behavioural needs was almost negligible for persons aged 75-79. The share of the *High* appraisal outcome was 60.2% for females and 60.6% for males. Apparently, female residents are more care-dependent than males, especially at younger and older ages in residential care. These findings are in accordance

with all previous statements raised in this chapter. Females enter care at older ages compared to males, but in cases of early entry their care needs are usually very high. Similarly, female residents stay in care much longer than males, securing enough exposure time for care needs to increase.

Table 3.13 People in permanent residential aged care, by care need domain, sex, care need rating and age group, at 30 June 2014 (Percentages)

Domain/Score	< 65	65–69	70–74	75–79	80–84	85–89	90–94	95+	Total
Activities of Daily Living (ADL)									
<i>Male</i>									
<i>High</i>	44,5	42,2	44,0	46,2	46,2	44,2	43,2	46,6	44,7
<i>Medium</i>	28,8	29,3	29,6	29,5	30,1	30,3	30,6	28,7	29,9
<i>Low</i>	23,3	25,6	24,0	22,3	21,9	23,4	24,4	23,1	23,3
<i>Nil</i>	3,4	3,0	2,4	2,0	1,8	2,1	1,8	1,6	2,1
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
<i>Female</i>									
<i>High</i>	53,2	47,2	46,5	47,5	45,9	45,4	48,3	56,2	47,9
<i>Medium</i>	29,2	29,5	29,8	30,5	31,8	31,5	31,0	28,4	30,8
<i>Low</i>	16,0	21,5	22,0	20,4	20,9	21,7	19,5	14,5	20,0
<i>Nil</i>	1,6	1,8	1,7	1,6	1,4	1,4	1,2	0,9	1,3
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
<i>Persons</i>									
<i>High</i>	48,5	44,5	45,3	47,0	46,0	46,0	47,2	54,5	46,9
<i>Medium</i>	29,0	29,3	29,7	30,1	31,2	31,2	30,9	28,5	30,5
<i>Low</i>	19,9	23,7	23,0	21,2	21,3	22,2	20,6	15,9	21,0
<i>Nil</i>	2,6	2,5	2,0	1,7	1,5	1,6	1,3	1,1	1,6
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Behavioral (BEH)									
<i>Male</i>									
<i>High</i>	63,2	62,1	61,3	60,6	57,2	53,6	47,7	44,2	55,7
<i>Medium</i>	22,3	21,1	21,8	21,6	22,8	23,1	25,8	27,4	23,2
<i>Low</i>	11,0	12,4	12,1	13,0	14,3	16,3	18,7	19,1	15,1
<i>Nil</i>	3,5	4,4	4,8	4,8	5,7	7,0	7,8	9,3	6,1
Total male	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
<i>Female</i>									
<i>High</i>	66,4	64,4	62,1	60,2	57,4	54,0	51,9	50,3	55,1
<i>Medium</i>	20,0	19,6	21,0	20,6	21,3	22,4	23,8	25,8	22,6
<i>Low</i>	10,2	11,5	11,9	13,8	14,7	16,4	16,8	16,9	15,5
<i>Nil</i>	3,4	4,5	5,0	5,4	6,6	7,2	7,5	7,0	6,8
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
<i>Persons</i>									
<i>High</i>	64,6	63,2	61,7	60,4	57,3	53,9	50,9	49,3	55,3
<i>Medium</i>	21,3	20,4	21,4	21,0	21,8	22,6	24,3	26,1	22,8
<i>Low</i>	10,6	11,9	12,0	13,4	14,5	16,3	17,2	17,3	15,4
<i>Nil</i>	3,5	4,5	4,9	5,2	6,4	7,2	7,6	7,3	6,5
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
Complex Health Care (CHC)									
<i>Male</i>									
<i>High</i>	39,8	39,4	40,1	41,3	41,2	40,1	40,0	39,8	40,4
<i>Medium</i>	24,4	26,5	27,2	26,8	27,2	27,4	28,3	28,2	27,2
<i>Low</i>	25,9	25,9	25,0	24,6	24,8	25,9	24,8	25,1	25,2
<i>Nil</i>	9,9	8,2	7,7	7,3	6,8	6,6	6,9	6,9	7,2
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
<i>Female</i>									
<i>High</i>	43,2	42,2	41,6	42,2	41,7	41,0	42,2	44,5	42,0
<i>Medium</i>	27,9	27,5	27,6	27,8	27,6	28,6	29,6	29,8	28,7
<i>Low</i>	21,9	23,2	24,3	23,8	24,8	24,6	23,1	20,8	23,7
<i>Nil</i>	7,0	7,1	6,5	6,2	5,9	5,8	5,1	4,9	5,6
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

	<i>Persons</i>								
<i>High</i>	41,1	40,7	40,5	41,4	41,1	40,8	41,6	43,7	41,5
<i>Medium</i>	25,8	26,9	27,2	27,1	27,2	28,2	29,3	29,5	28,2
<i>Low</i>	23,9	24,6	24,3	23,9	24,5	25,0	23,5	21,6	24,2
<i>Nil</i>	9,2	7,8	7,0	6,6	6,2	6,0	5,6	5,2	6,1
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

†Excludes people who did not have an assessment current as at 30 June

‡ Aggregate numbers are given in Appendix 2 (Table A3.1)

Source: AIHW 2015f.

Care Needs and Length of Stay

Care needs of aged care residents are associated with their length of stay. In theory, the higher the ACFI level, the shorter the expected length of stay (LOS), that is, higher levels of dependency lead to higher turnover. However, the relationship between ACFI levels and length of stay is much more complex. The reason is that a resident's overall situation is a combination of their assistance needs in all three care domains and other existing health conditions that are not always available from data. The aggregate data from the Australian Institute of Health and Welfare, used in this chapter can only partially explain the relationship between care needs and length of stay.

The most straightforward relationship between the ACFI needs and length of stay is found for residents appraised as *High* in Complex Health Care (CHC). They are more likely to have a shorter length of stay. For example, 29% of the residents with *High* CHC needs stayed in residential care for less than 3 months measured at the time of separation, and only 28% stayed more than 3 years (AIHW 2011b). Even more striking is the fact that of all residents separating within the first 4 weeks from the moment of admission, over two-thirds (69%) had *High* CHC needs (AIHW 2012a). This proportion reduces to only about 30% for lengths of stay longer than 3 months. In comparison, over 40% of residents with *High* appraisal in the BEH domain stayed more than 3 years and 21% stayed more than 5 years. The relationship between score in the ADL domain and length of stay is more complex than for the other two domains. Residents who had *High* appraisal in the ADL domain were, as opposed to others, either short-term stayers, with length of stay less than 3 months, or long-term stayers, with length of stay of 5 years or more (AIHW 2011b). Other care residents, with either a *Medium*, *Low* or *Nil* score for the ADL domain mostly stayed between 1 and 3 years in permanent residential care.

Care Needs and Dementia

Dementia is serious mental condition that usually impairs a person's ability to carry out daily

activities, causing confusion, wandering, poor mobility or incontinence (AIHW 2012b; Brodaty & Cumming 2010; Runge et al 2009; Fisher & Lieberman 1999). Even though care plans for older Australians in residential care with dementia are often adapted in a non-standard way (Jeon et al 2013), the ACFI appraisals are applied in the same way as for other residents who do not suffer from dementia (Joenerä 2017). Prevalence of dementia in residential aged care, at any point in time, should be carefully monitored because of the complexity of care requirements that are associated with this condition.

Data show that the number of permanent care residents diagnosed with dementia increased from 83,808 to 89,381, or by almost 7 per cent in the period between 2010 and 2014 (AIHW 2015f). However, the share of people with dementia in the total population of permanent care residents has remained stable, at 51.9%.²⁴ Small gender differences can also be observed. The percentage of females suffering from dementia was slightly higher than among males, 52.4% and 50.6% respectively. This sex difference can be attributed to longer life expectancy, higher age at the admission and higher average age of females in residential aged care. In other words, the higher mean age means a longer exposure to the development of dementia and other progressive diseases.

The ACFI appraisal outcomes in the three care needs domains for older people in residential care differed markedly in terms of their dementia status (Table 3.14). For example, on 30 June 2014, more than three-quarters of aged care residents diagnosed with dementia were appraised *High* in the BEH domain. In comparison, just above 55% of aged care residents with dementia were appraised *High* in the ADL domain and nearly 42% had *High* appraisal in the CHC domain. Among permanent aged care residents who were not diagnosed with dementia, the distribution of scores across the three ACFI domains did not differ drastically. For example, the percentages of residents without dementia who were appraised as *High* in ADL, BEH and CHC were similar at 37.7%, 34.0% and 40.6%, respectively. These findings are aligned with the results of literature review and with the outcomes of modelling conducted in later chapters. In other words, persons diagnosed with dementia tend to enter residential care in better physical condition and have a longer expected length of stay in residential aged care.

²⁴ The most recent reports suggest that these trends in dementia prevalence in residential aged care have continued over the next years. On 30 June 2015, there were approximately 89,000 care residents with dementia. The share of residents with dementia in the total number of care residents stayed at 52% (Joenerä 2017).

Table 3.14 Permanent aged care residents, by dementia status, care need rating and care need domain, on 30 June 2014

	High		Medium		Low		Nil		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>Dementia</i>										
ADL	49552	55.4	27500	30.8	11747	13.1	582	0.7	89381	100.0
BEH	67081	75.1	13587	15.2	7421	8.3	1292	1.4	89381	100.0
CHC	37811	42.3	25133	28.1	21650	24.2	4787	5.4	89381	100.0
<i>No dementia</i>										
ADL	31259	37.7	25145	30.3	24472	29.5	2110	2.5	82986	100.0
BEH	28181	34.0	25699	31.0	19092	23.0	10014	12.1	82986	100.0
CHC	33714	40.6	23467	28.3	19993	24.1	5812	7.0	82986	100.0

†Excludes people with unknown dementia status or no assessment, at 30 June 2014

Source: AIHW 2015f.

3.4. Conclusions, Implications for Modelling and Future Research

Chapter 3 provided a glimpse on the main processes happening in the Australian residential aged care system. Specifically, this chapter distinguished parts of the system that have displayed distinct patterns and trends in terms of system dynamics. Separations from residential aged care and length of stay under this type of care arrangement, for example, have been stable over the last few years. Some other parts of the residential care system, such as provision of beds or use of services by the residents, have changed over the same period. It is noteworthy that figures and reports presented in this chapter are mainly based on the analysis of publicly available aged care data. The Australian Institute of Health and Welfare (AIHW) and the Department of Health (DoH) provided a wide range of rich statistical overviews that were useful for building an initial picture of residential care system. Yet, these findings do not provide sufficient depth to explain the current state of the care system or to anticipate the directions of future changes in the system.

A substantial body of evidence has pointed out that a complex set of characteristics is associated with residential care trajectories of older persons. For example, a person's social, demographic or health characteristics influence the dynamics of the progression to residential care and the length of stay in such care. Furthermore, it is a well-established fact that the length of time spent in a nursing home depends on the direction and dynamics of changes in a person's needs for care. Indeed, an individual's aged care pathway is determined by a series of very complex interactions. These complex interdependencies can be described and explained using statistical models. Yet, to construct such models, data need to be in an adequate form. For instance, to derive the probability of exit from residential care given a set of assistance needs, data in the form of individual unit records are preferred. As already outlined, this research relies heavily on such unit record data. The next four chapters (4-7) show the results of statistical modelling of

residential care pathways of older Australians using extensive administrative and survey data on aged care.

In terms of the key research steps, the results presented in Chapter 3 raise a few issues relevant to modelling. Before giving a brief overview of these issues, it is worth reiterating that only the demand side of the residential aged care system has been modelled. This includes pathways of older Australians towards residential care, through such care and out of it. The provision of residential care in Australia, on the other side of the equation, is strictly controlled by the Commonwealth Government. Future provision of residential care, as previously described (section 3.1.1) is based on long-term policy goals and is beyond the scope of this study. Broadly speaking, the main drivers of supply are access to capital and land, investment returns, development time frames and access to operational capability (Cutler, Bailey & Cumpston, 2016, p. 4).

What are the main issues and insights relevant to modelling of residential aged care that were highlighted in Chapter 3? Firstly, this chapter described the structure of the admissions to residential aged care, including basic sociodemographic characteristics, dependency levels and some major conditions of new entrants to permanent care (section 3.2.3). In a similar way, separations from residential aged care during the past few years were analysed. With special attention, different modes of separation were examined from the perspective of completed length of stay and age of the residents (section 3.3.1). However, this static approach gave very limited insights into the mechanisms of separation from residential care. Furthermore, the analysis of aggregate data did not reveal how individual care needs relate to different modes of exit from residential care or length of stay in such care.

Secondly, Chapter 3 provided valuable insights about yearly changes in ACFI assistance needs of older Australians in nursing homes. Interpretation of aggregated data, however, did not reveal the underlying mechanisms of change in individual assistance needs inside residential care. To bridge this gap and broaden our understanding of internal dynamics of the care system it is necessary to derive the transition probabilities between ACFI care needs levels. Undoubtedly, these transitions are indispensable for accurate prediction of future aged care requirements. A detailed examination of changes in care needs, using the longitudinal ACFI data, may also answer the question *if there is some other plausible explanation for the recent increase in ACFI scores, aside from artificial inflation by the residential care providers*. Analyses of the assistance needs dynamics is essential as ACFI domain scores ultimately set the costs of care system subsidies. Modelling of the ACFI scores could give useful insights and contribute to our understanding of

the residential care system. For example, in Chapter 4 it is demonstrated that the ACFI needs levels are good predictors of separation from residential care, whereas Chapter 7 shows how the assistance needs can be used to derive life expectancy of care residents.

Thirdly, we have only touched upon the issue of length of stay in residential aged care and briefly discussed different ways of its measurement. In the analysis of the length of stay of permanent aged care residents in Australia, Liu (1996 p. 94) pointed out that there were associations between the resident characteristics in relation to length of stay are found, *“but these associations cannot be used to predict directly and accurately the length of stay for an admission. Statistical models, such as regression techniques, are needed to establish a quantitative relationship”*. The AIHW periodical summaries provide the length of stay by modes of separation, age and sex. Length of stay affects accessibility of beds in residential care and it has been widely used as a guideline for aged care policies. Notwithstanding, this measure is not suitable to handle multiple transitions in and out of aged care, such as short visits to hospitals, transfers to respite care or similar short episodes. Furthermore, length of stay does not provide accurate estimates of the costs of residential care subsidies. This happens because costs of care do not only depend on the number of days a person stays in residential care, but also on the ACFI care needs assigned to each resident and on the total length of time spent under different levels of the domain appraisal outcomes (ADL, BEH and CHC appraisal outcomes combined). Thus, the life expectancy estimates based on ACFI care needs, shown in Chapter 7, may be more useful measures for policy purposes than the length of stay. This longitudinal analysis of ACFI data can give more accurate estimates of how long a person with a specific set of care needs can expect to live in a nursing home. Models of exit from care based on ACFI levels were presented in Chapter 4.

On some occasions in this study, different methods were used to achieve the same objective. This happened because not all data sources were available at the same time. Nonetheless, being able to compare the results of different methods was useful for validation purposes. For example, the transition probabilities between care needs levels extracted from longitudinal ACFI data can be compared with the transition probabilities derived from cross-sectional ACFI data. These two approaches were utilised in Chapters 4 and 7, respectively. Combining different methods can be beneficial in detection of potential problems in data. For instance, in cases of large discrepancies (i.e. in life expectancy estimates or transition probabilities) it is good practice to further examine each data source.

Finally, Chapter 3, as well as the previous two chapters, showed that projections of demand for residential care, especially those that incorporate sociodemographic and health factors, are still missing. In the recent review of aged care reforms by the Commonwealth Department of Health, titled the *Legislative Review of Aged Care 2017* released on 31 July 2017, it is stated that *the uncertainty around demand for aged care means that the government is not yet able to predict it with the degree of precision and confidence that would be desirable* (DoH 2017, p. 49). Indeed, construction of a precise tool for prediction is a long process that needs to be informed by relevant data. It is worthy of reiterating that, even though the estimates of future trends and patterns in the system of aged care in Australia are beyond the scope of this study, it is important to have in mind such possibilities. It is a well-established fact that having accurate statistical models that explain links between various predictors (i.e. personal characteristics of older Australians) and the observed outcomes (i.e. events on residential aged care trajectory) may serve as a good foundation for future predictions of residential aged care trends. By deriving appropriate statistical models, this study contributes to the understanding of residential aged care processes. The following four chapters utilize information on individual characteristics of older Australians in different phases of the residential aged care trajectory. As already outlined, information from the three main data sources on residential aged care (SDAC, ACAP & ACFI) will be used to test the impacts of these individual characteristics on the likelihood of events on the residential care pathway. Consequently, this will enhance our confidence about the system dynamics and likely future trends. Probabilities of residential care events, estimates of mortality rates, transition probabilities between the ACFI assistance needs and life expectancy estimates will hopefully all be useful for policy planning in the Australian aged care sector.

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4. Modelling Entries to and Exits from Residential Aged Care

4.1 Introduction

The previous chapter has shown how, over recent years, the residential care system in Australia has changed (Figure 1.10). The changes were perceived from a macro-perspective and measured in aggregate numbers. From here onwards, the focus shifts to the micro-perspective. This looks at individuals and their pathways of care trajectories. In accordance with the research goals set in Chapter 1, I will explore factors associated with residential aged care events and model the probabilities of these events. Throughout this thesis, I also explore the usefulness of Australian administrative (“big”) data for modelling of the residential aged care system and for projection purposes.

The process of obtaining data on Australian residential aged care was an exciting journey. During this process, data have arrived erratically. Each new data set, obtained in the period from April 2015 to July 2017, has opened more modelling opportunities and deepened the understanding of the residential care system. For example, when the foundation for modelling in Chapter 4 was set, the only available data sets were the Survey of Disability, Ageing and Carers (SDAC) and the Aged Care Funding Instrument (ACFI cubes). Intentionally, I decided to keep the initial models in Chapter 4 to demonstrate a few modelling techniques that could be achieved if data sources are limited. Furthermore, the models of entry to residential care and exit from such care, as well as the multi-state transition model derived later in this chapter, were useful for comparison with more comprehensive models based on richer data sources, that are shown later in this study.

The first part²⁵ of Chapter 4 provides a theoretical foundation and a conceptual framework for the residential aged care modelling. The theories presented here will be utilized in all modelling chapters (4-7), primarily to support modelling decisions and variable selection, and to interpret the results. Several hypotheses were also raised in this section, primarily looking at the factors highly associated with residential aged care events. Consistent with the research aims outlined in Chapter 1, several variables will be in focus: age, sex, marital status, carer availability, and individual’s needs for assistance with activities of daily living, behaviour or complex health care. Other variables, such as diseases, are also considered where data allow.

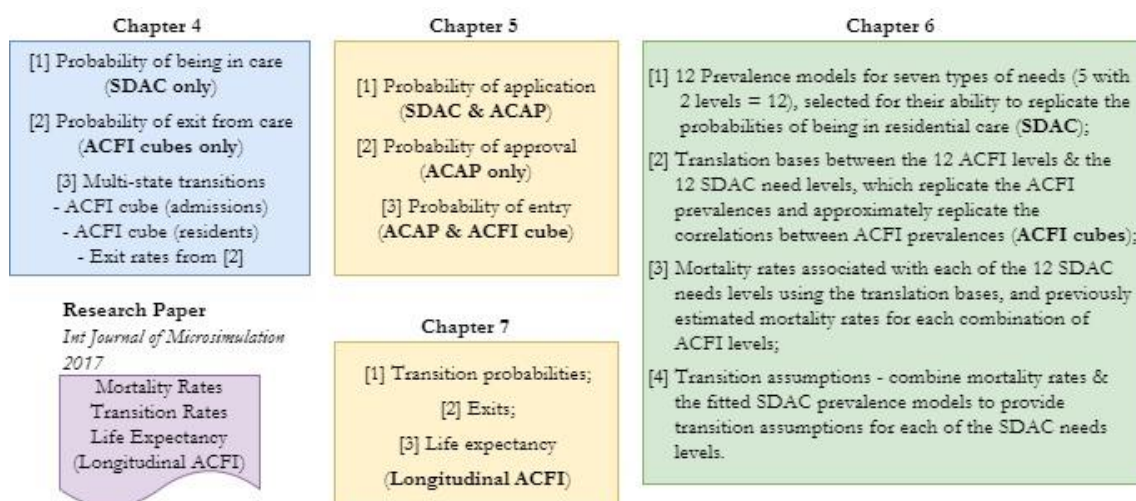
²⁵ Includes sub-chapters 4.1 – 4.5.

The second part²⁶ of Chapter 4 demonstrates a few modelling techniques that may prove useful in situations when researchers only rely on publicly available or easily accessible Australian data on residential aged care. For example, using only the cross-sectional data (ACFI cubes from the AIHW), the permanent aged care residents were compared with admissions to and separations from care to get approximate estimates of transition rates. This is much better done by the direct estimation of transition and mortality rates using the longitudinal ACFI data (Chapter 7).

4.2 Overview

Before turning our attention to the theoretical background, and for the sake of clarity, it is useful to review the research structure. Figure 4.1 contains a more detailed overview of the modelling steps undertaken and of data sets used in each of the following chapters. All chapters examine the residential aged care process (pathways of care) in Australia, covering the three main stages: entries, transitions and exits. Furthermore, as shown in Figure 4.2, the entry process can be perceived through the scope of the probability of being in care, application, approval and admission. The transitions stage of the care process can be seen through the lens of development of specific combinations of care (ACFI/assistance) needs. Finally, the process of exit or separation from care has been viewed through probabilities of death and life expectancy.

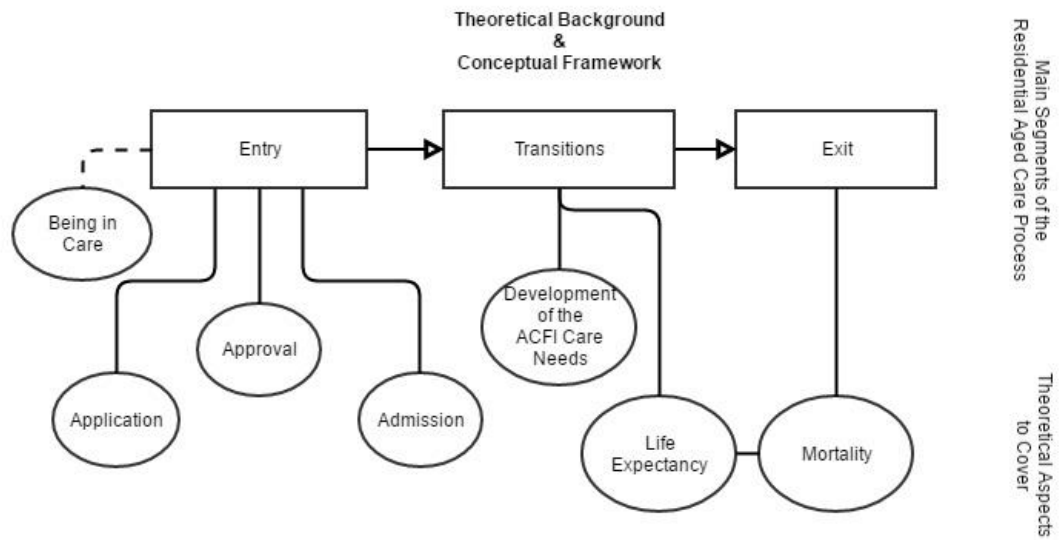
Figure 4.1 Overview of the modelling chapters



Source: Author, August 2017.

²⁶ Includes sub-chapters 4.6 – 4.11.

Figure 4.2 Main segments and theoretical aspects of residential care process



Source: Author, January 2017.

4.3. General and Specific Aims

The general aim in Chapter 4 is to set the theoretical and conceptual framework that will support statistical modelling conducted in the chapters that follow. The specific aim is to use Australian aged care data to illustrate three potentially useful methods:

- (1) Using unit record survey data to model the probabilities of being in residential care, as a guide to the variables likely to be useful in modelling admission probabilities;*
- (2) Comparing aggregate data on care residents and exits to model exit rates from residential aged care;*
- (3) Using a multi-state model, together with Excel's Solver, to estimate transition probabilities between ACFI assistance needs levels.*

4.4 Conceptual Models and Hypotheses

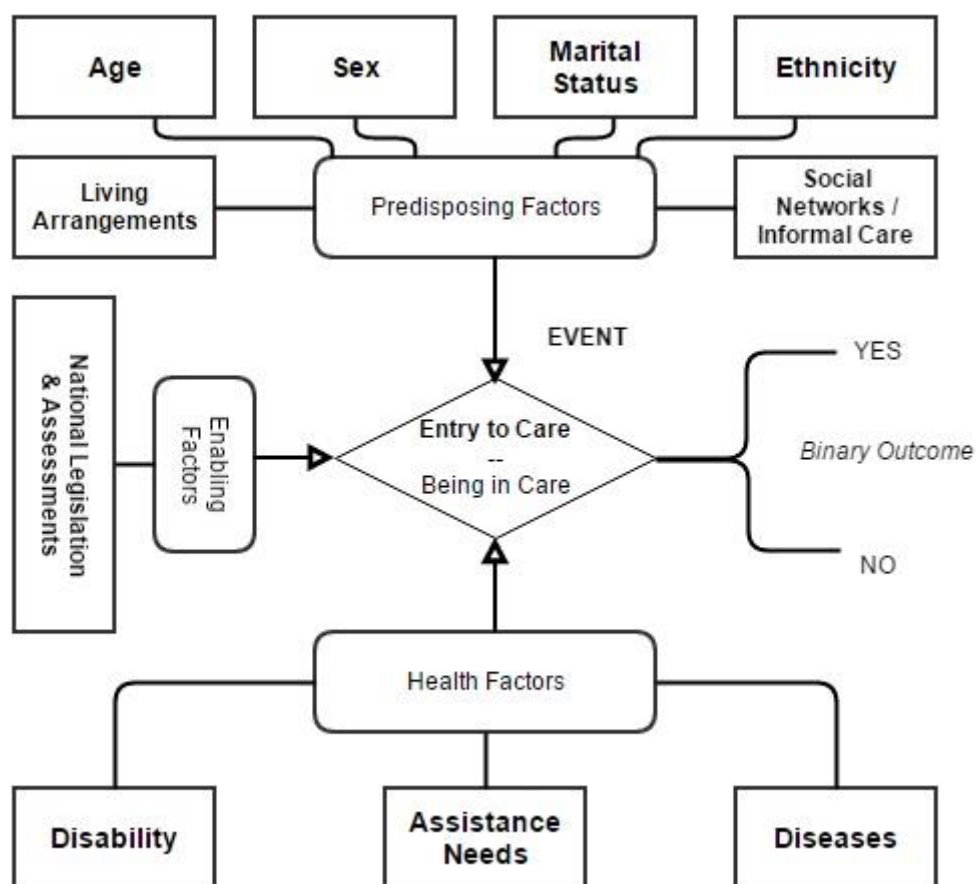
The conceptual framework of this thesis is consistent with its research focus. Being focused on the process of entry to, transition through and exit from residential aged care, I want to examine factors that might be associated with an individual's progression through the residential aged care system in each of the system's phases, using the best available data sources. Even though studies worldwide have documented and examined factors associated with being in residential aged care, it is necessary to be cautious in the interpretation of statistical relationships. This

means that the interpretation of potential associations needs to acknowledge that factors associated with residential aged care events, such as an entry to nursing home or an assessment of the care needs, are usually subject to national legislation in aged care. Therefore, generalisability may be limited due to the procedural norms or due to a narrow scope of the research.

4.4.1 Entry to and Being in Residential Care

Following from the evidence that has already been examined in the previous chapters, the conceptual model of entry to residential aged care is established (Figure 4.3). The model integrates both the predisposing sociodemographic factors and enabling factors, as well as various health factors, to explain the event of entry to care or the probability of being in care. Essentially, the resulting model I derived in this thesis describes a dichotomous or binary event (outcome): *entry* or *non-entry* to residential care (and *being* or *not being* in such care).

Figure 4.3 Conceptual model of entry to care (being in care)



Source: Author, February 2017.

This model, like several other conceptual models from earlier studies that have examined factors associated with residential care entry (Tomiak et al 2000; Wolinsky et al 1992; Greene & Ondrich 1990; Wingard, Jones & Kaplan 1987), partially builds upon Andersen's modelling²⁷ framework and further develops the concepts set by Andersen and his colleagues (Andersen & Davidson 2001; Andersen et al 1983; Andersen 1995; 1968). For many years, the Andersen Behavioural Model has been the dominant model used to predict the use of health care services (Andersen, 1995). In this seminal work, the author and his colleagues stated that the use of health services is an outcome of a person's predisposing, enabling and need variables. Predisposing variables include demographic and social variables, and health beliefs. Enabling variables usually include family, community and other factors influencing an individual's ability to access health services, whereas need factors relate to all sorts of health problems that cause the need for health care services. In this thesis, enabling factors include the Australian legislation on residential aged care (i.e. ACAT assessment and application procedure, the supply of care services etc.). Instead of the need factors, I use the term '*health factors*'. These factors include both diseases and disabilities, as well as the resulting assistance needs.

Not all investigations have operationalized and measured Andersen's terminology in a consistent way (Thygesen et al 2009). In many research pieces, the use of health or aged care services has been operationalized using a different set of predictors (Eriksson & Lindstrom 2006; Harris & Cooper 2006; Agüero-Torres et al 2001; Miller & Weissert 2000; Antonovsky 1993). Nowhere are these differences more understandable than in the context of the enabling factors for utilization of care services. This set of predictors heavily depends on the context of economic circumstances (i.e. different models for funding of aged care and health care etc.) and national legislation. To allow for the influence of factors that are unique to the Australian residential aged care system and to residential care itself, this study had to adapt the Andersen framework.

Because of the high cost of permanent residential care and the desire of older people to stay in their homes, it is important for the government and aged care providers to understand the predictors of nursing home placement. Not surprisingly, older people are a high-risk population for nursing home placement (Palmer et al 2014; De Almeida Mello et al 2012). The transition of older people to institutional aged care tends to be exacerbated by a lack of co-ordinated community or home care services (Ferris et al 2016; Rechel et al 2009; Hellstrom & Hallberg

²⁷ The Andersen's Behavioural Model was first time mentioned in his dissertation at Purdue University (Andersen 1968). Other conceptual frameworks, like the model by Flaskerud and Winslow (1998), have also been used (though less frequently) to examine the predictors of residential care placement (Palmer et al 2014).

2001; Benjamin 1999; Knight & Tjassing 1994; Coughlin et al 1992). A growing body of literature in gerontology and geriatrics has examined a multitude of factors that alter the probability of entry to residential aged care. Some of these factors, have been briefly mentioned in Chapter 1, including age, sex, marital status, living arrangements, carer availability, disabilities, diseases, social networks and informal care provision, national legislation or residential care regulations, ethnicity and cultural background, economic wellbeing and others. It is generally accepted that the influence of some of these factors is straightforward and unidirectional, leading to a higher probability of entry to care or of being in institutional arrangements regardless of the geographical location where an older person lives. These characteristics of older persons include: age, female gender, divorced or widowed marital status, need for assistance due to disability or disease and prior nursing home utilization (Gaugler et al 2007; Miller & Weissert 2000). Interpretation of the effect of some other factors on the probability of being in care is not so straightforward. The admission regulations, aged care legislation or provision of services, for instance, are country-specific and, therefore, have a limited level of generalisability.

Predisposing Factors

A substantial body of evidence on relative risks of institutionalization suggested that increasing age and female gender increase the likelihood of residential care placement (Kendig et al 2010; Gaugler et al 2007; McCallum et al 2005; Miller & Weissert 2000). Indeed, as persons get older, the risk of being institutionalized increases (Kasper et al 2010; Cohen-Mansfield & Wirtz 2009; Muramatsu et al 2007; Friedman et al 2006; Van Houtven & Norton 2004; Phillips & Diwan 2003). Gender was also a common predictor of nursing home placement. Being female (Kasper et al 2010; Smith & Stevens 2009; Banaszak-Holl et al 2004; Smith et al 2001) increased the risk of being admitted to residential care in some studies and decreased risk in one study (Phillips & Diwan 2003). Many other studies have reported that being male increased the risk of residential care placement (Shulz et al 2010; Gaugler et al 2004; Angel et al 2004; Gilley et al 2004).

It is not surprising that with an increase in age of a person, exposure to the risk of developing disabilities and diseases increases too. The Australian residential aged care review conducted in Chapter 3 showed that the most common group of newly admitted residents to permanent aged care over the years have been persons older than 85, a clear majority of whom were widowed women (AIHW 2015f; 2012a; 2011b). This reflects a natural tendency that females live longer, usually outlive their male partners, and thus tend to be more exposed to the risk of developing disabilities that require permanent care. Because the interdependencies between age, gender

and socioeconomic characteristics of older persons may alter the propensity of nursing home placement, it is worth examining these factors in more detail.

Using a 40% sample from the population registration data in Finland, Martikainen et al (2009 p. 34) found that being female, old, living alone and of low-socioeconomic status increased the risk of entering long-term aged care. In this key piece, the authors followed 280,000 persons older than 65 who, at the end of 1997, lived in private households. However, some researchers have provided evidence that these relationships are not so straightforward. Looking at the sex differences in the reception of aged care services and marital status of Swedish elderly in urban areas, Larsson and Thorslund (2002) found that, when care is needed, older men usually rely on their spouses whereas older females receive care from relatives or community. This is consistent with the results of analysis by Tomiak and her colleagues who have reported that marital status is a significant predictor of nursing home entry, but only for older men (Tomiak et al 2000). These authors have found that the risk of a single unmarried man entering care is 1.7 times higher than for married men. Similarly, others have reported that the risk of nursing home entry doubled for men following spousal death, but was unchanged for women (Noel-Miller 2010).

Being single or widowed regardless of gender, as reported by several researchers, significantly increases the probability of institutionalization (Hajek et al 2015; Luck, Lupp, Weber et al 2008), whereas living with a spouse may secure a healthier lifestyle, better psychological health and provision of informal care (Weissman & Russell 2016; Waite 1995). A 5-year follow up study of elderly persons in Finland by Nihtila and Martikainen also confirmed that marital status plays an important role in entry to care (Nihtila & Martikainen 2008). As suggested by the authors, having a partner has a major role in preventing or postponing entry to care among the elderly of both genders. A longitudinal study from Australia, conducted by Kendig et al (2010) has also reported the significant effect of age and marital status on the probability of being in care.

More generally, marital status, family structure and living arrangements are perceived as proxy measures of informal care or social support. It is noteworthy that the international literature has shown mixed findings on the effects of social support on nursing home placement, probably due to differences in measures, as well as country or policy differences. Some US studies have found that poor social support of older people is associated with entry to residential care (Bharucha et al 2004; Miller & Weissert 2000), while some other studies have found that for disabled older individuals, receipt of assistance from a child with basic personal care reduced the propensity of being admitted to residential care (Lo Sasso & Johnson 2002). In contrast, some US studies have reported that receiving informal care increases the risk of residential care placement (Miller and

Weissert 2000). Some UK researchers have provided evidence that persons who lived in a family with a spouse or a never married child had a significantly lower risk of entry to nursing home than those living alone and that marital status is more important for men than for women (Grundy & Jitlal 2007). Contrary to popular belief that family involvement in informal caregiving stops when a person enters a nursing home, some quantitative and qualitative studies have demonstrated the continuous involvement of family caregivers (Gaugler & Kane 2007; Gaugler 2005). It is generally accepted that the role of family caregivers has expanded from traditional tasks such as personal care provision and household chores to include medical and nursing tasks (i.e. administering injections, providing wound care) (Redfoot, Feinberg & Houser 2013). In addition, social support or informal care can be classified not only as a predisposing factor, but also as an enabling factor, especially if such support is provided as a part of the nationally or state administered community and home care programs.

Apart from age, gender, marital status and family caregiving as predisposing factors, other factors may also be important. Among the predisposing factors for institutionalization, socioeconomic status has been found to be particularly important. A large linkage study from England and Wales, on a nationally representative sample of 36,650 adults followed up from 1991 to 2001, showed that socioeconomic factors such as household type or housing tenure, together with some proxy variables (i.e. number of children and marital status), influence the risks of entry to institutional care (Grundy & Jitlal 2007). The authors found that social renters, compared with private renters and owners, have a higher chance of entry to residential care. Other researchers (Rouwendaal & Thomese 2010 in the Netherlands; Muramatsu et al 2007 and Gaugler et al 2007 in US) have found similar associations. Indeed, higher socioeconomic status has been found to be a protective factor against nursing home placement (Palmer et al 2014; Luppia et al 2010). However, this link can as well be attributed to health factors because wealthier persons like home owners are on average healthier than renters (Huisman et al 2005; Broese et al 2003).

Research reviews have found that social structure variables, such as income and education are important in understanding a person's predisposition to be admitted to residential aged care. In some studies, the effects of income and education have been examined controlling for ethnicity. This is because ethnic background has been found to alter an individual's propensity of being in a nursing home. A few studies from the US have identified a low annual income (less than \$5,000) or a missing report of income and Caucasian race (ethnicity) to be associated with greater odds of entry to permanent residential aged care (Massachusetts Health Care Panel Study [N=1625] & the Epidemiological Studies of the Elderly-Iowa [N=3,097]; reported in Foley

et al 1992; Branch & Jette 1982 as cited in Gaugler et al 2007). However, the evidence in these two studies comes from relatively narrow geographical areas and, as stated by these authors, the strength of the reported relationships varied between income and ethnicity groups. It is noteworthy that the association between income and the risk of being admitted to nursing home is equivocal in the international literature (Luppa et al 2010; Giles et al 2007), with some findings suggesting lower income to be associated with increased risk of being in care (Banaszak-Holl et al 2004; Kasper et al 2010; Kelman & Thomas 1990; Vicente et al 1979), whereas others have identified a positive relationship between higher income and entry to residential care (Gaugler et al 2000; Greenberg & Ginn 1979; Liu et al 1991; Palmore 1976). Similarly, some international studies have found a protective effect if an older person worked (Van Houtven & Norton 2004); owned a home; was considered to be wealthy (Cai et al 2009; Muramatsu et al 2007; Van Houtven & Norton 2004); or had family resources, including income (Gaugler et al 2003; Muramatsu et al 2007; Stevens et al 2004).

In their interpretation of the effect of income on residential aged care entry, Giles et al (2007) have pointed out that older Australians with a lower income may not be financially fit to keep paying for the community or home care services, and so are more likely to move to residential care. Wealthier persons, on the other hand, may be 'discouraged' to enter nursing home due to substantial entry costs or ongoing costs and new changes in means-tested criteria. It is possible to speculate that these processes will also depend on the future economic situation in Australia. Indeed, measuring complex interdependency between income, aged care policies and entry to residential aged care, is an issue of great importance. Deciding what to do with the family home, for example, can be a big challenge for wealthy older Australians about to enter nursing home. As Teale pointed out, new legislation introduced on 1 January 2016, included any rental income from recently vacated houses to resident's income for the purpose of calculating their means-tested care fee (Teale 2016). With the median house prices in the Sydney area now exceeding the \$1 million mark, older persons preparing to be admitted to a nursing home need to make a difficult decision on what to do with their properties. As repeated throughout this study, modelling and projections may be helpful in measuring the potential effects of such complex policy issues.

As previously underscored, difference in the propensity of being in residential care was observed among racial groups. Yet, the direction and strength of this association largely varied between studies. Several studies have reported that being white was associated with higher risk of being institutionalized (Schulz et al 2010; Cohen-Mansfield & Wirtz 2007; Van Houtven & Norton 2004; Yaffe et al 2002; Kersting 2001a). Other researchers have found that being black (Muramatsu et

al 2007; Stevens et al 2004; Phillips & Diwan 2003), Asian (Friedman et al 2005) or Hispanic (Muramatsu et al 2007; Yaffe et al 2002) reduces the risk of entry to nursing home. Interestingly, in one of his earlier studies, Kersting analysed associations between ethnicity (race) and income and found that being below the poverty level predicted earlier placement to nursing home. Yet, this finding was only significant for Blacks that were below the poverty line, whereas Blacks who were above the poverty line were not at risk of earlier institutionalization (Kersting 2001b). Living above or below the poverty line was not predictive of placement to residential care for Whites.

Australian reports about ethnicity and aged care utilization are in line with the international findings. Effects of the ethnicity on the probability of being in residential care have already been discussed in Chapter 1. Recent reports by the Australian Institute of Health and Welfare (AIHW 2013d; 2016b) showed that older Australians born overseas were less likely to be in permanent aged care and that the share of people in permanent care whose preferred language spoken at home was not English was very low.

The effect of education on entry to residential care has also been interpreted in the international and the Australian literature but the findings are inconsistent. Some researchers suggest that higher education is a protective factor against residential care placement (Miller & Weissert 2000; Smith, Kokmen & O'Brien 2000). In contrast, more educated older people were at higher risk of being admitted to residential care in other studies (Latham 2011; Muramatsu et al 2007; Van Houtven & Norton 2004; Gilley et al 2004). However, it has been argued by several authors that lower education is associated with a higher likelihood of use of informal community care (Larsson & Thorslund 2002). Other researchers have reported that education was not found to be a significant predictor of residential aged care placement (Kendig et al 2010; Bharucha et al 2004; Greene & Ondrich 1990). When interpreting the association between education and nursing home use, similar to the link between income and the probability of entry to nursing home, we need to acknowledge the fact that better educated people also tend to be wealthier and healthier compared to those with lower education.

Several studies mentioned above have examined the effects of social support on relative risk of being institutionalized. Even though social networks or social activities may have been examined and operationalized under the notion of social support, they can also be discussed separately. It is worthy of mentioning that recent longitudinal studies on broad social factors as predictors of residential care entry suggest that low social activities can increase the relative risk of early institutionalization, especially for older men, while other factors, such as social vulnerability and

functional capacities were important for women (Kendig et al 2010). It is now a well-established proposition that entry to residential care can be predisposed by existing social networks. If available, social networks, especially links with family or friends, may delay entry to residential care (Wilmoth 2000; Wolinsky 1992). Yet, uncertainty surrounds the findings because studies on social networks are usually restricted to very narrow geographical areas. Moreover, such studies sometimes draw their findings on relatively small samples (Walters & Bartlett 2009). Using the Australian Longitudinal Study of Ageing (N=1,477), Giles and colleagues reported no significant effect of social networks on use of residential aged care, but the authors argued that support networks can slightly enhance the life expectancy of older people (Giles et al 2007; 2005). These studies argued that some other factors related to social networks may have altered the relative risk of nursing home placement. For example, social networks are directly correlated to marital status, family structure, geographical location (Cohen & Roebuck Bulanda 2015; Antonucci 2001; Bull 1998), health status and some other factors. Therefore, it may be difficult to clearly interpret the effects of social networks on the chance of entry to nursing home.

Health Factors

The propensity to enter residential care has been extensively investigated from the perspective of medical and geriatric studies. It has been documented both in the international and Australian literature that a range of functional, mental and physical health conditions is closely associated with entry to residential care and with probability of being in such care arrangement (Kendig et al 2010; Gaugler et al 2007, 2003, 2000; Thomese & Broese 2006; Miller & Weissert 2000; Fried et al 2001; Geerlings et al 2000). Indeed, health status of older individuals, that encompasses the prevalence and incidence of health conditions (physical or mental conditions, comorbidities, and functional deficits) greatly alters the likelihood of nursing home placement (Palmer et al 2014). Furthermore, most studies agree that assistance needs, together with age, are the most important group of factors that determine an individual's entry to residential aged care (Fong, Shao & Sherris 2012; Angel et al 2004; Tomiak et al 2000). This is consistent with earlier findings that age, functional status and mental status are the best predictors of nursing home placement (Bharucha et al 2004; Foley et al 1992; Freedman et al 1994; Shapiro & Tate 1985). Interestingly, in their time-varying model of care needs, Tomiak et al (2000) have supported Andersen's claims (Andersen 1995; Andersen et al 1983) that a person's needs for assistance (predetermined by a range of health factors) are independent of both enabling and predisposing factors (Tomiak et al 2000).

Studies that examined the effects of assistance needs on the propensity of residential care entry are of special interest to this research for at least three reasons. Firstly, a substantial body of evidence has pointed out that the assistance needs of an elderly person are, after this person's age, the single most important predictor of entry to nursing home (Kendig et al 2010; Kasper et al 2010; Harris & Cooper 2006; Banaszak-Holl et al 2004; Gaugler et al 2003; Ostir et al 2001; Wang et al 2001). Secondly, Australian residential care admission and its legislation largely revolve around the assessment of care needs. Having a specific combination of assistance needs is a prerequisite of being recommended for a residential care setting. Thirdly, Australian data on aged care, both the administrative sources (ACAP & ACFI) and survey data (SDAC) include well recorded personal needs for assistance for older Australians.

A substantial body of evidence suggests that difficulty with activities of daily living (ADL)²⁸ greatly increases the risk of nursing home entry (Fong et al 2012; Latham 2011; Kasper et al 2010; Gaugler et al 2007; 2003; Harris & Cooper 2006; Bharucha et al 2004; Ostir et al 2001; Kersting 2001a; Wang et al 2001). More specifically, researchers have found that unmet demand for assistance with basic ADLs (i.e. bathing, toileting, eating, mobility) is a good predictor of an earlier entry to residential care (Kendig et al 2014, 2010; Cai, Salmon & Rodgers 2009; Gaugler et al 2007; 2003; Sands et al 2006; Gaugler et al 2003). Examining the association between some specific activities of daily living and the risk of nursing home placement, researchers have identified that not every ADL impacts the risk in the same way. For example, several studies have found that assistance with bathing and eating (Fong, Shao & Sherris 2013; Fong et al 2012), toileting (Drame et al 2012) and mobility (Hajek et al 2015; Wang et al 2001) predict earlier entry to nursing home remarkably well. Similarly, in a cohort follow-up study, Bonsdorff et al (2006) found that mobility limitation and an accumulation of various constraints in mental or physical performance increase a person's chance of being in a nursing home. More generally, two more longitudinal cohort studies (Miller et al 2008; Guralnik et al 1989) have reported that physical performance is strongly associated with future admission to residential care.

Not surprisingly, functional disability, measured as poor physical performance, may precipitate a fast trajectory towards residential care (Palmer et al 2014; Latham 2011; Giuliani et al 2008). Some studies suggest that functional disability is rarely absent as a factor of nursing home entry (Taylor & Hoenig 2004). Yet, functional disability is usually interrelated with other precipitating factors such as chronic disease or illness (Miller et al 2011; Scarmeas et al 2005). Several studies have reported that visual and hearing impairments are positively associated with the probability

²⁸ In some studies, activities of daily living (ADL) are also called instrumental activities of daily living (IADL).

of being in a nursing home (Whitson et al 2007; Friedman et al 2005). One Australian study (Jee et al 2005) has reported a significant association between early institutionalization and hearing impairments. Other studies, such as one by Wang and colleagues, observed no significant effects between this type of impairment and nursing home placement (Wang et al 2003). One possible explanation is that this study did not adjust for cognitive and functional types of impairments (Hajek et al 2015).

It has also been argued that incontinence, while not explicitly related to activities of daily living, increases the risk of being in institutional care (Andel et al 2007; Morison & Levy 2006; McCallum et al 2005; Friedman et al 2005; Banaszak-Holl et al 2004; Thom, Haan & Van den Eeden 1997). In contrast, Kendig and colleagues found that urinary incontinence was not among significant predictors of entry to care (Kendig et al 2014). Similarly, one earlier US study found that urinary incontinence was not predictive of nursing home placement, if taken as a single factor (Holroyd-Leduc et al 2004).

It is generally accepted that unexpected (acute) events, such as falls and fractures, may trigger earlier admission to a nursing home. A growing body of literature reported that falls are associated with a higher likelihood of residential aged care placement (Ritchey & Studenski 2012; Spoelstra et al 2012; Robinson et al 2011; Smith & Stevens 2009; Stillwell & Kerslake 2004; Banaszak-Holl et al 2004; Leibson et al 2002; Tinetti & Williams 1997). Researchers have also reported that the inability to perform activities of daily living, doubles the risk of fall (Rubenstein & Josephson 2006 p. 807). These authors also argued that *falls may be caused by some acute problem, such as an infection or arrhythmia, but also may be a consequence of a chronic disease (dementia, Parkinson's) or just a marker for the progression of age-related changes in vision, gait, or strength*. This is consistent with findings of other researchers who found that older adults with dementia are at high risk of falls and fractures (Rowe et al 2010). Emergency department visits or hospital admissions, in general, were found to increase the likelihood of institutionalization (Palmer et al 2014).

Assistance needs with behaviour are positively linked to nursing home entry for older persons (Bigby et al 2010; Thygesen et al 2009; Chan et al 2003). Indeed, many studies have reported that behavioural and psychiatric diseases increase the risk of residential care placement. For example, dementia (Tomiak et al 2012; Cumpston 2011; Luppá et al 2008; Andel et al 2007; Bharucha et al 2004; Hebert et al 2001), depression²⁹ (Davison et al 2007; Harris & Cooper 2006;

²⁹ The most recent reports show that 46% of people in permanent residential aged care on 30 June 2016 had depression—it was the most commonly diagnosed mental health condition (AIHW 2017).

McCallum et al 2005), Alzheimer's disease (Tomiak et al 2012; Haupt & Kurz 1993) or schizophrenia have all been associated with higher likelihood of being in a nursing home. Andrews and colleagues found that middle-aged individuals with schizophrenia have a nearly four times higher chance of being in care compared with their same-age peers with no mental illness (Andrews et al 2009). Severe cognitive diseases usually lead to an increase in an individual's need for assistance. For example, dementia and Parkinson's disease lead to cognitive impairment (Aarsland 2016) and consequently increase a person's assistance needs. Specifically, using a Cox proportional hazards linear regression Aarsland and colleagues have shown that dementia, functional impairment, hallucinations and old age were independent predictors of nursing home admission (Aarsland et al 2000). In the assessment and evaluation process prior to entry to residential care in Australia (ACAP & ACFI data), this type of assistance need is included in the BEH (behavioural) domain. Treating such diseases, however, might delay or even prevent nursing home placement (Chase & Folstein 1990). Interestingly, in a large study of persons with dementia, including their caregivers, Gaugler and colleagues found that caregiver factors, rather than disease, greatly increased the chance of nursing home placement (Gaugler et al 2000).

Complex health care requirements of older persons such as the distribution of medications are also found to be associated with risk of nursing home placement. Specifically, the number and types of medication influenced the probability of being in residential care. For example, Bharucha and colleagues reported that taking more medications increased the risk of residential care placement (Bharucha et al 2004). In a similar study restricted to a group of hip fracture patients (Leibson et al 2002), the same association was reported. Yet, in another study of persons with cognitive impairment, more medication increased risk, but having assistance with medication decreased the risk of nursing home entry (Chernew, Weissert & Hirth 2001). The number of medications taken by a person as well as types of medications were found to be associated with the risk of being in residential care (Meldon et al 2003). A highly significant association was found between use of antipsychotics and earlier placement to a nursing home (Zuckerman et al 2006).

Finally, and before moving to a brief overview of enabling factors, it is important to underscore that self-related health was also found to be an important predictor of residential aged care events. In one of their earlier studies, Gaugler and colleagues have found that self-rated health of older individuals is a significant predictor of earlier placement to residential care (Gaugler et al 2003). This is consistent with some earlier findings that posited a link between poorer self-rated health of persons living in the community and an increased risk of nursing home entry

(Weinberger et al 1986). Such findings are important for this thesis because some data sources I relied on, such as the Survey of Disability, Ageing and Carers, recorded self-related health of older Australians.

Enabling Factors

In the conceptual model used for this study (Figure 4.3), enabling factors included legislation on aged care (i.e. assessment and admission procedures), provision of operational places in nursing homes and the availability and accessibility of informal care. Chapter 1 showed that, like in many developed countries (OECD 2015; Mor, Leone & Maresso 2014), Australian residential aged care is a heavily regulated system. A set of policies and aged care acts regulate (section 1.3) how the system operates over time. Chapter 3 identified changes in the dynamics of the system, such as changes in the supply of operational places in residential aged care. The Government's policies on substitution of formal care with informal care have been discussed. Indeed, a growing body of literature has examined how these enabling factors influence nursing home admission. Those older persons with unmet needs for assistance (Gaugler, Kane, Kane & Newcomer 2005) as well as people who have not used home assistance services very much (Gaugler et al 2003) were at greater risk of nursing home placement.

As previously mentioned, enabling factors are usually country-specific. Therefore, the findings from other countries have a limited level of generalisability. In a cross-cultural study between Germany and the USA, Himes and colleagues reported that, even though the percentage of older people living in nursing homes is similar in these two countries, the age-specific rates of entry to aged care appear to be much lower in Germany than in the USA, possibly because of public policy (Himes et al 2000). In some areas where admission to care is less regulated compared to Australia, such as in Kansas (United States), residents' capacities to stay outside of nursing home are limited by the set of facility policies and discharge policies that can be more restrictive than state regulations in the behavioural domain, cognition or incontinence (Chapin & Dobbs-Kepper 2001).

In Australia, especially in remote regional areas, provision of residential aged care services might not be at the same level as in some urban or easily accessible areas (Bell & Cooper 2016; Gibson, Brown & Liu 2002). For example, the share of operational places (Figure 3.3) and the provision ratios by state and territory (Table 3.3) clearly show big discrepancies from the perspective of remoteness and geographical location. Consequently, this may affect the process of entry to residential care. McGrath et al (2006) have found that Indigenous people in remote areas of

Australia can hardly meet their care needs. These authors have also found that rural and regional patients are forced to relocate to metropolitan areas.

It has been argued by several authors that home and community care services impact residential aged care placement rates (Palmer et al 2014; Fischer et al 2003). Some research studies have reported lower rates of nursing home usage in areas that provide more community and home-based services (Temkin-Greener et al 2008). In their study of retirement community support and service programs, Elbert and Neufeld (2010) have found that older persons exposed to a wider range of community care services had lower rates of entry to residential care, when compared with national and state averages. Interestingly, some other studies reported that persons suffering from Alzheimer disease, who have more regularly used day care services, were at an increased risk of nursing home placement (McCann et al 2005). However, uncertainty surrounds the effects of use of day care services on residential care entry. For example, in a study of persons with dementia, Gaugler and his colleagues did not find differences in nursing home placement rates between individuals with lower and higher rates of usage of day care services (Gaugler et al 2003).

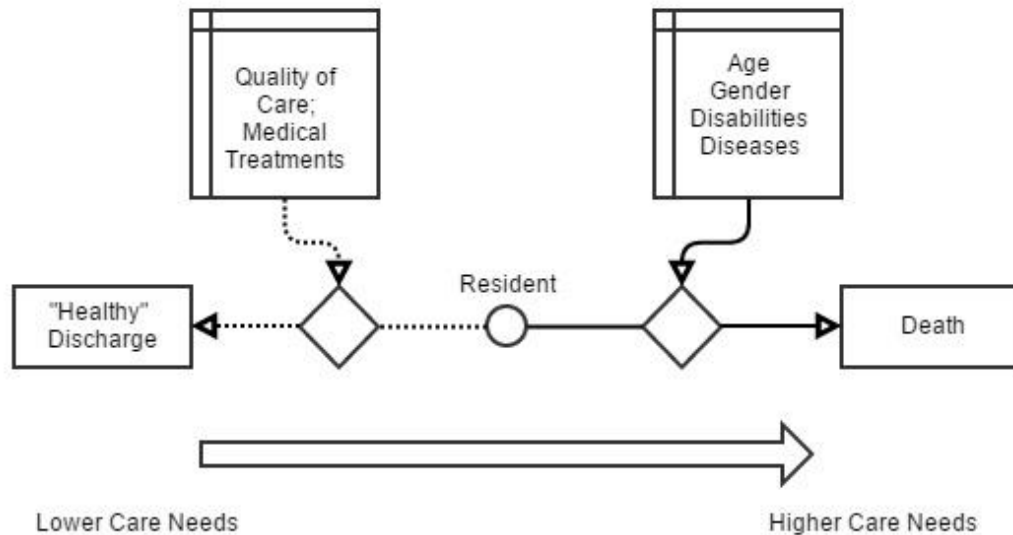
As previously outlined, the availability of informal aged care can also be perceived as an enabling factor, although it is directly related to marital status, living arrangements and social networks. For example, Geerlings and colleagues have found a significant relationship between informal and institutional care (Geerlings et al 2005). These authors argue that informal care can compensate for the lack of formal care. However, research evidence by Henderson and Caplan (2008) has suggested that the dispersed population in rural and remote areas presents significant challenges in meeting these care needs.

4.4.2 Transitions between Care Needs in Residential Care

A substantial body of evidence has shown that an individual's functional capabilities, on average, deteriorate towards higher care needs, in residential care. Variables that have been found to be associated with entry to residential care will most likely be responsible for further deterioration of an individual, and death (Porock et al 2010). A recent study based on Singaporean nursing homes (Ang et al 2015) has confirmed that degenerative, multiple or chronic conditions and disabilities present on admission are predictive of later functional decline. These authors have also found that functional decline of residents is primarily caused by progression of chronic diseases, particularly dementia (which was the main cause of functional decline in 40% of cases),

rather than development of new diseases. Most studies show that age and the presence of chronic diseases cumulatively increased the severity of functional decline.

Figure 4.4 Hypothetical transitions of an individual's care needs



Source: Author (March 2017).

Similarly, Binder et al (2003) have found age and short-term memory problems to be associated with general decline in the activities of daily living inside care. However, Ang et al (2015) pointed out that age, in many cases, may act as a surrogate of co-morbidities. Contrary to other findings, Gillen et al (1996) have argued that within the first 3 months in a nursing home, it is more likely to observe improvement in functional capabilities rather than deterioration.

As it was argued in section 4.4.1, progression of various diseases can increase an individual's care needs in residential facilities, namely cardiovascular diseases, respiratory diseases (Binder et al 2003), neurological conditions, stroke, parkinsonism, influenza (Barker et al 1998) and others. Mitchell et al (2003) have found that younger age, a recent decline in functional status, non-white race, divorced marital status, male sex and no diagnosis of Alzheimer's disease are associated with a higher chance of feeding tube use. In Australian residential care, for example, use of a feeding tube belongs to the complex health care domain (CHC).

Quality of care, although not the focus of this research, should also be briefly discussed. It is possible that institutions offering higher quality of care can facilitate functional improvement or at least slow down deterioration of a resident's health and disability status. Research evidence suggests that certain ADL exercise programmes, in the short term, can improve the health status

of older people living in residential care (Peri et al 2008; Rolland et al 2007). Similarly, Walk et al (1999) have found a positive association between quality of care and functional improvement of residents in the domains of bladder continence and bathing. Because of these findings, and some others showing significant behavioural improvement of residents after therapies (Fossey et al 2006), it is possible to argue that institutions offering a high quality of residential care can facilitate improvement in residents' disability or disease status. This may primarily be due to the presence of trained and skilled staff or better staffing ratios. For example, Bostick et al (2006) have shown an association between a higher number of licenced staff and improved quality of care. Moreover, these authors have posited a link between high staff turnover and poor resident outcomes.

4.4.3 Exits from Residential Care

Residential aged care is an important place of death for older people across different countries (Broad 2013; Van Rensbergen et al 2006). Most people who enter residential care also die there. In the period, 2011-2012, more than 92% of older Australians who entered residential care have also died there. Of those older people who left permanent care due to death, 17% died within 3 months of entry and another 8% by 6 months (AIHW 2011b). Figure 4.1 shows that residents who die in care, compared to those discharged to other places, have on average higher levels of care needs across all domains (ADL, BEH & CHC). Furthermore, it can be expected that similar factors associated with entry to care will also be associated with a deterioration of an individual's functional capabilities and with a shorter time to death.

Table 4.1 Modes of exit from residential care, by mean age and assistance needs 2011-12

Mode	Percent	Mean Age	Mean ADL	Mean BEH	Mean CHC
Death	92.2%	86.77	2.56	2.28	2.21
Other	1.2%	79.69	1.86	2.02	1.67
Return to community	3.3%	80.57	1.84	1.82	1.61
To another aged care service	1.3%	83.40	2.32	2.32	1.98
To hospital	2.0%	82.68	2.19	2.14	1.91
Total	100.0%	86.35	2.52	2.26	2.17

Source: Authors analysis based on AIHW data cubes on residents and exits (AIHW 2013b)

Predicting mortality in residential aged care is important for financial planning and adequate care provision. As previously mentioned, the same factors associated with entry to care, and with deterioration of functional capabilities inside care, are also associated with higher probability of death. Because the previous two sections have already discussed the impacts of

each factor on entries and transitions, this short section will provide additional international evidence related to exits from institutional care.

It is accepted in the international literature that mortality is closely associated with higher level of needs, presence of chronic diseases and higher age. While predicting 6-month mortality in nursing homes using the MDS Minimum Mortality Ratio Index³⁰, Porock et al (2010) found that diagnosis of cancer, shortness of breath, previous admission and renal failure are the best predictors of death within six months in residential care. Other important predictors of early exit from care that these authors have identified are increasing age, high ADL dependency and physical deterioration, poor appetite, diagnosis of dementia or Alzheimer's disease, being male, unintended weight loss over the past 90 days, chronic heart failure, increasing age and dehydration. Similarly, Ang et al (2015) have found that functional decline is associated with mortality. According to these authors, nursing home residents whose functionality declined shortly after the entry to care (35%), died within 2 years.

The probability of being discharged alive, according to Green & Ondrich (1990), can be predicted by several factors, including being of younger age, better self-reported health, lower medical acuity and better cognitive and functional capacities. Discrete-hazard modelling by these two authors has shown that owning a home is associated with higher chance of being discharged alive whereas being of Black or Hispanic race decreases the chance of being discharged alive.

An important finding by Hjaltadottir et al (2011) has revealed that health stability and ADL are strong predictors of mortality in residential care. These authors have also found that more than half of residents died within 3 years from entry to care. Furthermore, only ADL scores assessed as "High" are good predictors of mortality, according to the authors, whereas "Medium" or "Low" ADL levels were not significant in predicting mortality. Although Finnish and Australian ADL assessment levels ("High – Medium - Low") slightly differ, these findings provide a meaningful benchmark for further analyses. Similarly, Martikainen et al (2009) found that mortality in Finnish residential care varies by gender. The mean duration of care was 2.91 years for females and 1.88 years for males which are similar to the mean durations in Australian permanent residential care.

³⁰ The MMRI was derived to predict mortality using Minimum Data Set (MDS). The MDS contains around 400 items (from questionnaire) related to health and social wellbeing of care residents. (Porock et al 2010).

Before hypothesizing on the outcomes of residential aged care modelling (for Chapters 4-7) it is necessary to point out that some of the aforementioned studies (sub-chapters 4.4.1–4.4.3) have been restricted to relatively narrow geographical areas or have used small population samples, which may have limited the level of generalisability. Furthermore, several geriatrics studies have been focussed on a relatively restricted group of medical factors or diseases (i.e. cardiovascular, urinary, neurological, ophthalmologic and other) and their association with the events of entry, progression and exit from residential care. Research conducted in this thesis, as opposed to most other analyses presented in the review, relies on big data in the form of large and comprehensive administrative data sets, complemented by survey data. These data include detailed information on sociodemographic factors, assistance needs and diseases that will altogether be useful for modelling and hypothesis testing.

4.5 Hypotheses

Following from the theoretical background and conceptual models presented in Chapter 4, and to a lesser extent in Chapters 1 and 3, as well as having in mind the research questions set in 1.7, I formulate the following hypotheses:

- (1) Sociodemographic factors, including age, gender and marital status, will be significant predictors of entry to care;*
- (2) Health factors (functional disabilities, assistance needs and presence of diseases) will be by far the most important predictors of entry to and exit from residential care; These factors will also be good predictors of life expectancy in care;*
- (3) Functional capabilities of aged care residents will deteriorate in residential care reflected through intensification of their assistance needs; More people will 'move' towards upper levels in each domain of assistance needs (ADL, BEH & CHC);*
- (4) Higher care needs (ACFI) of older people who enter aged care will lead to earlier exit from care by death or, in other words, assistance needs at the moment of admission will determine the life expectancy in care;*
- (5) Australian administrative & survey data enable derivation of transition probabilities and life expectancies needed for statistical simulations.*

4.6. Modelling entries to and exits from residential aged care

Statistical modelling conducted in this study deals with residential care events, namely entry to, transition through and exit from residential aged care. These events can happen or not. Chapter 4.4 showed that the probability of residential care events was routinely measured in many studies. The outcomes of these events are binary. For that reason, and as a 'gold standard', a binary logistic regression has been heavily used throughout the thesis. In their meta-analysis of 4024 research abstracts on the prediction of nursing home admission in the US, Gaugler et al (2007) have found that most studies have relied on logistic regression as the main method of analysis.

Logistic regression analyses (odds ratios) have been suitable in this thesis because both, research questions and hypotheses were concerned with the probability of and factors associated with care-related events. Cox regression models (hazard ratios), on the other hand, although related to the logistic regression, essentially answer different questions. Whereas the logistic regression explores whether entry to residential care occurred or not, Cox survival modelling is focused on the time to residential aged care entry. Furthermore, a choice of method is often restricted by the data format. Throughout the thesis, and especially in earlier stages, data were purely cross-sectional or a combination of different sources, which enabled logistic regression models to be employed. In instances where longitudinal data were available, such as in Chapter 7, survival modelling was possible. However, the decision was made to directly estimate life expectancies based on assistance needs. Each of the methods used in this research will be further explained in the corresponding chapters.

4.6.1 Methods

Logistic regression using weighted SDAC data

As SDAC has weighted unit records of persons in residential aged care and persons in private dwellings, it can provide logistic models of the probability of being in aged care. These models may be helpful guides to the variables most relevant to entry probabilities. As the average period in residential care is about 3 years, the characteristics of residents as a whole may not be far different from those of admissions.

An initial step was a preparation for merging of the two relevant SDAC input files. First, the main health conditions were sorted using the "*dac12con*" file from the SDAC Confidentialised Unit Record File (CURF). This was followed by sorting out of the person's attributes, mainly the

demographics and the assistance needs, contained in the “*dac12per*” file sourced from the same CURF. Finally, the two files were merged to form the input for the logistic regression.

Stepwise backward logistic regression (Hosmer and Lemeshow 2000, p. 116) was used to derive models of the probability of being in residential care. At each stage of this sequential procedure, the variable giving the least reduction in the log likelihood is omitted. Only variables significant at the 10% level were retained. This method is fast, enables fine-tuning of the model and gives insights about the quality of predictor variables (i.e. the order in which variables are removed or added). However, some authors claim that this method may give unusually high R^2 values and may suffer from collinearity problems (Sribney 1996). To deal with potential collinearity, every model in this thesis has been checked for collinearity (i.e. Appendix 4.1).

Hosmer and Lemeshow (2000, p. 118-120) note that models containing more variables are sometimes sought to provide a more complete picture of possible models, and a significance level (α) of 0.25 or even larger may be a reasonable choice. The p-values calculated in stepwise selection procedures are not p-values in the traditional hypothesis testing context, but rather should be thought of as indicators of relative importance. Models with many variables may show that significant regressions are sometimes obtained from ‘noise’ variables, completely unrelated to the outcome variable. The logistic regressions in this chapter showed that a 10% significance level gave plausible explanatory variables, with very few variables in the 10% to 25% range.

High log-likelihood values are very desirable in regressions intended for use in multi-purpose projection models particularly where reasonable estimates are required for individuals. One of the main purposes of this chapter is to look at the value of different types of data for use in a projection model of residential aged care in Australia. As data collection and model building can be very costly, early information on potential value is important.

Regression using matching between resident and exit summaries

Deriving matching data from resident and exit data cubes

Tabulating residents by each combination of sex, age, ADL, BEH and CHC would in theory have given 1028 combinations. However, some combinations of these variables were non-existent in the 30/6/12 data that I was given access to meaning a total of 999 combinations can be used, representing 166,160 residents. Similarly, I had 910 combinations, representing 55,950 exits in 2011-12.

The valid resident and exit records were merged, to obtain resident and exit numbers for each combination of age, sex and ACFI variables. I omitted 97 combinations with 566 residents for which there were no exits with the same age, sex and ACFI combination. Similarly, I omitted 8 combinations with 9 exits for which residents had the same combination. Some of these mismatches may have arisen from missing ACFI details, and some by random chance. For example, if a specific combination has a low force of exit, then no exits may by random chance have occurred for that category in 2011-12. Pooling the data from several years would reduce the proportions of mismatches arising by random chance.

Fitting a regression model to resident and exit data

I divided the number of exits by the number of residents for each combination of factors. To get estimates of the force of exit, I took logs of these estimates, and fitted a linear regression model. Note that the matching method described above ensured I always had positive estimates of forces of exit. The model was fitted by backwards stepwise regression, omitting all coefficients not significant at the 10% level.

Multi-state model

Similarities between multi-state and microsimulation models

A multi-state model has been defined as a “*model for a process which at any one time occupies one of a few possible states*” (Hougaard 1999, p. 239). Statistics Canada (2015) defines microsimulation models as “*models that operate at the level of the individual behavioural entity, such as a person, family or firm*”. Multi-state modelling is a useful tool for obtaining *the correlated individualized transition rates that are required for the quantification of a microsimulation model*. (Bongers et al 2016 p. 86). For example, a household microsimulation model may be constructed using birth, death and migration assumptions from a national multi-state model, and its population projections can then be compared with the national projections.

For a multi-state model, the number of cells required for the model at any point of time is the number of possible combinations of state values (i.e. clinical states such as developing disease). For a microsimulation model, the number of cells required is the number on entities, times the number of variables recorded for each entity. When many different multi-valued variables are

relevant, then a microsimulation model is likely to need many fewer cells, and will compute more quickly.

Using a multi-state model to choose assumptions for a microsimulation model

One characteristic of microsimulation models is that they randomly generate events, so that each projection gives different results. These random variations can greatly complicate any systematic search for assumptions best fitting observed data. To avoid this problem, a simple multi-state model was created to help choose assumptions for a planned projection model.

4.7. Models of the probability of being in residential care

In a situation where a binary outcome is modelled, the linear probability model and the ordinary least square (OLS) estimation method would generate erroneous assumptions (Stapleton 2007). Specifically, such a model would potentially violate the assumption of normal distribution of the outcome variable (Kaiser 2005), it would predict values that potentially may lie outside of the unit interval [0,1] and the assumption of constant variance would be violated as well (Hosmer & Lemeshow 2000). The solution to this problem is to use link functions for binomial data and apply a logit transformation of the form $\log[\pi/(1 - \pi)]$ where π is the probability of the event happening (success) and $(1 - \pi)$ the probability of the event not happening (failure) (Agresti 2007).

I used the logistic regression (logit) to model a relationship between the binary outcome (probability of being in care) and the explanatory variables (sociodemographic factors, assistance needs and diseases). It models the logit-transformed probability as a linear relationship with the predictor variables. More formally, let π be the probability of being in care indicating success/failure with **1/0**, and let x_1 to x_i be a set of predictors. Then the logistic regression of y , on x_1 to x_i , estimates parameter values for β_0 , β_1 to β_i via the *maximum likelihood method* of the following equation:

$$\text{logit}(\pi) = \log(\pi/(1 - \pi)) = \beta_0 + \beta_1 x_1 + \dots + \beta_i x_i \quad [\text{Eq. 4.1}]$$

The regression coefficients β can be interpreted along the same lines as in linear models, bearing in mind that the left-hand-side is a *logit rather than a mean*. Thus, β_i represents the change in the logit of the probability associated with a unit change in the i-th predictor holding all other predictors constant. An alternative interpretation of the logistic regression parameter β uses

the odds ratio measure. Exponentiating both sides of the equation 4.1 results in the model of the following form, expressed in terms of the probability as:

$$\pi = \exp(\beta_0 + \beta_1 x_1 + \dots + \beta_i x_i) / (1 + \exp(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k)). \quad [\text{Eq. 4.2}]$$

This model can be interpreted in terms of odds ratios as:

$$\frac{\pi}{1-\pi} = \exp(\beta_0 + \beta_1 x_1 + \dots + \beta_i x_i) \quad [\text{Eq. 4.3}]$$

The effects of explanatory variables are multiplicative on the odds scale, which means that a unit increase in x_i multiplies the odds by $\exp(\beta_i)$. In general, exponentiating the regression parameters gives the odds ratios.

Table 4.2 Logistic model of probability of being in aged care 2012

Variable	Odds Ratio	P> z	[95% Conf. Interval]	
Age	1.204	0.000	1.136	1.276
Age square	0.999	0.003	0.998	0.999
Married	0.206	0.000	0.165	0.257
Needs help with emotional/cognitive tasks	2.888	0.000	2.112	3.948
Needs help to cope with emotions	2.105	0.000	1.525	2.906
Needs help with understanding family/friends	1.955	0.002	1.281	2.985
Needs help with communication	4.310	0.000	3.148	5.901
Needs help with dressing	1.781	0.001	1.275	2.487
Needs help with mobility about residence	2.684	0.000	2.076	3.468
Needs help with toileting	4.371	0.000	3.273	5.836
Head Injury	0.580	0.003	0.404	0.831
Dementia	2.541	0.000	1.818	3.551
Diabetes	0.719	0.043	0.522	0.989
Schizophrenia	3.859	0.002	1.612	9.241
Depression	3.172	0.000	2.392	4.206
Retardation	0.433	0.094	0.162	1.154
Epilepsy	2.853	0.013	1.244	6.541
Multiple Sclerosis	2.167	0.028	1.087	4.321
Paralysis	4.786	0.000	2.591	8.841
Heart Disease	1.653	0.000	1.283	2.130
Urinary	1.593	0.052	0.996	2.549
Constant	1.150	0.000	1.420	9.340
Number of resident records				9787
Pseudo R^2				0.799

† All predictors are binary, except age.

‡ All variables significant at 10% were retained.

§ Reference category: not married (including separated and never married); for all other predictors the ref. category is not having a need for assistance and not having a disease (condition). Except for the “married”, reference categories are those with the highest prevalence.

Source: Author’s analysis of SDAC 2012 (ABS 2012a);

Table 4.2 shows the odds ratios³¹, and confidence intervals for the odds ratios, for a logistic model fitted to SDAC 2012 by stepwise backwards regression, retaining only variables significant at the 10% level. The column headed “ $P > |z|$ ” gives *p-values* based on univariate Wald statistics which is the most appropriate test for weighted data (Hosmer & Lemeshow 2000, p. 37). Goodness of fit measures and the available model testing specifications are displayed in Appendix 4.1.

Sex was not a significant variable in the fitted model of the probability of being in aged care once other variables are taken into account. A similar result was obtained by Fong et al (2012, p. 39) for US nursing home admissions. This is in accordance with other studies (Miller & Weissert 2000; Luppá et al 2010) that did not report any conclusive evidence surrounding sex as a significant factor for the probability of being in care. However, McCann et al (2011) found evidence that sex can modify the effects of marriage or living arrangements on the risk of being admitted to residential care. An older person’s gender, as suggested by these authors, largely predetermines characteristics of their spouse (i.e. men tend to marry younger women). The odds ratio for a married person is 0.206, suggesting that a married person has only about 20% of the probability of being in aged care as an otherwise similar unmarried person. This is a stronger effect than the 0.55 odds ratio reported by Fong et al (2012) for admissions.

Furthermore, persons in aged care have about 4.3 times the probability of needing help with communication, and about 4.4 times the probability of needing help with toileting. Of all included variables, by far the highest log odds have been obtained for assistance needs. These statistically significant observations appear to support my working hypothesis that assistance needs are the most important predictors of entry to and being in residential care. Similar results were obtained in a meta-analysis by Gaugler et al (2003) who reported odds ratio of 3.25 for 3 different activities of daily living. Furthermore, these results are consistent with findings of other authors on the predictors of being in residential care (Kendig et al 2010; McCallum et al 2005; Fisher et al 1999), as well as with qualitative research on older people's reasons given for accepting admission to residential care (Van Bilsen et al 2006).

Of the disease variables, the highest effects on the probability of being in care have been found for paralysis, schizophrenia, depression and dementia. This is consistent with the findings by other authors (Aarsland 2016; Tomiak et al 2012; Andrews et al 2009; Luppá et al 2009;

³¹ In this model, odds ratios (OR) are used to compare the relative odds of the occurrence of the event of being in care, given exposure to the variables of interest (age, marriage situation, care needs, diseases). $OR > 1$ means that the exposure to a condition (i.e. dementia) is associated with higher odds of being in care; $OR < 1$ means that the exposure to such a condition is associated with lower odds of being in care.

McCallum et al 2005). For example, holding other variables constant, persons with schizophrenia have about 3.9 times the probability of being in residential care compared to persons without schizophrenia. Andrews et al (2009) obtained almost identical results, reporting the odds ratio of 4.

The variables age, agesquare and married are demographic variables. The next 7 variables in Table 4.2 are “needs” variables, and the next 11 variables are for disease conditions found to significantly affect the probability of being in aged care. All but age and agesquare are binary variables.

McFadden’s pseudo R^2 (McFadden 1974) is used to compare predictive power between logistic models. As Alisson (2013) pointed out, McFadden’s pseudo R^2 has good properties, it is intuitive, easy to calculate and works well with weighted data. If L_0 is the value of the likelihood function for a basic model with no predictors, and L_M is the likelihood for the model being estimated, then McFadden’s pseudo R^2 is defined as:

$$R_{McF}^2 = 1 - \ln(L_M)/\ln(L_0) \quad [\text{Eq. 4.4}]$$

The rationale for this equation is that the value of the likelihood function L_0 corresponds to the residual sum of squares in linear regression. Therefore, it is often referred to as the pseudo R^2 as the formula corresponds to a proportional reduction in “error variance”.

Table 4.3 Measures of predictive power and information criteria using different sets of variables

Variables	Pseudo R^2	AIC	BIC
Demographic	0.459	14.814	275838.019
Demographic, needs	0.789	5.801	-423253.119
Demographic, needs, diseases	0.799	5.509	-445812.449

† Pseudo R^2 (McFadden), AIC (Akaike’s information criteria), BIC (Bayesian information criteria).

Table 4.3 shows that demographic and needs variables gave the McFadden R^2 of 0.789. Adding diseases to the model only increased this figure to 0.799. This was helpful, as it suggested that projections based on demographic and needs for assistance data might be almost as useful for some purposes as models also including diseases.

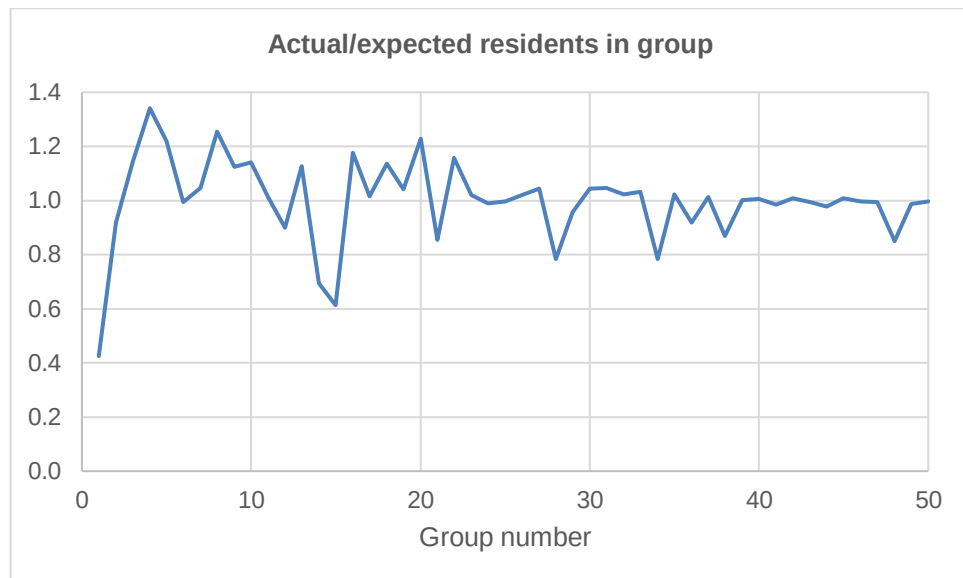
Model selection criteria such as Akaike’s (AIC) (Akaike 1974) or Bayesian information criterion (BIC) (Schwarz 1976) help us to determine which of the candidate models best approximates the data (Long & Freese 2014). These two criteria compare the models using a combination of the maximum likelihood and a number of included parameters such that the model with the highest

number of parameters is penalised. The best model is the one with the lowest values of AIC and BIC. The drop in AIC from 14,814 to 5,509 (and in BIC as well) (Table 4.3) indicates that the model including assistance needs and diseases fits the data better. The highest drop in AIC has been recorded when assistance needs were included in the model. At the same time, the inclusion of assistance needs caused the highest increase in the McFadden R^2 .

The R^2 of 0.799 is high compared with those normally obtained when developing assumptions for household microsimulation. Cumpston (2012) reported R-squares for 56 logistic analyses, with an average value of 0.137, and a maximum value of 0.58. Brouwers et al (2014) reported McFadden R-squares for 18 regressions related to health and elderly care, with an average reduction of 0.128 and a maximum value of 0.25. The McFadden R^2 of 0.799, supported by the logistic regression diagnostics (Appendix 4.1) suggests that a systematic process is being used to admit persons to residential care, and that SDAC is capturing the key variables with reasonable accuracy.

Using a procedure suggested by Hosmer and Lemeshow (2000, p. 147-150) a graph to look for local deviations from good fits was constructed. Figure 4.5 shows the estimated actual numbers of persons in residential aged care in Australia, as proportions of the expected numbers, for each of 50 groups. The fitted probability of being in aged care was calculated for each of the 77,570 person records, and multiplied by the weight for the record, to obtain expected numbers of persons in aged care. The records were sorted by fitted probability, and grouped into 50 groups with approximately equal numbers. The actual weighted numbers of persons reported as being in aged care were then divided by the expected numbers for each group, and graphed. The actual/expected ratios are close to 1, with little sign of any systematic departures. The variations around 1 are larger for the low probability groups, as the weighted nature of the SDAC file meant that there were fewer data points for the lower groups. The standard deviation of the 50 ratios is 0.154. There were 9,787 residents in the data, an average of 196 per group, suggesting that the standard deviation from resident numbers alone should be about 0.071. Figure 4.5, together with the R^2 of 0.799 (Table 4.2), suggests that a good fit has been achieved, except for the 2% of residents with the lowest probabilities of entry.

Figure 4.5 Local deviations from the good fit (for the probability of being in residential aged care)



This model of the probability of being in residential care has generated observations that appear to support some of my working hypotheses:

- Sociodemographic factors are indeed significant predictors of being in residential aged care. Of all factors, however, only age and marital status have proven to be significantly associated with higher likelihood of being in care. Factors such as gender, education, or living arrangements were not significant in this specific model [Hypothesis 1 partially accepted; Research question 1].
- Health factors, namely functional disabilities, assistance needs and presence of diseases are positively associated with higher probability of being in residential care [Hypothesis 1; Research question 1].
- Individuals' assistance needs have had the highest contribution to the log likelihood and AIC/BIC reductions and, thus, are the most important predictors of being in residential care, although diseases are also significant predictors [Hypothesis 2 accepted; Research question 1];

To sum up, Wald, McFadden and AIC/BIC tests have lent strong support to the hypothesis that the probability of being in care is determined through a combination of sociodemographic and health/needs factors as important explanatory variables. These results support my proposed theoretical model for the entry to and probability of being in residential aged care in Australia.

4.8. Models of the probability of entering aged care

For projection purposes, we are interested in the probabilities of entry to residential aged care, rather than the probabilities of being in care. From the data available to us from SDAC and the

AIHW data cubes, we cannot derive these probabilities. SDAC does not have ACFI domain values, and the data cubes only have ACFI domain values. Two possible approaches to this problem are:

- (1) Using more detailed data on aged care residents to construct predictors of ACFI values using data available in SDAC, such as needs for assistance and diseases, then using these predictors to impute ACFI values in SDAC data (Chapter 6);
- (2) Constructing detailed models of the processes of deciding to apply for approval to enter aged care, having the application approved, and then entering an aged care home.

Chapter 4 is restricted to the construction of data from SDAC and AIHW data cubes, but the above approaches will be explored in the following chapters.

4.9. Models of the probability of exiting aged care

In chapter 4.4 we have found that assistance needs were the most important predictors of the probability of being in residential care. Following from my research questions and hypotheses it is also necessary to examine whether these assistance needs can predict the probability of exit from residential care. For this purpose, a log-linear model of the following form was fitted:

$$\log(Y_i) = \beta_0 + \beta x_i + \varepsilon_i \quad [\text{Eq. 4.4}]$$

Y_i in this equation is the force of exit defined as a ratio of separations and residents, β is the estimated coefficient, x an independent variable and ε_i an error term. The literal interpretation of the estimated coefficient β is that a one-unit increase in x will produce an expected increase in $\log(Y)$ of β units. In terms of the force of exit itself, it means that the expected value of Y is multiplied by e^β . For an unlogged effect of changes in x on Y , this means that each 1-unit increase in x multiplies the expected value of Y by e^β . If an increase in x is more than one unit and if we designate such change as c , then the effect of a c -unit increase in x will multiply the expected value of Y by $e^{c \cdot \beta}$.

Table 4.4 shows the exponentials of the coefficients fitted to the model of $\log$ (force of exit from residential care). This allows the effects of particular levels of ADL, BEH and CHC on the force of exit to be estimated by multiplying their exponentiated coefficients. Confidence intervals for these exponentiated coefficients are also shown, together with p-values.

Table 4.4 Regression model of $\log$ (force of exit from residential care)

Variable	Exp(coefficient)	P> z	[95% Conf. Interval]	
Age	0.985	0.328	-0.047	0.015

Agesquare	1.000153	0.000***	1.000139	1.000167
Female	0.623	0.000***	0.603	0.643
ADL2	1.818	0.000***	1.736	1.905
ADL3	3.267	0.000***	3.116	3.427
BEH1	0.941	0.066	0.881	1.004
BEH2	0.872	0.000***	0.822	0.926
BEH3	0.782	0.000***	0.739	0.828
CHC1	1.212	0.000***	1.139	1.285
CHC2	1.300	0.000***	1.223	1.378
CHC3	1.964	0.000***	1.838	2.095
Constant	0.052	0.000***	0.045	0.058
Number of exits				55950
R-square				0.899

† Regression model is log-linear (OLS foundation), with regression coefficients being exponentiated;

‡ Results significant at the 0.1% level are marked ***, 0.1% to 1% **, and 1% to 5% *;

§ ADL (Activities of Daily Living), BEH (Behaviour), CHC (Complex Health Care).

Source: Author's analysis of ACFI boxes on residents and separations 2011-12 (AIHW 2013b);

The fitted model had an R-square of 0.899. Although the ACFI components were designed to allocate government subsidies, they also appear to be good predictors of exit rates. Deaths made up 92% of exits in 2011-12, so the exit model is probably similar to the model which would be obtained by analysing deaths. Although age was included in the regression variables, it did not prove significant at any acceptable level. The square of age was however significant, with exit rates increasing with age. Females had exit rates about 0.62 times those of males with the same age and ACFI variables. This is comparable with the 0.71 odds ratio reported by Fong et al (2012) for nursing home deaths.

The ACFI variables were numbered from 0 up, so that for example ADL2 corresponds to the third highest level of the ADL measure. Only the top two ADL levels proved significant, with the top 3 BEH and CHC levels being significant. The top ADL level had a much greater effect on the force of exit estimate than any other ACFI component. Interestingly, the top three BEH levels reduced the estimated force of exit. This may reflect the greater need for institutional care of persons with behavioural problems, resulting in their admission to aged care in better physical health than other admissions.

Table 4.5 R-square values obtained with different sets of variables (for log force of exit from residential aged care)

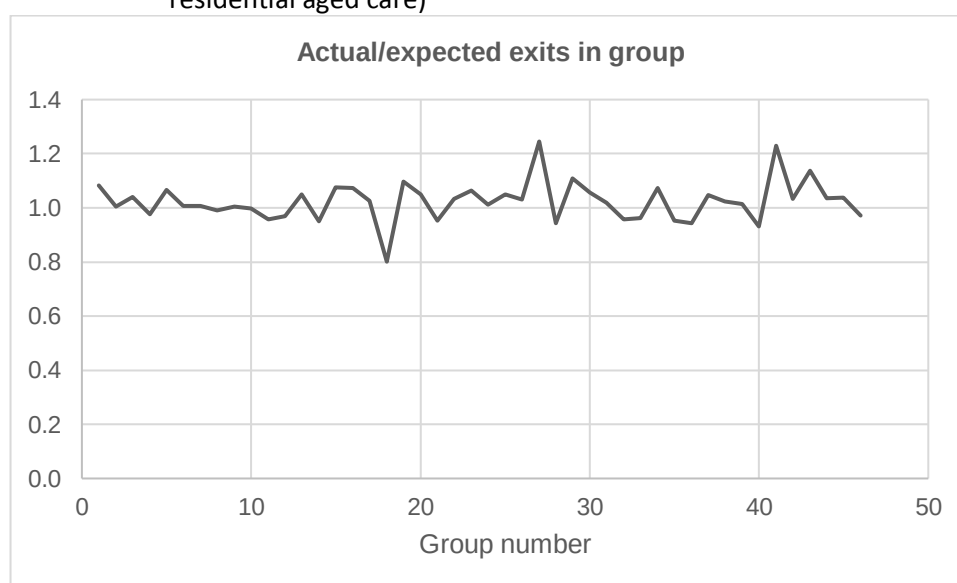
Variables	R-square	AIC	BIC
Age, sex	0.155	1.906	-4403.918
Age, sex, BEH	0.204	1.851	-4444.574
Age, sex, CHC	0.545	1.294	-4941.591
Age, sex, ADL	0.796	0.491	-5671.100
Age, sex, ADL, BEH, CHC	0.899	-0.199	-6264.017

Source: Author's analysis of ACFI boxes on residents and separations 2011-12 (AIHW 2013b);

Table 4.5 shows that the ADL, BEH and CHC variables accounted for most of the 90% R-square value obtained with the full model. ADL variables accounted for most of this value, with BEH and CHC only accounting for about 10%. Testing models with AIC and BIC criteria has also confirmed that inclusion of ADL has the most significant effect on improving the model fit. For example, adding ADLs to age and sex has reduced AIC from 1.906 to 0.491 and BIC from -4403.918 to -5671.100. Brouwers et al (2014) found that ADL dependency and the presence of dementia were pivotal background variables for the mortality of persons receiving elderly care assistance in Sweden. Disease conditions are included in the data held by AIHW for Australian aged care residents, so given unit record data it should be feasible to examine the effect of diseases such as dementia on mortality rates.

Figure 4.6 shows the actual numbers of exits from residential aged care in Australia in 2011-12, as proportions of the expected numbers, for each of 46 groups. The fitted probability of exit was calculated for each of the 902 exit summary records, and multiplied by the number of residents in the record, to obtain expected numbers of exits. The intention was to obtain 50 groups, but the unequal sizes of the 902 summary records resulted in 4 groups being empty. The records were sorted by fitted probability, and grouped into 46 groups with approximately equal numbers of expected exits. The actual numbers of exits were then divided by the expected numbers for each group, and graphed.

Figure 4.6 Local deviations from the good fit (for the probability of exiting residential aged care)



The actual/expected ratios are close to 1, with little sign of any systematic departures. The standard deviation of the 46 ratios is 0.073. There were 55,950 exits in the data, an average of 1,216 per group, suggesting that the standard deviation from resident numbers alone should be about 0.029. Figure 4.6, together with the R-square of 0.899, suggests that a good fit has been achieved.

Models of the probability of exit from residential aged care partially confirm one of my working hypothesis:

- Higher assistance needs (ACFI) will lead to earlier exit from residential care by death or, as my log-linear models show, to a higher force of exit from care [Hypothesis 4; Research question 1];
- However, it appears that only high levels in the ADL domain and assistance needs in the CHC domain are associated with higher force of exit, whereas the BEH assistance needs actually lead to a decrease in the force of exit from care.

It is important to acknowledge that models of exit presented in this chapter have relied only on ACFI cube data. These cross-sectional aggregate data contain only a limited number of variables restricted to assistance needs, age and sex. More detailed analysis of the effects of assistance needs on exit from residential care using longitudinal ACFI data is shown in Chapter 7.

4.10. Multi-state model of transitions between ACFI levels

Indirect estimates of the transition rates between ADL, BEH and CHC levels were obtained by constructing a multi-state model of aged care entries and exits, and adjusting the assumed transition assumptions to give results reasonably matching the ACFI data on entries, resident and exits.

The inputs to this modelling process were:

- ACFI data on admissions, in 5-year age groups from under 65 to 95+;
- ACFI data on residents, in 5-year age groups from under 65 to 95+;
- Estimates of exit rates, derived using the regression model in Table 4.4.

The data on admissions and residents were apportioned into one-year ages from 60 to 99. The model was incremented in one-year steps for 10 years, and the numbers and composition of the residents at the end compared with those at the start. Transitions were assumed to always be upwards one level, and transition rates out of each domain value were assumed to be of the

form $\exp(a+bx)$, where a and b are fitted parameters and x is age. We assumed transitions out of each domain occur independently, although in practice transitions may occur in more than one domain simultaneously as residents are reassessed. Each sex was treated separately.

Parameters were fitted using Microsoft's Excel Solver with a generalized reduced gradient nonlinear engine, minimizing an objective function defined as the sum of squares of the differences between the numbers of residents at the start and end of the 10 years, over the 8 5-year age groups and the 64 combinations of domain values.

The fitted transition parameters are shown for males in Table 4.6, together with calculated transition rates at ages 60 and 100. An exponential format was used to ensure non-negative transition rates. For example, the transition rate out of the second-highest CHC level at age 60 was calculated as: $\exp(-3.115 + 0.0191 \times 60)$ (i.e. 0.139).

Table 4.6 Fitted net transition rates out of ACFI levels

Initial level	Transition Constant	Transition age factor	Transition rate at age 60	Transition rate at age 100
ADL0	0.776	-0.0171	0.777	0.391
ADL1	-1.347	0.0052	0.355	0.438
ADL2	-1.648	0.0070	0.293	0.387
BEH0	-0.268	-0.0131	0.348	0.206
BEH1	-0.685	-0.0017	0.456	0.427
BEH2	-1.243	0.0018	0.322	0.347
CHC0	-1.040	-0.0003	0.347	0.344
CHC1	-1.468	0.0028	0.273	0.305
CHC2	-3.115	0.0191	0.139	0.299

Source: Author's analysis of ACFI boxes on residents and separations 2011-12 (AIHW 2013b);

The rates for transitions out of the lowest ADL and BEH levels decline markedly with age. This contrasted with approximate analyses of 5-year data for transitions out of the lowest ADL and BEH levels, which showed rates initially declining with age, and then rising with the oldest ages. Most of the fitted transition rates are broadly reasonable, but better estimates of transition rates require longitudinal data.

Fong, Shao and Sherris (2013), using longitudinal data from a sample of US adults aged 50 to 100 in 1998, found substantial rates of transition from disabled to non-disabled, dropping from about 0.15 at 60 to 0.05 at 100. However, it is unlikely that there are significant numbers of improvements in ACFI levels, as residential aged care homes are not required to report such improvements.

4.11. Discussion

In Chapter 4 it has been demonstrated how Australian aged care data, both administrative and survey, can be used for statistical modelling and derivation of transition probabilities, even when such data is not in an ideal form. Furthermore, it has been shown which variables are likely to be significant for modelling of probabilities of admission and exit from residential care. Because the theoretical and conceptual framework that was presented in the first part of this chapter will be used repeatedly throughout the thesis, in this discussion I will focus solely on the potential uses of data on residential care.

Usefulness of residential aged care data

Probabilities of care-related events and transition rates derived in this chapter have the potential to inform projections of the demand for residential care [Hypothesis 6; Research question 3]. The analyses of ACFI and SDAC data showed that Australian administrative data on aged care are comprehensive and reliable. Many different data fields are recorded, particularly on disease conditions and assistance needs. Nearly all fields appear to be filled out for nearly all records, and reasonableness checks applied. Because the ACAP process determines approvals for aged care, and ACFI assessments determine subsidies for residential aged care, there are strong incentives for the government to ensure data are reliable. The data are collected on an ongoing basis for all applicants and all residents, with relatively minor rule changes from year to year. Given their volumes and ongoing nature, the data should allow the detection and future modelling of any system changes.

Replacing the multi-state model with a projection

The multi-state model assumed stability in the numbers and composition of entrants and residents, and derived estimates of transition and exit probabilities. The ACFI system was introduced in March 2008, and has evolved as care providers and regulators have become more experienced in its use. Data from a number of recent years would be needed to get estimates of current entrant distributions, transition probabilities and exit probabilities. Using linked data following individuals through residential care would provide better estimates than the indirect method used in this chapter. Allowance could be made for disease conditions as well as needs.

In addition to those in residential aged care, there are many older persons needing lower levels of care, or trying to get admission to residential care. Using data linkages between the ACAP and ACFI data could help the extension of the projection model to include these additional persons. Such an extended projection may have management uses, both for the Australian government and for aged care providers. Ideally, a projection model of persons in aged care, or needing aged care, should be part of a representative model of the whole Australian population. As previously noted, this model should be robust enough to simulate both disease development, and the development of the needs measured by the ACFI system.

Relevance of longitudinal studies of older persons

Brown et al (2011) used nine different Australian longitudinal studies of ageing to provide data for a microsimulation model. Longitudinal studies can provide information well beyond that needed for administrative purposes, and a well-funded projection model of ageing and aged care should be able to use both cross-sectional and longitudinal administrative data.

Better access to Australian data on aged care

The National Aged Care Data Clearinghouse was established in 2013, in response to the Productivity Commission's 2011 recommendation that there be a national clearinghouse for aged care data. The Commission also recommended that the Clearinghouse should link databases and invest in de-identification of new data sets. Adoption of this recommendation would provide quicker access to some of the data, at much lower cost to users.

The purpose of the following chapter is to examine the process of application for and admission to residential care using the ACAP unit record data. This contributes to our understanding of the entry process to Australian residential care.

5. Modelling Applications for Aged Care and Approvals for Entry into Residential Aged Care in Australia

5.1. Introduction

The Aged Care Assessment Program (ACAP) is an initiative of the Australian Government and a key event on an individual's trajectory towards aged care (Department of Human Services 2017; Australian Government 1997). An ACAP assessment is undertaken when ACAT teams receive referral or application for assessment of an older person³². To be eligible for an assessment, the person needs to meet all of the following three criteria: (1) to be an 'aged person' (older than 65) or have an age-related illness; (2) give a consent to this referral (family/carer can also give the consent) and (3) have multiple service requirements or *require residential care approval*. (Department of Social Services 2016 p. 1). The assessment and approval are separate processes and therefore, there is no guarantee that assessment will result in an approval of a person as a care recipient.

Policy recommends that the ACAP assessment be comprehensive, client-focused, holistic and multi-disciplinary (Department of Social Services 2015). After a referral for an assessment is received, an ACAT team collects information about an applicant's assistance needs, living arrangements and socio-demographic characteristics. Intake documents or screening questions serve as a primary source of information about physical, psychological, social or other care needs of an applicant. ACATs can also contact the GP to assess medical needs more thoroughly, given prior consent by the applicant.

Assessment outcomes are based on core assessment activities, including: (1) Using the ACAP Toolkit for Assessors for an initial needs identification; (2) Developing a care plan with the details of the types of services recommended and (3) Coordinating care to the point of effective referral³³ (Department of Social Services 2015a). All ACAT teams comply with these procedures to promote national consistency and the utilization of appropriately validated tools.

³² In special cases ACAP assessments can consider "non-aged care people" (persons aged 60 or younger), but it must be demonstrated that aged care facilities are the most appropriate long-term care settings for such people.

³³ Effective referral is the one where client has been admitted to aged care home, or where carer is willing to provide services, or where home care provider has agreed to provide HACC package (DSS 2015a p. 18).

ACAP assessments may result in various long-term care settings being recommended. This can include residential care, home and community arrangements, hospital or other care settings. However, an ACAP approval is necessary for older persons to receive either residential or home and community care. The Australian government's administrative data, as already noted, provide rich information on older Australians moving towards care. Currently, however, the assessment data are not linked with the admission data which makes modelling of entry to care much more challenging. Modelling in this chapter focuses on the residential care application and approval outcomes (Figure 1.10).

5.2. General and Specific Aims

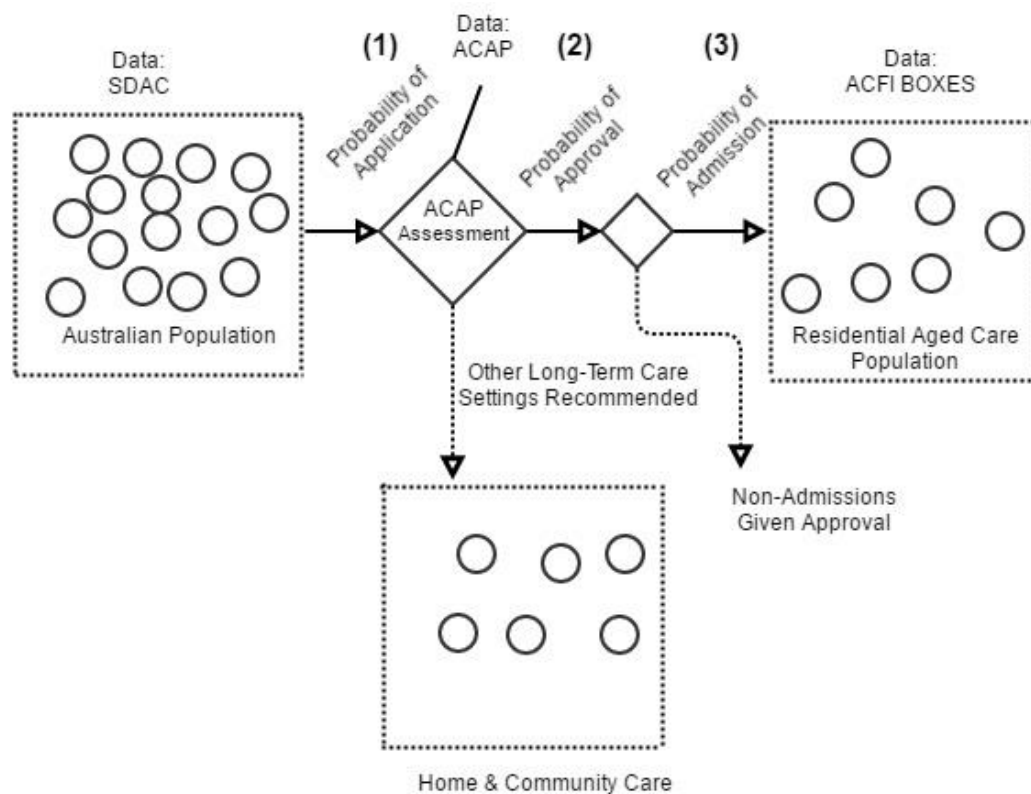
The three specific aims in this chapter are to:

- (1) Derive probabilities of an ACAP application being made by a person not in residential care;
- (2) Derive probabilities of an ACAP application resulting in approval for residential care;
- (3) Derive probabilities of approval for residential care resulting in admission to residential care;

General aims are to:

- (4) Illustrate statistical techniques to make use of unlinked data sets;

Figure 5.1 Modelling applications, approvals and admissions to residential care



In Chapter 5, the process of entry to residential aged care is modelled in three steps (Figure 5.1). The probability of application (1st step) and the probability of admission (3rd step) are modelled using logistic regression with summary results from unlinked data sets. To do so, the ACAP data were merged with the SDAC data (1st step) and with the ACFI data (3rd step) as described in 5.4.2. Although this procedure has certain drawbacks, it is used to demonstrate how unlinked data can be used to extract information on applications and admissions to Australian residential care. The probability of an application being approved for residential care (2nd step) is modelled with logistic regression, using a single unit record file.

5.3. Data Preparation

To model the entry to residential aged care, three data sets were used:

1. Survey of Disability Ageing and Carers (SDAC) 2012 (ABS 2012a);
2. Administrative data generated through ACAP (AIHW 2013a);
3. Administrative data on admissions to residential aged care, obtained from a data cube on the AIHW website (AIHW 2013b)

The 2012 SDAC survey (ABS 2012a) provided unit records for 77,570 persons and 122,382 disability conditions. The administrative ACAP data provided unit records from 846,543 applications for aged care referred to assessment teams between 1/7/10 and 30/6/2013 (AIHW 2013a). Each record had fields for 152 variables.

An initial step in the analysis of this ACAP data was to remove duplicated and incomplete assessments. We found 141,917 records with the same referral and approval dates as another record, and another 94,134 records with the same referral date as an approved record but with blank approval date. These 236,051 observations were dropped, giving 610,492 unit records (Table 5.1) included in the final analysis. The STATA (v13) software package was used for all data tabulations and statistical analyses (StataCorp 2013). Out of all applicants for aged care, 51.3% were between ages 80 and 90, and 60.5% were female. In total, 512,179 assessments were completed (Table 5.2) and 207,039 older people were recommended for residential aged care (Table 5.3).

The SDAC and ACAP numbers were merged to create input records for logistic analyses. For variable combinations where the ACAP number was higher than the SDAC estimate, the ACAP number was reduced to equal the SDAC number. Analyses of the probability of applying for aged

care are made from synthetic unit records, created by combining ACAP data with data from the Survey of Disability Ageing and Carers 2012. Analyses of the probability of an application for care resulting in approval for residential aged care are based on the ACAP assessment records.

Table 5.1 Aged care assessments (ACAT) from 1 July 2010 to 30 June 2013

Age Group	Males		Females		Total	
	%	No.	%	No.	No.	%
>50	0,47	1129	0,29	1067	2196	0.4%
50–54	0,61	1468	0,36	1326	2794	0.5%
55–59	1,15	2764	0,71	2630	5394	0.9%
60–64	2,75	6605	1,66	6130	12735	2.1%
65–69	6,03	14515	4,09	15101	29616	4.9%
70–74	9,82	23626	7,83	28936	52562	8.6%
75–79	16,16	38862	14,40	53232	92094	15.1%
80–84	25,37	61018	24,91	92052	153070	25.1%
85–89	24,22	58256	27,44	101431	159687	26.2%
90–94	11,03	26537	14,42	53306	79843	13.1%
95–99	2,20	5294	3,52	13019	18313	3.0%
100+	0,19	445	0,37	1354	1799	0.3%
Missing					389	0.1%
Total	100.0%	240519	100.0%	369584	610492	100.0%

Source: (AIHW 2013a).

Table 5.2 Reasons for ending ACAT assessments

Reason for ending ACAT assessment	Number	%	Mean Days
1. Assessment complete	512179	83.9	18
2. Client withdrew	36626	6.0	28
3. Client died	5213	0.9	24
4. Client transferred to another ACAT	3494	0.6	21
5. Medical condition unstable	22987	3.8	17
6. Functional condition unstable	3389	0.6	11
7. Other reason	25377	4.2	23
9. Not stated/inadequately described	936	0.2	26
Missing	291	0.0	
Total	610492	100.0	19

Source: (AIHW 2013a).

Table 5.3 Recommended long term care setting from 01/07/2010 to 30/06/2013, after removing the duplicates

Type of setting	Number	%
1. Private residence	275521	53.8
2. Independent living in a retirement village	20626	4.0
3. Supported community accommodation	3229	0.6
4. Residential aged care - low care	80544	15.7
5. Residential aged care - high care	126495	24.7
6. Hospital	272	0.1
7. Other institutional care	308	0.1
8. Other	4522	0.9
99. Not stated/inadequately described	488	0.1
Missing	174	0.0
Total	512179	100.0

Source: (AIHW 2013a).

The data cube for admissions to residential aged care in 2011-12 on the AIHW web site (AIHW 2013b) gave data on 58,574 admissions, subdivided by sex, 5-year age group and state.

5.3.1 Derivation of assistance codes compatible with ACAP codes

Unlinked data sets may not have identical coding systems. Table 5.4 shows how assistance codes from SDAC 2012 (ABS 2014) were grouped to form codes broadly compatible with those used in the ACAP data. Each of the SDAC codes has two levels, 1 for help always needed, and 2 for help sometimes needed. Either of these two levels were assumed to be sufficient for the SDAC code to apply. Several SDAC codes can be equivalent to one ACAP code. For example, both the SDAC codes for *“mobility about place of residence”* and *“mobility away from place of residence”* were assumed to be equivalent to the ACAP code *“almoving”*.

Table 5.4 Conversions from SDAC to ACAP assistance codes

SDAC code	SDAC description	ACAP code
LVLADNKB	Level of assistance needed understanding someone does not know	alcomm
LVLAFAMB	Level of assistance needed understanding family and friends	alcomm
LVLCOMMR	Level of communication limitation	alcomm
LVLODNKB	Level of assistance needed being understood by someone does not know	alcomm
LVLOFAMB	Level of assistance needed being understood by family or friends	alcomm
LVLMOBBC	Level of assistance needed transferring to or from bed or chair	almove
LVLMOBFH	Level of assistance needed with mobility away from place of residence	almoving
LVLMOBAH	Level of assistance needed with mobility about place of residence	almoving
LVLBATHE	Level of assistance needed with showering or bathing	alself
LVLBOWEL	Level of assistance needed with bladder or bowel control	alself
LVLDRESS	Level of assistance needed with dressing	alself
LVLEATIN	Level of assistance needed with eating	alself
LVLTOILT	Level of assistance needed with toileting	alself
LVLPUBTR	Level of assistance needed to use public transport	altrans

Sources: ABS 2014; AIHW 2015d.

Table 5.5 shows the descriptions of each of the 5 ACAP codes in table 1, taken from the Clearinghouse data dictionary (AIHW 2015d).

Table 5.5 ACAP assistance codes

ACAP code	ACAP description
alcomm	Needing the assistance or supervision of another person with understanding others, making oneself understood by others.
almove	Needing the assistance or supervision of another person with activities such as maintaining or changing body position, carrying, moving and manipulating objects, getting in or out of bed or a chair.
almoving	Needing the assistance or supervision of another person with walking and related activities, either around the home or away from home.
alself	Needing the assistance or supervision of another person with daily self-care tasks such as eating, showering/bathing, dressing, toileting and managing incontinence.
altrans	Needing the assistance or supervision of another person with using public transport, getting to and from places away from home or driving.

almeals	Needing the assistance or supervision of another person with meals, including the delivery of prepared meals, help with meal preparation and managing basic nutrition.
aldom	Needing the assistance or supervision of another person with household chores such as washing, ironing, cleaning and formal linen services.
alsocial	Needing the assistance or supervision of another person with shopping, banking, participating in recreational, cultural or religious activities, attending day centres, managing finances and writing letters.
alhealth	Needing the assistance or supervision of another person with taking medication or administering injections, dressing wounds, using medical machinery, manipulating muscles or limbs, taking care of feet (includes a need for home nursing and allied health care, such as physiotherapy and podiatry).

Source: AIHW 2015d.

5.4. Methods

Logistic regression was used to derive probabilities of application, approval and admission to residential care. The option to report estimated coefficients, rather than estimated odds ratios, was used. The regression technique is the same in each stage of modelling of the residential aged care trajectory (Figure 5.1), but the file preparation required a different approach. In the first (1) and the last step (3), the statistical merging procedure had to be performed because these data sets were not linked. In step 2, the procedure was much simpler because a single unit record data (ACAP) was used to derive the probability of approval for residential care. Each ACAP record in the second step is about an application by a person for aged care, including a code to show whether the application resulted in approval for residential care. Thus, the interpretation of the logistic models in the second step was straightforward, and all the normal output details such as coefficient estimates, standard errors and significance levels were useable (Table 5.7).

A single data source that would cover the processes of application, approval and admission to residential aged care in Australia is currently not available. An alternative way of modelling of the residential care trajectory is to use unlinked sources. Data sets used in this chapter cover the same population of interest (older Australians in different stages of entry to residential care) and these sources can be used to infer information on most likely personal trajectories towards residential care. However, the methods used to statistically link different data sets, representing the same target group, rarely result in perfect linkage (Chambers 2008). Following from research aims, and having in mind financial constraints, the focus in this thesis is to identify the factors that influence the residential care trajectory rather than to establish ‘perfect’ linkage of different data sources on aged care.

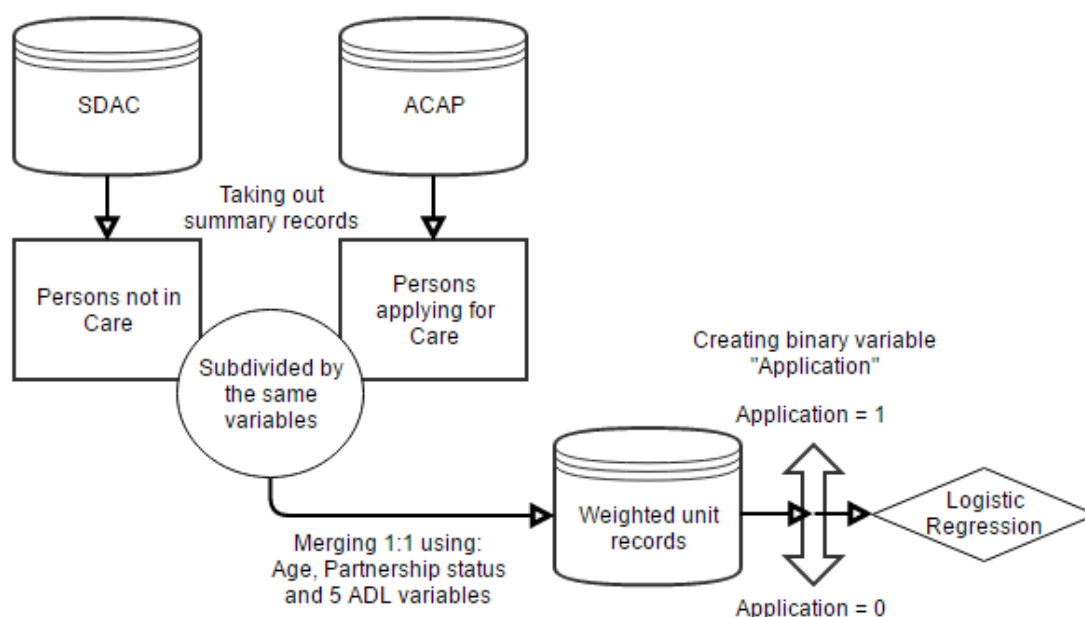
5.4.1 Preparing summaries of unlinked data sets

Using regression analysis on incompletely linked data, particularly in cases where one data set is a sample from the target population, is not uncommon (Kim & Chambers 2009). For example,

the SDAC survey is a sample of the Australian population of both persons in and out of residential care whereas the ACAP administrative data includes all people who applied for residential care. In cases where different data sources share a set of common variables, researchers can combine them (Fellegi & Sunter 1969) without necessarily assuming further hypothesis (Vantaggi 2008). Following such practice, SDAC and ACAP were merged to create summary records and to enable derivation of the logistic regression models.

One summary record contained persons not in residential care, subdivided by sex, 5-year age group, partnership status, care needs and state, obtained as weighted totals from SDAC 2012 (Figure 5.2). Another summary record that was obtained from ACAP, contained persons applying for aged care in 2012, subdivided by the same variables. The two sets of summary records were then merged to create weighted unit records suitable for logistic regression. For each variable combination, two records were created: one with the number not applying for aged care, and a second record with the number applying.

Figure 5.2 Using summary records to merge unlinked data (SDAC & ACAP)



† The same procedure is used in the modelling step 3 (ACAP & ACFI; see Figure 5.1)

This use of summary records from unlinked data sets created a problem where the number of persons recorded as applying for care (ACAP) was greater than the number of persons with the same combination of variables in the SDAC estimates. This problem was resolved by reducing the recorded numbers applying to be no greater than the estimated numbers available to apply.

This technique was used to prepare files for the logistic regression models presented in Tables 5.7 and 5.9.

Table 5.7 in the *Results* section shows logistic regression coefficients and standard errors for three different models, derived from the unlinked SDAC 2012 and ACAP data sets using summary results from unlinked data sets.

The three fitted models were:

- Model A, based on the numbers of each combination of sex, six age-groups, partnership and two assistance needs (96 combinations)
- Model B, based on the numbers of each combination of sex, six age-groups, partnership and five assistance needs (768 combinations)
- Model C, based on the numbers of each combination of sex, six age-groups, partnership, five assistance needs and eight states (6144 combinations).

The ACAP data contained 138,290 records of first applications for aged care made in 2012. Because of the merging process, some ACAP applications were discarded when there were no matching SDAC records. Further ACAP records were removed to ensure that the numbers of ACAP applications in a category did not exceed the number of SDAC records. The numbers of ACAP records lost for these reasons, and the retained numbers, are shown in Table 5.6 for each model. For example, in model B, 6514 ACAP records had no matching SDAC records, and a further 4678 ACAP records were removed to ensure that ACAP numbers did not exceed SDAC numbers. Model A retained 99.3% of ACAP records, model B 91.9% and model C 75.8%. The high numbers of records lost for models B and C make them of lower practical validity.

Table 5.6 Matching details for models of the probability of application for aged care

Model	ACAP records not merged with SDAC records	ACAP records in excess of SDAC records	Retained ACAP records	Total ACAP records	Retained as % of total
A	0	1031	137259	138290	99.3%
B	6514	4678	127098	138290	91.9%
C	31825	1706	104759	138290	75.8%

† Matching details are for the models A, B, C also presented in Table 5.7

5.4.2 Allowances for sampling variability in SDAC estimates

SDAC is a survey of 77,570 persons, and weights are provided to allow unbiased estimates for all Australians. These weighted estimates are used as exposure data for the regressions described in section 5.4.1. A different sample of 77,570 persons would have given different results. To allow for this sampling variability, 10 repeated simulations of the SDAC totals were made, replacing each total with a Poisson random variable with the same mean. Logistic regressions were done with each of the 10 sets of simulated totals, for each of models A, B and C. The coefficients shown in Table 5.7 are the means of the coefficients from each of the 10 regressions, and the standard errors (SE) are the standard deviations of the 10 regression coefficients.

5.5. Results

5.5.1 Models of the probability of application for aged care

Table 5.7 Models of the probability of application for aged care

Variable	Model A			Model B			Model C		
	Coeff.	SE	Sig.	Coeff	SE	Sig.	Coeff	SE	Sig.
Female	-0.338	0.086	***	-0.272	0.083	*	-0.183	0.046	**
Age 60-64	-3.020	0.123	***	-3.034	0.098	***	-3.201	0.084	***
Age 65-69	-2.002	0.091	***	-2.065	0.058	***	-2.232	0.076	***
Age 70-74	-1.313	0.119	***	-1.309	0.103	***	-1.483	0.100	***
Age 75-79	-0.757	0.094	***	-0.722	0.080	***	-0.787	0.064	***
Age 80-84	-0.309	0.155		-0.285	0.109	*	-0.318	0.145	
Partner	-1.422	0.082	***	-1.349	0.078	***	-1.439	0.053	***
Alself	2.204	0.102	***	2.081	0.090	***	1.673	0.100	***
Altrans	1.595	0.048	***	1.577	0.038	***	1.364	0.057	***
Alcomm				0.104	0.117		0.069	0.135	
Almove				-0.336	0.101	*	-0.274	0.093	*
Almoving				-0.222	0.117		-0.771	0.174	**
Victoria							0.178	0.057	*
Queensland							-0.105	0.072	
South A.							-0.324	0.101	*
Western A.							0.047	0.098	
Tasmania							-0.416	0.104	***
Northern T.							-0.168	0.147	
ACT							-0.802	0.125	***
Constant	-2.841	0.102	***	-2.863	0.101	***	-2.803	0.073	***
LLR	0.401	0.008		0.364	0.007		0.313	0.007	

† Reference categories: Age 85+; Male; Not having a partner; Not having any ADL; State NSW.

‡ The above results are the means and standard deviations from 10 trials for each model.

§ Significance levels were determined using a two-sided t-test with 8 degrees of freedom.

¶ Results significant at the 0.1% level are marked ***, 0.1% to 1% **, and 1% to 5% *.

The last line of Table 5.7 shows the average log likelihood reduction (LLR) for the 10 regressions for each model, and their standard deviations. STATA logistic regression outputs show LLR values

as “Pseudo R2”. Log likelihood is a probability measure that is maximised in logistic regression (Hosmer and Lemeshow 2000). The LLR is calculated as:

$$1 - (\log \text{likelihood for fitted model}) / (\log \text{likelihood for constant probability model}).$$

Surprisingly, the LLRs for models B and C are lower than for model A, even though they use more explanatory variables. Discarding applications where there are no matching SDAC records (Table 5.6) appears to be introducing errors into the data, and thus reducing the fit achievable.

Relative to persons aged 85+, younger persons are much less likely to apply for aged care. For example, the mean regression coefficient in model A for persons aged 60-64 was -3.020, and exponentiating suggests that the probability of application is about 0.049 times that for a similar person aged 85+. In model C, the mean coefficient for persons aged 60-64 was -3.201, a change of 0.181. This change partly reflects the age-dependent dropping of records to derive model C - the number of applications by persons 60-64 in model C was 66.2% of that in model A, compared with 78.9% for persons aged 85+. This should have changed the magnitude of the coefficient for 60-64 by about $\ln(.789/.662)$, i.e. by about 0.176.

The mean regression coefficient in model A for partnered persons was -1.422, suggesting that their probability of application is about 0.241 times that of an unpartnered person. This is plausible, as the presence of a partner should reduce the need for external care.

Model A gave a mean regression coefficient of 2.204 for “*alself*” (help needed with self-care) and 1.505 for “*altrans*” (help needed with transport). Re-running model A without these two variables gave a mean LLR of 0.194, much lower than the LLR of 0.401 for model A. Needs for help with self-care and transport are thus strong predictors of the probability of an application for aged care being made. By contrast, model B shows that needs for help with communication, movement activities and moving around are weak or even negative predictors of applications for aged care.

The mean regression coefficients for each state and territory in model C show a surprising range. The large negative coefficients for Tasmania and the ACT may be artefacts of the substantial losses of application records in model C, rather than measures of real differences.

Matching details (Table 5.6) and comparison of the results (Table 5.7) strongly support Model A as the most sensible model of the probability of application for residential aged care that could

be derived by combining SDAC and ACAP data. Standard post-estimation diagnostic tests were used to ensure the accuracy of the model (Appendix 5.7).

5.5.2. Models of the probability of approval for residential care

Table 5.8 shows logistic regression coefficients and standard errors for three different models, derived from 599,719 ACAP records with application dates from 1/7/10 to 30/6/13, for persons aged 60+. Significance levels, as calculated by the regression, are shown using asterisks.

The fitted regression coefficients in Model A are generally lower in magnitude than those in Table 5.7. For example, the coefficient for age 60-64 relative to age 85+ in Table 5.8 is -0.638, compared with -3.020 in Table 5.7. Table 5.7 estimates probabilities of persons making application for care, while Table 5.8 estimates probabilities of an applicant being approved for residential care. It seems that the decision to apply for care selects persons with relatively high care needs so that regression analyses of the approval process for residential care are unlikely to show large coefficients for any characteristic.

Including 8 needs variables in Model A increased the LLR from 0.055 to 0.221 ($p < 0.001$). Needs variables are clearly important predictors of probabilities of applications for care resulting in approval for residential care. The estimated coefficient for “*alself*” (help with self-care) reduced from 2.204 in Table 5.7 to 0.590 in Table 5.8, while that for “*altrans*” (transport) reduced from 1.595 to 1.037. All the 8 needs variables gave highly significant increases in the probabilities of approval for residential care.

Including 18 ICD disease groups in Model B increased the LLR from 0.221 to 0.244 ($p < 0.001$). Of the 18 disease groups, 15 gave highly significant increases in the probability of approval for residential care. The 3 highest coefficients were 0.375 for group 2 (neoplasms), 0.611 for group 5 (mental/nervous diseases) and 0.433 for group 15 (congenital diseases).

Including the 8 states and territories increased the LLR from 0.244 to 0.250 ($p < 0.001$). All the estimated coefficients were highly significant. For South Australia and the ACT, large positive coefficients in Table 5.8 are approximately balanced by negative coefficients in Table 5.7, suggesting that lower application rates for aged care are resulting in higher rates of approval for residential care. No such balancing is evident for Western Australia and the Northern Territory. Regional differences in health and administrative procedures (composition of the ACAT teams) may underlie the state differentials in Tables 5.7 and 5.8.

Table 5.8 Models of the probability of approval for residential care

Variable	Model A			Model B			Model C		
	Coeff.	SE	Sig.	Coeff.	SE	Sig.	Coeff.	SE	Sig.
Female	-0.191	0.007	***	-0.155	0.007	***	-0.155	0.007	***
Age 60-64	-0.638	0.021	***	-0.627	0.022	***	-0.607	0.022	***
Age 65-69	-0.693	0.014	***	-0.709	0.015	***	-0.698	0.015	***
Age 70-74	-0.617	0.011	***	-0.640	0.012	***	-0.631	0.012	***
Age 75-79	-0.494	0.009	***	-0.526	0.009	***	-0.523	0.009	***
Age 80-84	-0.296	0.008	***	-0.325	0.008	***	-0.323	0.008	***
Carer	0.229	0.008	***	0.142	0.008	***	0.146	0.009	***
Partner	-0.439	0.008	***	-0.467	0.008	***	-0.467	0.008	***
Alself	0.590	0.008	***	0.584	0.008	***	0.564	0.008	***
Almove	0.316	0.008	***	0.375	0.008	***	0.369	0.008	***
Almoving	0.136	0.007	***	0.141	0.007	***	0.104	0.007	***
Alcomm	0.547	0.009	***	0.475	0.009	***	0.462	0.009	***
Adlhealth	0.707	0.009	***	0.549	0.009	***	0.576	0.009	***
Altrans	1.037	0.013	***	0.843	0.013	***	0.839	0.013	***
Adlsocial	0.793	0.010	***	0.612	0.011	***	0.615	0.011	***
Adlother	0.319	0.014	***	0.250	0.014	***	0.275	0.015	***
ICD1				-0.055	0.025	*	-0.095	0.025	***
ICD2				0.375	0.008	***	0.383	0.008	***
ICD3				0.092	0.013	***	0.080	0.013	***
ICD4				0.057	0.006	***	0.061	0.006	***
ICD5				0.611	0.007	***	0.618	0.007	***
ICD6				0.147	0.008	***	0.141	0.008	***
ICD7				0.156	0.007	***	0.166	0.007	***
ICD8				0.161	0.008	***	0.171	0.008	***
ICD9				0.242	0.007	***	0.253	0.008	***
ICD10				0.115	0.008	***	0.120	0.008	***
ICD11				0.085	0.007	***	0.077	0.007	***
ICD12				0.091	0.012	***	0.105	0.012	***
ICD13				0.121	0.006	***	0.114	0.006	***
ICD14				0.129	0.007	***	0.146	0.007	***
ICD15				0.433	0.067	***	0.310	0.067	**
ICD16				-0.350	0.008	***	-0.337	0.008	***
ICD17				0.354	0.007	***	0.402	0.007	***
ICD18				0.020	0.021		0.020	0.021	
Victoria							-0.102	0.008	***
Queensland							0.118	0.010	***
South Australia							0.453	0.013	***
Western Australia							0.428	0.012	***
Tasmania							-0.209	0.019	***
Northern Territory							-1.026	0.046	***
ACT							0.580	0.031	***
Constant	-2.247	0.011	***	-2.661	0.013	***	-2.757	0.014	***
LLR	0.221			0.244			0.250		

† Reference categories: Age (Age 85+); Gender (Male); Partner (Not having a partner); Carer (Not having a carer); ADL (Not having an ADL); ICD (Not having an ICD); State (New South Wales).

‡ Results significant at the 0.1% level are marked ***, 0.1% to 1% **, and 1% to 5% *.

§ Disease variables are: icd1 (infections/parasitic diseases); icd2 (neoplasms); icd3 (blood); icd4 (endocrine, nutritional & metabolic); icd5 (mental/behaviour); icd6 (nervous system); icd7 (eye); icd8 (eye & adnexa); icd8 (ear & mastoid); icd9 (circulatory); icd10 (respiratory); icd11 (digestive); icd12 (skin & subcutaneous); icd14 (genitourinary); icd15 (congenital); icd16 (injury & poisoning); icd17 (abnormal symptoms & signs); icd18 (not elsewhere specified)

Models A, B and C were also compared using the Akaike and Bayesian information criteria (AIC and BIC) to determine which model better approximates the data. Although both criteria drop when an additional set of variables is included (diseases in Model B and states in Model C), the decrease is relatively small (Appendix 5.8). Nonetheless, the biggest drop in AIC and BIC, and at the same time the highest increase in the McFadden Pseudo R^2 , is recorded when diseases (ICDs) were included in the model (Model B).

5.5.3 Models of the probability of entry to residential aged care given approval

Table 5.9 shows logistic regression coefficients and standard errors for two models, derived from the unlinked ACFI and ACAP data sets using a similar technique to that used for modelling the probability of an application for aged care (as in Table 5.7).

Age groups are important predictors of entry to residential aged care given approval. Relative to those people aged 85 and over, younger persons are less likely to enter residential aged care. Sex was not a significant predictor of entry, which is compatible with the finding by Karmel, Powierski & Anderson (2014) that, once approved for permanent residential aged care, men and women had similar take-up rates of such care (49%) within 12 months of approval. Combined ACAP and ACFI data used for these two models had 110,793 approvals for residential care in 2011-12, and 58,574 admissions, a take-up rate of 53% at any duration.

Table 5.9 Models of admissions to residential aged care

Variable	Model A			Model B		
	Coeff.	SE	Sig.	Coeff.	SE	Sig.
female	-0.007	0.012		-0.005	0.012	
Under 65	-0.097	0.033	***	-0.088	0.034	***
Age 65-69	-0.372	0.031	***	-0.364	0.031	***
Age 70-74	-0.351	0.024	***	-0.348	0.024	***
Age 75-79	-0.352	0.018	***	-0.352	0.018	***
Age 80-84	-0.246	0.015	***	-0.249	0.015	***
Victoria				-0.185	0.015	***
Queensland				-0.791	0.017	***
South Australia				0.019	0.023	
Western Australia				-0.767	0.021	***
Tasmania				0.029	0.038	
Northern Territory				0.035	0.114	
ACT				-0.725	0.051	***
Constant	0.270	0.011	***	0.425	0.014	***
LLR	0.004			0.014		

† Reference categories: Age (Age 85+); Gender (Male); State (New South Wales).

‡ Results significant at the 0.1% level are marked ***, 0.1% to 1% **, and 1% to 5% *.

Including the eight states and territories only slightly increased the LLR from 0.004 to 0.014 ($p < 0.001$). Queensland, Western Australia and the ACT had strongly negative coefficients. These variations could have been caused by variation in the supply of residential aged care places. However, to further explore such differences more detailed data are needed. Ideally, ACAP data would be linked to the ACFI admissions data (not limited to ACFI cubes) and provided at a smaller geographical level.

Currently, and due to data availability, it is not possible to derive detailed statistical models that would capture personal trajectories between the approval and the admission to residential care. Models presented in Table 5.9 rely only on a very small set of common variables between ACAP and ACFI cubes (gender, age and state). In the absence of assistance needs or disease variables, and without full information on take-up of residential care for each approved person, the models could only achieve LLRs of 0.004 and 0.014.

5.6. Discussion

5.6.1 Predictors of the residential aged care application, approval and entry

The results show that assistance needs are strong predictors of the probability of applying for aged care and of being approved for residential aged care [Hypothesis 2; Research Question 1]. Likewise, demographic factors (age, sex, partnership status and carer availability) were found to be statistically significant predictors of the application and approval for residential aged care [Hypothesis 1; Research Question 1]. Diseases are also strongly associated with the probability of approval for residential aged care, but inability to fully link SDAC, ACAP and ACFI does not allow a comprehensive examination of the effects of diseases on the probability of application and admission to residential aged care. Nonetheless, in Chapter 4 it is demonstrated that some diseases significantly increase the probability of being in residential care.

5.6.2 Usefulness of Australian administrative data on aged care

The ACAP data are the result of detailed assessments performed on most applicants for aged care. As shown in Table 5.8, the large numbers and many data fields allow the derivation of multi-purpose models [Hypothesis 5; Research Question 3]. Even though there are no low-cost methods to allow ACAP data to be linked with other administrative data in the NACDC, the ACAP data can be used to derive valuable information on the Australian aged care system.

Table 5.7 shows that adding variables to logistic regression models based on unlinked data gives increasingly poor fits mostly due to loss of records in the matching procedure (the LLR drops from 0.40 in Model A to 0.31 in Model C) (Appendix 5.7). It would be valuable if AIHW adopted the Productivity Commission's 2011 recommendation (Productivity Commission 2011) that the AIHW NACDC should link databases and invest in de-identification of new data sets. Having in mind all the data limitations, data from the National Aged Care Data Clearinghouse can be used to model the residential aged care trajectory and derive probabilities of care related events (applications, approvals, admissions). Linking data sets within the Clearinghouse (ACAP and ACFI), as recommended by the Productivity Commission, would enable more accurate statistical models that would lay a foundation for the development of aged care projections.

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6. Transition and Mortality Assumptions based on Care Needs of Older Australians

6.1. Introduction

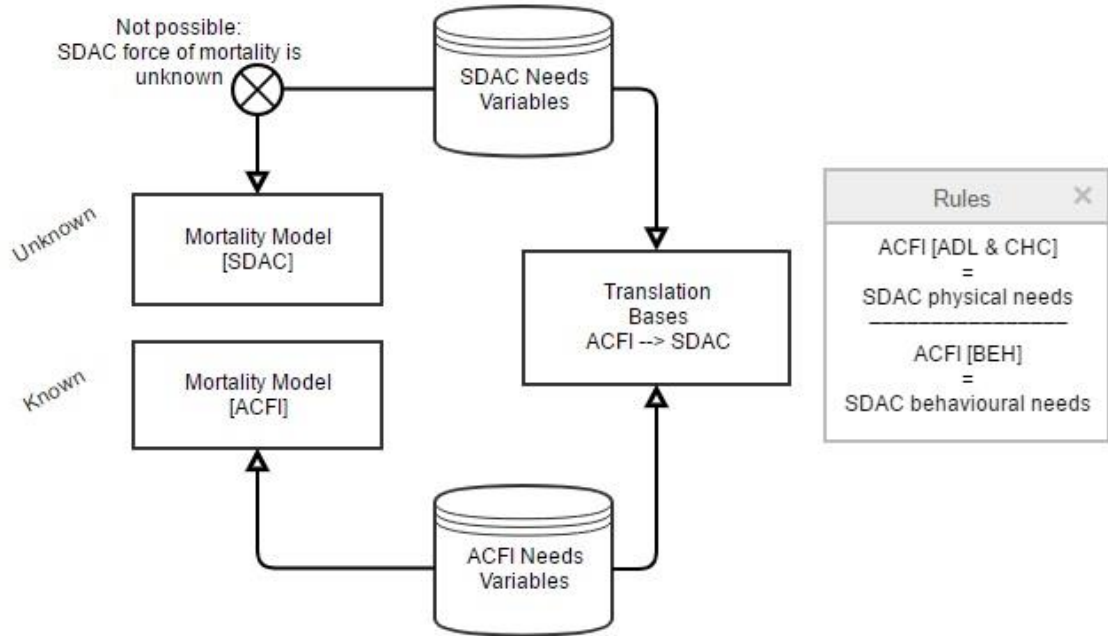
To be reliable and accurate, any projection or simulation of large systems needs to be based on a complete ‘picture’ of the process being projected or simulated. Throughout this study, it has been reiterated that, although rich in information, Australian data on aged care are fragmented and disconnected. Because SDAC is the only source that has information about the population in residential care and in private dwellings, it can be used to derive models of the probability of being in residential care, as demonstrated in Chapter 4.7. However, being a survey, SDAC does not contain information on deaths that is needed to derive the force of mortality. On the other side of the residential aged care trajectory, ACFI cross-sectional data allow models of the probability of exit from residential care to be constructed (Chapter 4.9), but the ACFI data cover only events that happen at the end of residential aged care trajectory.

Because both SDAC and ACFI contain a set of care need variables, it is possible to allocate the ‘*translation bases*’ between each corresponding variable. These bases or rules can be then used to approximate transition and mortality rates for persons in ACFI, to the persons in SDAC, where such transitions and rates are unknown. Based on this procedure, it is possible to construct the force of mortality model based on the SDAC care assistance needs variables and to derive transition rates between these variables. Using such a framework, Chapter 6 examines whether the available Australian care data contain necessary inputs for a holistic projection model of the demand for residential aged care.

Aged care legislation is yet another compelling reason to connect fragmented data. Australian Government subsidies to residential aged care facilities are based on the Aged Care Funding Instruments (ACFI), which assess four levels of each of the three care-assistance domains (ADL, BEH & CHC). Knowing an older person’s approximate scores in these domains prior to aged care entry is valuable because it can help in planning aged care needs. Combining the prevalences of specific assistance needs with the transition and mortality rates would lead to better projections of residential aged care. Moreover, such knowledge enables estimation of life expectancies for a sample of individuals of different ages and combinations of assistance needs.

Figure 6.1 summarizes the procedures used to derive the transitions and mortality assumptions based on care needs of older Australians.

Figure 6.1 Practical steps in deriving transition and mortality assumptions based on care needs of older Australians, using SDAC survey and ACFI cross-sectional data



6.2. Aims

In Chapter 6, the unit record data from the Survey of Disability Ageing and Carers (SDAC) 2012 were combined with aggregate administrative data on persons in residential aged care (ACFI), subdivided by sex, age and care needs to achieve the following aims:

- (1) Fit prevalence models for seven types of needs, selected for their ability to replicate the probabilities of being in residential aged care (*five of the selected needs have two levels, giving a total of 12 prevalence models*);
- (2) Derive translation bases between the 12 ACFI levels and the 12 SDAC need levels, which replicate the ACFI prevalences and approximately replicate the correlations between ACFI prevalences;
- (3) Estimate approximate mortality rates associated with each of the 12 SDAC needs levels using the translation bases, and previously estimated (see 4.9) mortality rates for each combination of ACFI levels;
- (4) Combine mortality rates with the fitted SDAC prevalence models to provide transition assumptions for each of the SDAC needs levels.

Methods in Chapter 6 build upon and further extend findings from Chapter 4 utilizing previously derived models (Figure 1.10). For example, the model of the probability of exiting residential care (discussed in Chapter 4.9; Table 4.4) is used in achieving the third aim of Chapter 6. For the sake of parsimony, this model will not be repeated or interpreted in the current chapter.

In terms of the research questions, Chapter 6 examines whether currently available residential care data provide sufficient information for a projection of the residential aged care system in Australia [Research Question 3]. Such a projection would require the transition probabilities and the mortality assumptions to be known from the moment prior to residential care entry to the moment of exit from residential care. This entire trajectory or period is not captured in a single data set. For that reason, the two available data sources (SDAC and ACFI) were used to derive the transition and mortality assumptions in this chapter. Furthermore, the current chapter provides information on how common are certain care assistance needs and how they change with age or vary by gender [Research Question 2]. Understanding of the development of assistance needs throughout the life course of older Australians can assist policy makers to anticipate future needs for care arrangements.

6.3. Data Preparation: Variable selection and coding

The variables from SDAC shown in Table 6.1 were selected because they had been found to be significant in a model of the probability of being in residential aged care (Table 4.2). The prefix “a” was used for variables considered to reflect physical needs, and “b” was used for those thought likely to reflect behavioural needs. SDAC levels were allocated in increasing severity. For example, the SDAC variable LVLDRESS category “*Always needs assistance with dressing*” was coded as *adrs2=1*, “*Sometimes needs assistance with dressing*” was coded as *adrs1=1*, and “*Does not need assistance with dressing but has difficulty*”, “*Has no difficulty with dressing*” and “*Not applicable*” were coded as *adrs0=1*. In this context, “*Not applicable*” means having no disability, and thus no need for assistance.

Table 6.1. Selected SDAC assistance needs variables

SDAC code	SDAC description	Code	Levels
LVLDRESS	Level of assistance needed with dressing	adrs	3
LVLMOBAB	Level of assistance needed with mobility about residence	amob	3
LVLTOLT	Level of assistance needed with toileting	atlt	3
WNASEMOB	Whether needs assistance with cognitive or emotional tasks	bcog	2
LVLCOMMR	Level of communication limitation	bcom	3
NASEMOTC	Whether needs assistance to cope with feelings or emotions	bemo	2
LVLAFAFB	Level of assistance needed understanding family and friends	bfam	3

Source: ABS 2012a.

Furthermore, a few minor changes needed to be applied for practical reasons. For example, “Does not use toilet” was one of the categories for LVLTOILT, and was treated as “Always needs help with toileting”. Similarly, “Does not move about place of residence” was one of the categories for LVLMOBAH, and was treated as “Always needs help with moving about place of residence”.

“Assessment of cognitive or emotional support tasks not performed (establishments only)” was recorded for NASEMOTC for 6.7% of the persons in residential care, and WNASEMOB for 2.9% of persons in residential care. These were treated as “Does not need assistance”. There were 67 records of persons in residential care recorded as aged “0-39”. These were split evenly between age quintiles.

Table 6.2 Prevalences of ACFI levels at 30 June 2012, by age

Age	60	65	70	75	80	85	90	95	Total
adl0	0.033	0.036	0.030	0.025	0.024	0.024	0.021	0.017	0.024
adl1	0.210	0.250	0.238	0.226	0.236	0.244	0.234	0.179	0.231
adl2	0.291	0.298	0.294	0.304	0.306	0.308	0.304	0.296	0.304
adl3	0.466	0.416	0.438	0.445	0.434	0.424	0.441	0.508	0.441
beh0	0.045	0.058	0.056	0.064	0.073	0.082	0.085	0.083	0.076
beh1	0.116	0.131	0.132	0.137	0.152	0.169	0.178	0.181	0.160
beh2	0.221	0.216	0.222	0.221	0.227	0.237	0.258	0.272	0.239
beh3	0.618	0.596	0.590	0.578	0.548	0.512	0.480	0.465	0.526
chc0	0.102	0.117	0.094	0.088	0.089	0.087	0.082	0.080	0.088
chc1	0.251	0.263	0.266	0.274	0.288	0.290	0.290	0.273	0.283
chc2	0.319	0.319	0.320	0.326	0.322	0.330	0.333	0.330	0.327
chc3	0.328	0.301	0.320	0.312	0.302	0.293	0.295	0.318	0.302

Source: AIHW 2013b.

In Table 6.2, “adl0” is the lowest level in the ACFI domain. No subsidy is paid for this level, or for “beh0” or “chc0”, the lowest levels in the BEH and CHC domains. Only 2.4% of residents at 30 June 2012 had the lowest ADL level, 7.6% the lowest BEH level, and 8.8% the lowest CHC. At the same time, 44.1% residents had the highest ADL level, 52.6% were assessed ‘High’ in the BEH domain, and just above 30% had the highest CHC level. There was surprisingly little age variation in the prevalences for any of the 12 levels.

6.4. Methods

The methods used in Chapter 6 can be summarized into the following four steps:

1. Fitting prevalence models for SDAC assistance needs;

2. Deriving allocation rules to assign the ACFI type assistance needs to the SDAC type assistance needs;
3. Deriving a model of mortality based on SDAC assistance needs using the previously developed model of mortality based on ACFI assistance needs;
4. Estimating transition rates between SDAC assistance needs.

6.4.1 Fitting Prevalence Models for SDAC Assistance Needs

Linear regression was used to fit prevalence models to the SDAC 2012 data for the 12 selected needs levels. Prevalences were calculated by dividing the weighted numbers of persons with the particular need by the weighted numbers of persons in the population, separately for each sex and 18 age groups, giving a total of 36 data points for each regression. Persons aged 0 to 4 were treated as having age 2.5, and so on up, with persons 80-84 being treated as having age 82.5. Persons aged 85+ were treated as having age 92.5.

To avoid fitted prevalences that were negative, zero or above 1, a logit transform was used and applied to the calculated prevalences:

$$Q_x = -\ln\left(\frac{1}{P_x - 1}\right) \quad [\text{Eq. 6.1.}]$$

where P_x is the observed prevalence at age x

and Q_x is the transformed prevalence at age x .

Linear regression was used to fit expressions of the form:

$$Y(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x \exp(-x/7.5) + a_5 \text{female} \quad [\text{Eq. 6.2.}]$$

where a_i represent the fitted regression coefficients.

Fitted prevalences R_x at age x were calculated using a logistic transform:

$$R_x = \frac{1}{(1 + \exp(-Y(x)))} \quad [\text{Eq. 6.3.}]$$

To achieve better fits at the older ages, weighted regression was used, with the weight equal to the age, and a minimum weight of 10. The list of regression coefficients for prevalence models of SDAC needs variables with significance levels and adjusted R-square values are in Table 6.6.

Comparisons between the actual and fitted prevalences for selected SDAC assistance needs are shown in Figures 6.2 - 6.7 (see 6.5.1 “Regression Coefficients for SDAC needs variables”).

6.4.2 Allocation rules to create ACFI needs from SDAC needs

A mortality model based on ACFI data for persons in residential care has already been estimated (Table 4.4; Chapter 4). In this chapter, the previous work was further developed and used to make mortality estimates for persons for whom SDAC but not ACFI variables were available. The main assumption here is that the ACFI’s ADL and CHC levels are related to SDAC’s physical needs and the ACFI’s BEH levels are related to the SDAC’s behavioural needs.

From the SDAC file, an unweighted file was constructed, containing 17,649 persons in residential care aged 60 and over (Table 6.3). A “physical score” was assigned for each person in this unweighted file, based on 1 point for each level 1 and 2 points for each level 2 for “*adrs*”, “*amob*” and “*atlt*”. For example, a person with level 0 for “*adrs*”, level 2 for “*amob*” and level 1 for “*atlt*” would have a score of 3. This gave a minimum physical score of 0, and a maximum of 6. Similarly, a “behavioural score” was assigned, based on 1 point for each level 1 and 2 points for each level 2, for “*bcog*”, “*bcom*”, “*bemo*” and “*bfam*”, again giving a minimum of 0 and a maximum of 6.

Table 6.3 Physical and behavioural scores for SDAC aged care residents in 2012

Score	Physical score			Behavioural score		
	Number	Percent	Cumulative	Number	Percent	Cumulative
0	1688	9.7%	9.7%	2702	15.5%	15.5%
1	889	5.1%	14.8%	1457	8.3%	23.8%
2	1070	6.1%	20.9%	4073	23.3%	47.1%
3	1421	8.1%	29.0%	2266	13.0%	60.1%
4	1659	9.5%	38.5%	3818	21.9%	82.0%
5	1918	11.0%	49.5%	1231	7.0%	89.0%
6	8824	50.5%	100.0%	1922	11.0%	100.0%
Total	17469	100.0%		17469	100.0%	

† Unweighted SDAC file with 17,469 aged care residents.

Table 6.4 shows the distribution of the domain levels for the 166,160 aged care residents at 30 June 2012 for whom ACFI scores were available. The main assumption was that the physical scores and ADL levels would be identically ordered, so that a person with a higher physical score would always have a higher or identical ADL level. Behavioural scores and BEH levels were also assumed to be identically ordered. These assumptions allowed a development of allocation rules, providing hypothetical ADL and CHC levels for each person depending on their physical score, and hypothetical BEH levels depending on their behavioural score. The allocation rules

were chosen to replicate the proportions at each ACFI level in the file of 166,160 persons in residential care at 30 June 2012 with known ACFI levels.

Table 6.4 ACFI levels for aged care residents at 30 June 2012

Level	ADL			BEH			CHC		
	Number	%	Cum. %	Number	%	Cum.%	Number	%	Cum.%
0	3967	2.4	2.4	12551	7.6	7.6	14601	8.8	8.8
1	38458	23.1	25.5	26556	16.0	23.5	46942	28.3	37.0
2	50449	30.4	55.9	39651	23.9	47.4	54364	32.7	69.8
3	73286	44.1	100.0	87402	52.6	100.0	50253	30.2	100.0
Total	166160	100.0		166160	100.0		166160	100.0	

Source: AIHW 2013b.

Of the 17,469 unweighted SDAC records for persons in residential care, 9.7% had zero scores. Of the 166,160 residents at 30 June 2012 for whom ACFI scores were available, 2.4% had level 0 in the ADL domain. The percentage of persons with a score of 0 assumed to have an ADL level of 0 was thus:

$$\frac{2.4}{9.7} * 100 = 24.7\%$$

Of the 17,469 SDAC records, 20.9% had a score of 0, 1 or 2, and a further 8.1% had a score of 3. Of the 166,160 residents, 25.5% had an ADL level of 0 or 1. The percentage of persons with a score of 3 assumed have an ADL level of 1 was thus:

$$\frac{(25.5 - 20.9)}{8.1} * 100 = 57.2\%$$

Furthermore, 50.5% of the SDAC records had a score of 6, and a further 11% had a score of 5. To replicate the 44.1% of residents with an ADL level of 3, the percentage of persons with a score of 6 assumed to have an ADL level of 3 was thus:

$$\frac{(50.5 - 44.1)}{50.5} * 100 = 12.7\%$$

This leads to the assumed relationships in Table 6.5 between physical scores and ADL levels. If a figure less than 100% was relevant for a person, then random allocation was used to determine which domain value applied. For example, if a person had a physical score of 3, then in 57.2% of cases that person would be assumed to have an ADL level of 1, and in 42.8% of cases would be assumed to have an ADL level of 2. This random allocation meant that slightly different overall results were obtained from each run.

Table 6.5 Allocation bases between physical and behavioural scores and ACFI levels

Level	Score 0	Score 1	Score 2	Score 3	Score 4	Score 5	Score 6
Allocation basis between physical score and ADL domain							
adl0	24.7%						
adl1	100.0%	100.0%	100.0%	57.2%			
adl2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	12.7%
adl3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Allocation basis between behavioural score and BEH domain							
beh0	48.8%						
beh1	100.0%	96.7%					
beh2	100.0%	100.0%	100.0%	2.1%			
beh3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Allocation basis between physical score and CHC domain							
chc0	90.9%						
chc1	100.0%	100.0%	100.0%	100.0%	84.5%		
chc2	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	40.1%
chc3	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

6.4.3 Model of Mortality Rates based on SDAC Assistance Needs Levels

The allocation rules developed in the previous section were used to allocate the ACFI (ADL, BEH and CHC) levels to each of the 78,039 person records in the weighted SDAC file. The exit rate model developed in Chapter 4³⁴, based on sex, age and ACFI levels, was then used to estimate a mortality rate for each of the 78,039 SDAC records. Weighted regression of $\ln(\text{mortality})$ was used to estimate the mortality model coefficients shown in Table 6.7³⁵ based on sex, age and SDAC variables.

6.4.4 Mortality rates associated with each SDAC needs level

Applying the mortality model derived in the section 6.4.3 gave estimates of deaths for each age quintile below 65 that were higher than the total numbers of deaths for that quintile, even though the estimates assumed no deaths from persons with no SDAC needs. The deaths for each quintile below 65 were thus adjusted down to make the adjusted deaths such that, together with deaths expected from external causes, they equalled total deaths. Logistic transforms were made of the adjusted death rates for each sex and age quintile, and weighted regression was used to estimate the model coefficients in Table 6.8. The rate for each sex and age quintile was

³⁴ The procedure for fitting individual mortality rates based on ACFI assistance needs variables is described in Chapter 4.6.1 (in the “Methods” section: “Deriving matching data from resident and exit data cubes” and “Fitting a regression model to resident and exit data”). The mortality model based on ACFI assistance needs is shown in Table 4.4.

³⁵ See 6.5.2 “Force of mortality model based on SDAC values”.

weighted by the number of population deaths in Australia in 2012 in that quintile. This weighting was used to make the fitted mortality rates closer to those at older ages where most of the deaths occur. The fitted mortality rates for an SDAC level are intended to be a reasonable guide to the mortality rates on average applying to persons with that assistance need level.

6.4.5 Deriving transition and recovery rates for SDAC needs levels

The fitted prevalence and mortality rates were used to estimate annual transition and recovery rates between each level for each of the seven assistance needs variables in SDAC. This was done by using fourteen development tables³⁶, one for each sex and need. Each table started with the fitted prevalence of each non-zero level of the need, for each age from 0 to 95, calculated from the coefficients in Table 6.6. Prevalences at the lowest level were calculated by deducting the prevalences at higher levels from 1. Population mortality rates are from the Australian Life Tables 2010-12 (Australian Government Actuary 2014). The mortality rates associated with each level are from the coefficients in Table 6.7. Transitions and recoveries were assumed to be possible between each adjacent level. Mortality rates for levels 1 and 2 were calculated as in Table 6.8. The transition and recovery rates were assumed to follow simple mathematical functions shown in Equations 6.4 – 6.7. Prevalences at the start of the year were multiplied by the mortality, transition and recovery assumptions to estimate death, transitions and recoveries during the year, as percentages of the total population.

Let P_{ix} be the proportion of lives aged x in level i
 D_{ix} be the proportion of lives aged x dying while in level i
 T_{ijx} be the proportion of lives aged x transferring from level i to j
 q_x be the population mortality rate at age x
 q_{ix} be the mortality rate associated with level i at age x
 T_{ijx} be the transfer rate from level i to j at age x

Then for a three-level need:

$$P_{1x+1} = (P_{1x} - D_{1x} + T_{01x} + T_{21x} - T_{12x}) / (1 - q_x) \quad [\text{Eq. 6.4.}]$$

and

$$P_{2x+1} = (P_{2x} - D_{2x} + T_{12x} - T_{21x}) / (1 - q_x) \quad [\text{Eq. 6.5.}]$$

where

$$D_{ix} = q_{ix} * P_i \quad i = 1,2 \quad [\text{Eq. 6.6.}]$$

³⁶ An example of developmental table is given in Appendix 6.8.

and

$$T_{ijx} = t_{jix} * P_i \quad i = 1, 2. \quad [\text{Eq. 6.7.}]$$

In Equations 6.4 and 6.5, division by $(1 - q_x)$ is done because the total population reduces by the proportion q_x in the year, and P_{ix} is measured relative to the total population.

For each year of age, the prevalences calculated from Equations 6.4 and 6.5 were used as simulated prevalences. The sum of squares of their differences between simulated and fitted prevalences over levels 1 and 2 for ages 1 to 95 was used as an objective function. Parameters were fitted for each table by minimising the objective function, using *Excel's Solver* with a *generalized reduced gradient nonlinear engine*.

6.5. Estimates

6.5.1 Regression coefficients for SDAC needs variables

Table 6.6 shows the regression coefficients and adjusted R^2 values obtained as described in 6.4.1. Each row of the table represents one fitted prevalence model for specific SDAC assistance need. Models for some assistance needs, such as “adrs2” or “bcog1”, better fit the data than models for some other SDAC needs, such as “amob1” or “bfam2”. This differences are reflected in lower R^2 values for “amob1” and “bfam2”.

Table 6.6 List of regression coefficients for prevalence models of SDAC needs variables

Need	Female	Age	Age ²	Age ³	Age(exp)	Constant	R ²
adrs1	0.029	<i>0.15373</i>	<i>-0.00120</i>	<i>0.0000045</i>	<i>1.476</i>	-9.861	0.894
adrs2	-0.146	-0.04612	<i>0.00118</i>	-0.0000016	<i>0.523</i>	-5.789	0.967
amob1	<i>0.374</i>	-0.00929	0.00104	-0.0000053		-6.674	0.755
amob2	0.131	<i>-0.19021</i>	<i>0.00399</i>	<i>-0.0000168</i>		-4.881	0.880
atlt1	0.105	<i>0.11691</i>	<i>-0.00174</i>	<i>0.0000139</i>	<i>1.278</i>	-9.658	0.931
atlt2	-0.238	<i>-0.16117</i>	<i>0.00291</i>	-0.0000093		-4.201	0.913
bcog1	0.043	<i>0.13894</i>	<i>-0.00250</i>	<i>0.0000172</i>	<i>0.794</i>	-6.167	0.924
bcom1	<i>-0.381</i>	0.04729	-0.00060	0.0000083	<i>1.556</i>	-7.622	0.909
bcom2	-0.168	<i>-0.07613</i>	0.00047	0.0000061		-4.001	0.917
bemo1	0.077	<i>0.17258</i>	<i>-0.00313</i>	0.0000204	0.914	-6.963	0.859
bfam1	<i>-0.682</i>	<i>0.07850</i>	<i>-0.00073</i>	0.0000089	<i>2.296</i>	-10.043	0.838
bfam2	-0.004	<i>-0.06628</i>	0.00019	0.0000089		-5.527	0.810

† Coefficients with a significance level of 0.1 or less are shown in italics.

‡ Note: this table shows the list of models for each SDAC assistance need level.

Figure 6.2 shows the actual prevalences for “adrs1” (“sometimes needs assistance with dressing”), and “adrs2” (“always needs assistance with dressing”). Shown in dotted lines are the

prevalences fitted as described in the section 6.3.1. A logarithmic scale has been used, to allow the fits at younger ages to be better examined.

Figure 6.2 Prevalence for assistance needed with dressing (“*adrs*”)

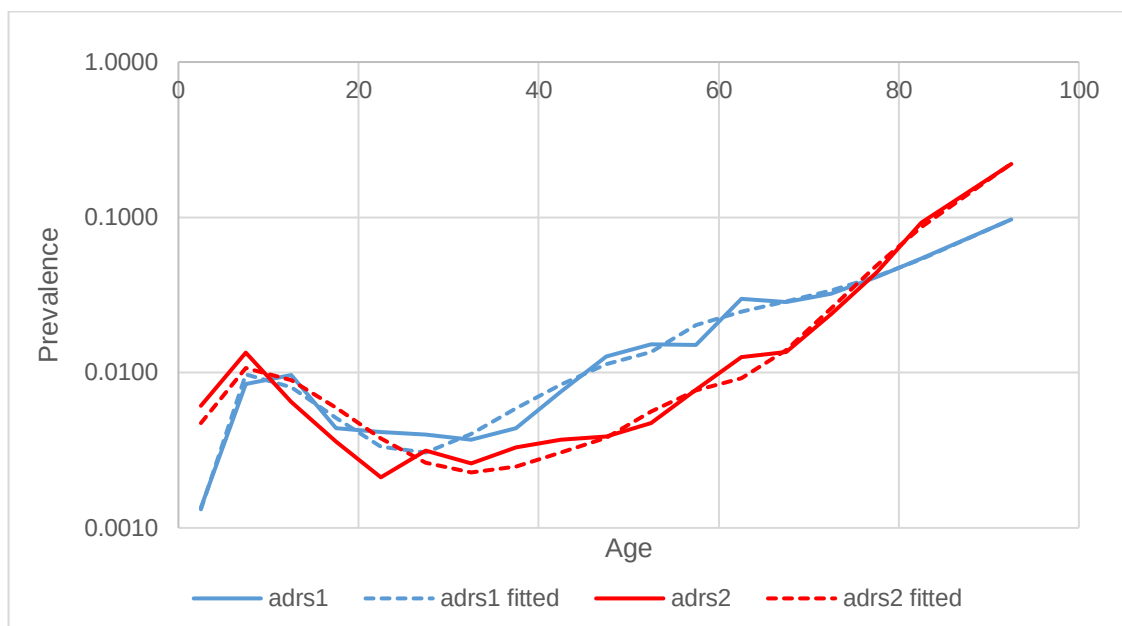


Figure 6.3 Prevalence for assistance with toileting (“*atlt*”)

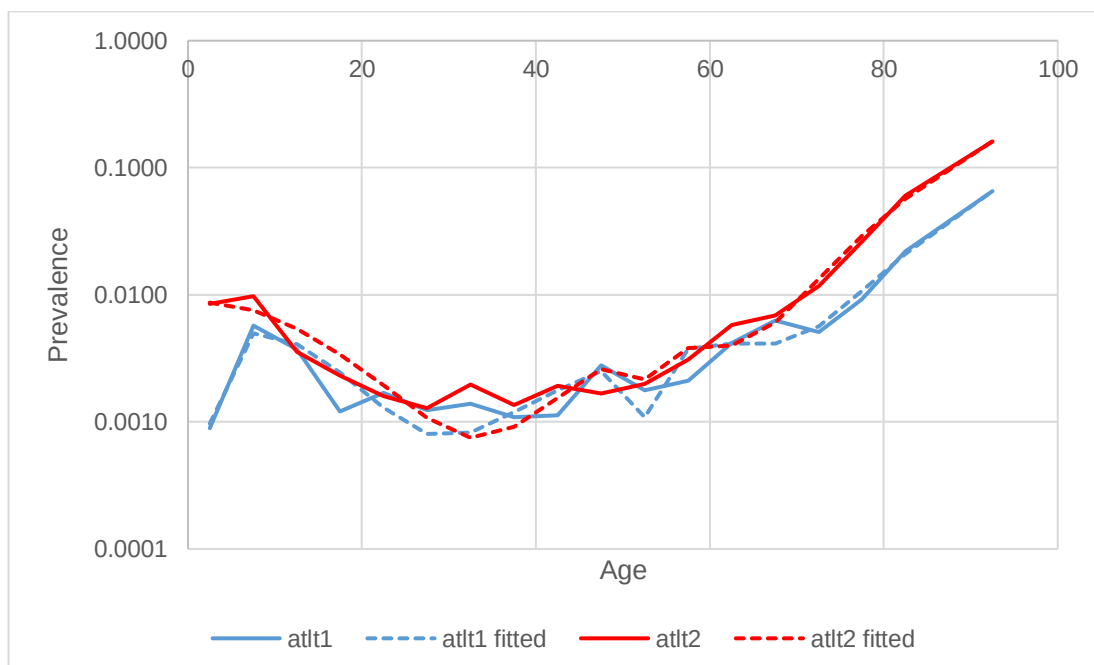


Figure 6.4 Prevalence for assistance with mobility around residence (“*amob*”)

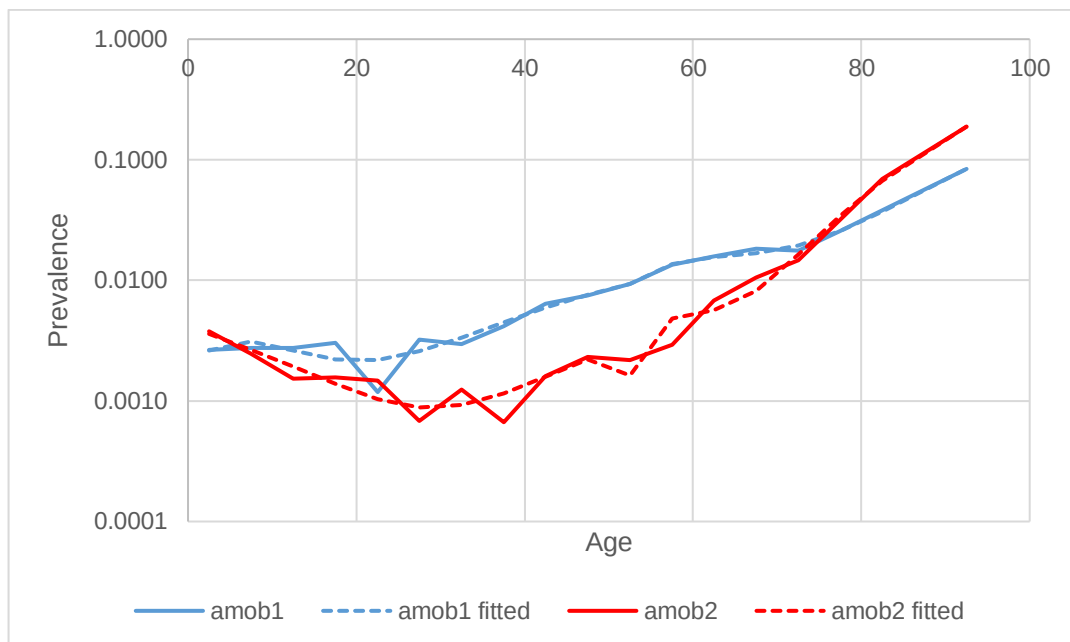


Figure 6.4 shows prevalences for assistance with mobility around the residence (“*amob*”). Expectedly, prevalences for a lower level (“*amob1*”) are higher in earlier ages than prevalences for a higher level (“*amob2*”). At the age of 70, however, a lower level (“*amob1*”) is overtaken by a higher level (“*amob2*”). Prevalences for assistance needed with cognitive or emotional tasks (“*bcog*”) and for coping with feelings or emotions (“*bemo*”) are relatively low until the age of 70 and then rapidly increase (Figure 6.5).

Figure 6.5 Prevalence for assistance needed with cognitive or emotional tasks (“*bcog*”) and for coping with feelings or emotions (“*bemo*”)

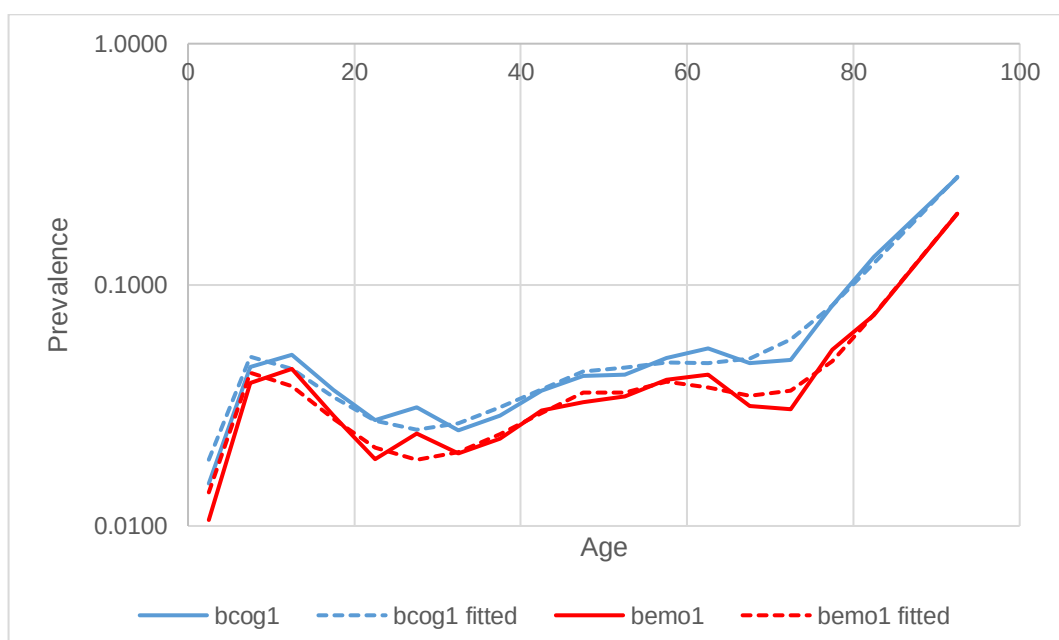


Figure 6.6 Prevalence of levels of communication limitations (“bcom”)

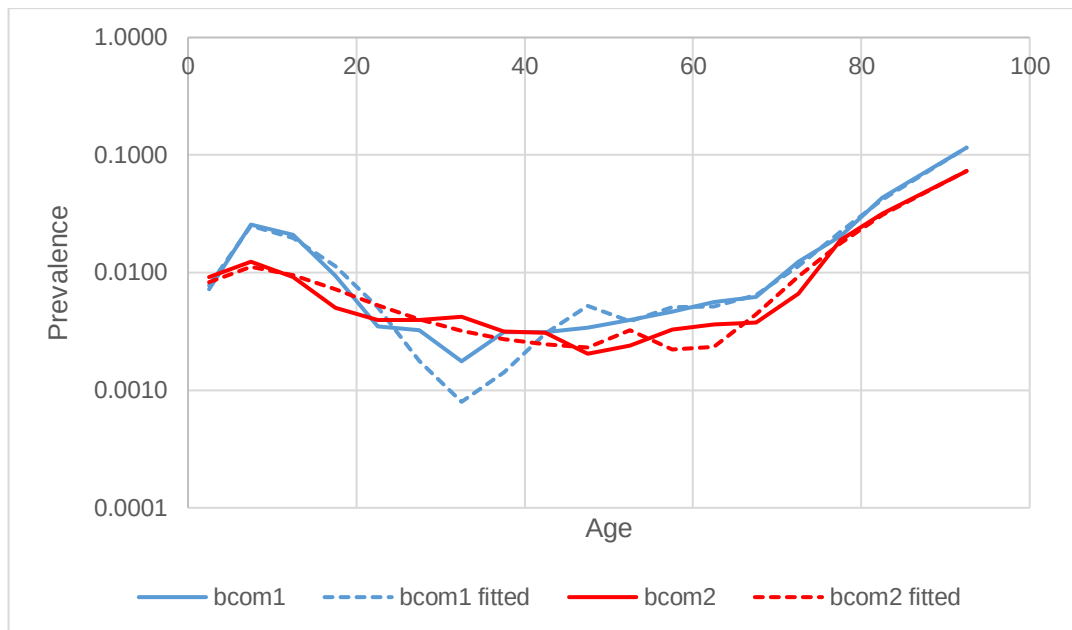
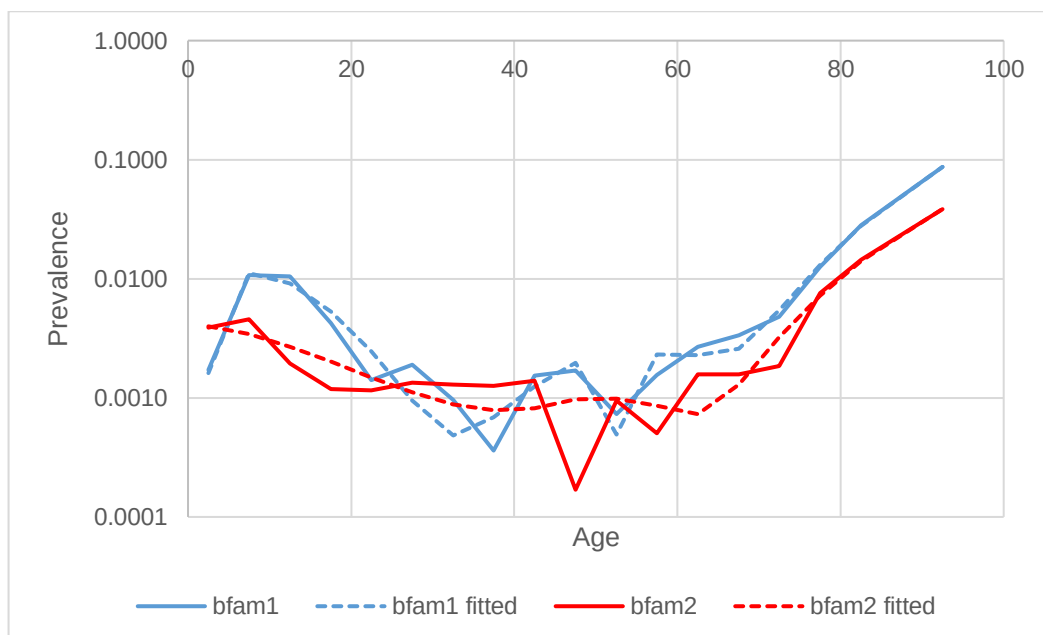


Figure 6.6 shows that prevalences of communication limitations (“bcom”) are low until about age 65, then rise. Similarly, prevalence for assistance needed in understanding family and friends (“bfam”) is low until the age of 60 and then rapidly increases (Figure 6.7)

Figure 6.7 Prevalence for assistance needed in understanding family or friends (“bfam”)



6.5.2 Force of mortality model based on SDAC values

The model of the log of the force of mortality shown in Table 6.7 was obtained from the 78,039 SDAC person records, after allocating ACFI values and calculating the force of mortality for each person using the mortality model from Table 4.7 (see section 6.4.3). Linear regression using the weights in the SDAC file was then used to fit the model in Table 6.7 to the log of the force of mortality. The fitted coefficients for female and agesquare, and the constant, are almost identical to those in Table 4.4. This is reassuring as it suggests that the allocation process between SDAC and ACFI needs variables has not disturbed the overall fit.

Table 6.7 Linear model of ln (mortality rate) based on SDAC needs variables

Variable	Coefficient	SE	P> t	Sig.	95% LCL	95% UCL
Age	0.0000167	0.0000367	0.650		-0.000553	0.0000886
Agesquare	0.0000364	0.0000001	0.000	***	0.0000361	0.0000366
Female	-0.3966	0.0004	0.000	***	-0.3975	-0.3957
adrs1	-0.0179	0.0038	0.000	***	-0.0254	-0.0105
adrs2	0.2118	0.0143	0.000	***	0.1838	0.2399
amob1	0.0479	0.0071	0.000	***	0.0340	0.0619
amob2	0.4473	0.0174	0.000	***	0.4131	0.4814
atlt1	0.1614	0.0152	0.000	***	0.1315	0.1912
atlt2	0.5490	0.0207	0.000	***	0.5084	0.5896
bcog1	0.0143	0.0019	0.000	***	0.0106	0.0180
bcom1	0.1050	0.0066	0.000	***	0.0921	0.1180
bcom2	0.1248	0.0105	0.000	***	0.1042	0.1454
bfam1	0.0751	0.0090	0.000	***	0.0574	0.0928
bfam2	0.0710	0.0164	0.000	***	0.0388	0.1032
Constant	-2.0904	0.0004	0.000	***	-2.0911	-2.0896
Records						78,039
McFadden R ²						0.951

+ *** p<0.001 **p<0.01*p<0.05

‡ Reference category for each assistance needs variable is “no need for assistance”.

§ Additional model specifications are in Appendix 6.7.

Table 6.7 shows that all SDAC assistance needs, except “adrs1” (“sometimes needs assistance with dressing”), are associated with an increase in the force of mortality. The highest positive coefficients are found for “atlt2” (“always needs assistance with toileting”) (0.5490 p<0.001) and “amob2” (0.447 p<0.001) (“always needs assistance with mobility around residence”). These results are consistent with findings from Australian (Kendig et al 2014; 2010) and international literature (Drame et al 2012; Gaugler et al 2003) that having needs for assistance with toileting and mobility around the residence are among the most significant predictors of being in

residential aged care.³⁷ Likewise, having high needs for assistance with the activities of daily living is associated with an increased mortality in nursing homes (Porock et al 2005; Dale et al 2001; Zuliani et al 2001; Ostby et al 1999; Breuer et al 1998).

6.5.3 Estimated mortality rates associated with each SDAC need level

The force of mortality models for each SDAC assistance need variable (Table 6.8) were obtained as described in Chapter 6.5.2. All the coefficients in 12 models shown in the table are significant at a level of 0.1 or less. These models were used, in a combination with 14 developmental tables, to estimate transition and mortality rates in a multi-state model (see Chapter 6.5.4).

Graphs of mortality rates associated with need for assistance with dressing and mortality rates associated with communication limitations are in Figures 6.8 and 6.9 respectively.

Table 6.8 Regression models for mortality associated with each SDAC need level

Need	Female	Age	Age ²	Age ³	Age(exp)	Constant	R ²
adrs1	-0.48677	0.18010	-0.0015681	0.00001	9.77657	-8.819	0.991
adrs2	-0.40938	0.14966	-0.0011608	0.00000	8.76034	-7.554	0.977
amob1	-0.49616	0.18615	-0.0017759	0.00001	9.74868	-8.687	0.990
amob2	-0.57887	0.13531	-0.0009262	0.00000	8.09120	-6.837	0.976
atlt1	-0.51527	0.17117	-0.0012436	0.00000	9.20367	-8.672	0.984
atlt2	-0.49235	0.13523	-0.0007556	0.00000	7.79265	-7.111	0.981
bcog1	-0.42020	0.11625	-0.0005569	0.00000	8.20901	-7.859	0.993
bcom1	-0.42632	0.12030	-0.0004336	0.00000	8.03853	-8.153	0.992
bcom2	-0.23887	0.14712	-0.0008991	0.00000	8.45087	-8.126	0.974
bemo1	-0.43141	0.09448	-0.0001433	0.00000	7.68559	-7.553	0.991
bfam1	-0.44405	-0.03007	0.0022866	-0.00001	3.43152	-6.742	0.954
bfam2	-0.36832	0.06728	0.0006103	-0.00001	6.67132	-6.612	0.950

† All coefficients shown in the table are at the significance level of 0.1 or less.

‡ Note: this table shows 12 simple linear models for each of the 12 SDAC assistance needs.

³⁷ The model of the probability of being in residential care (Table 4.2) is also consistent with these findings.

Figure 6.8 Mortality rates associated with need for assistance with dressing

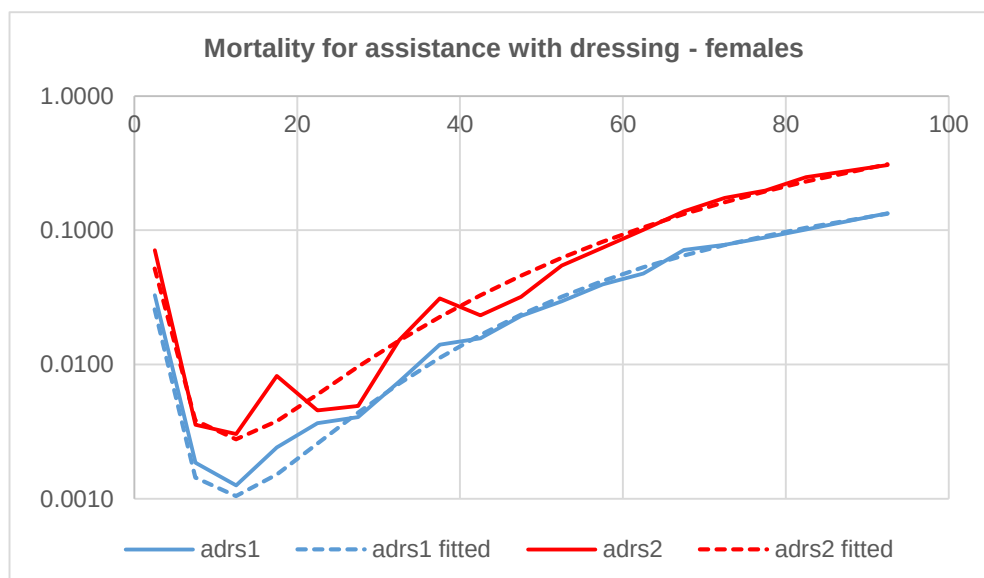
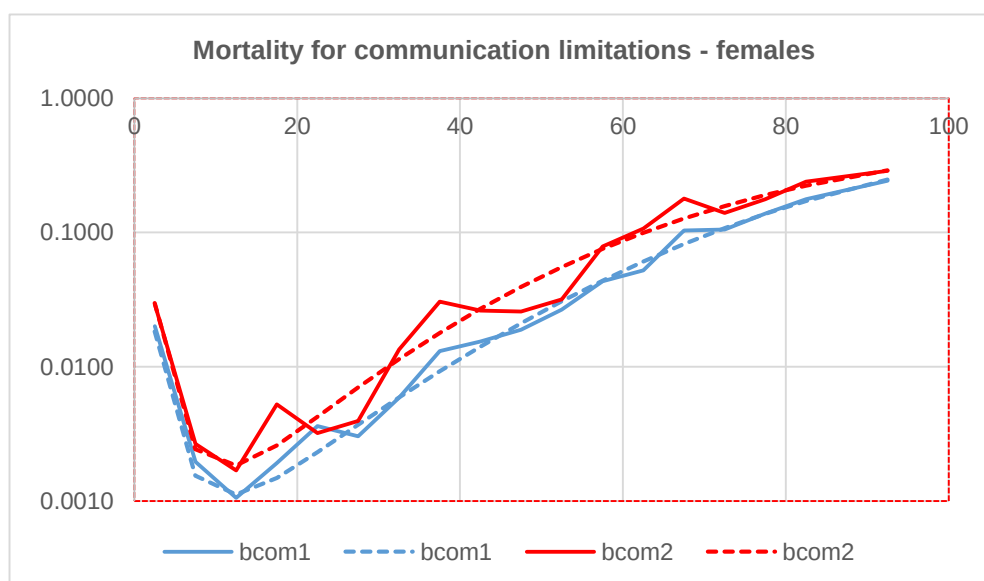


Figure 6.9 Mortality rates associated with communication limitations



6.5.4 Estimated transition rates between SDAC needs levels

Multi-state parameters for the 3-level and the 2-level assistance needs variables are shown in Tables 6.9 and 6.10, respectively. The same transition rate formulas were applied to both tables (Equations 6.8 and 6.9). Furthermore, the same methods can be used to estimate transition parameters for both sexes, but for reasons of parsimony only transition parameters for males are shown in this section. In Table 6.9, transition rates from 0 to 1, and from 1 to 2 for a three-level need were assumed to be of the form:

$$\text{height factor} / (1 + \exp(-\text{width factor} * (\text{age} - \text{inflexion age}))) + \text{scale factor} * \text{age} * \exp(-\text{peak factor} * \text{age}) \quad [\text{Eq. 6.8.}]$$

A limit of 1.000 was applied to height, and these cases are shown in italics. Transition rates from 1 to 0, and from 2 to 1, were assumed to be of the form:

$$\text{scale factor} * \text{age} * \exp(-\text{peak factor} * \text{age}) \quad [\text{Eq. 6.9.}]$$

Table 6.9 Transition parameters for three-level needs (males)

Transition	Parameter	adrs	amob	atlt	bcom	bfam
0 to 1	Inflexion age	121.45	121.47	111.35	104.52	110.01
0 to 1	Width factor	0.0995	0.1080	0.1427	0.1890	0.1664
0 to 1	Height	<i>1.0000</i>	<i>1.0000</i>	<i>1.0000</i>	<i>1.0000</i>	<i>1.0000</i>
0 to 1	Peak factor	0.3029			0.3828	0.3959
0 to 1	Scale factor	0.0016			0.0097	0.0069
1 to 2	Inflexion age	98.761	91.739	67.504	74.906	120.464
1 to 2	Width factor	0.0718	0.0870	0.1276	0.2169	0.0639
1 to 2	Height	<i>1.0000</i>	<i>1.0000</i>	0.7060	0.1928	<i>1.0000</i>
1 to 2	Peak factor	0.2794	0.3579			
1 to 2	Scale factor	0.1070	0.0854			
1 to 0	Peak factor	0.1469	0.3206	0.1691	0.1333	0.1249
1 to 0	Scale factor	0.0679	0.4133	0.1372	0.0826	0.0923
2 to 1	Peak factor	0.0977	0.1867	0.1642	0.1670	0.1172
2 to 1	Scale factor	0.0167	0.0978	0.0637	0.0487	0.0252
Sum squares of ln(S/F)		14.02	5.53	6.81	16.26	19.50

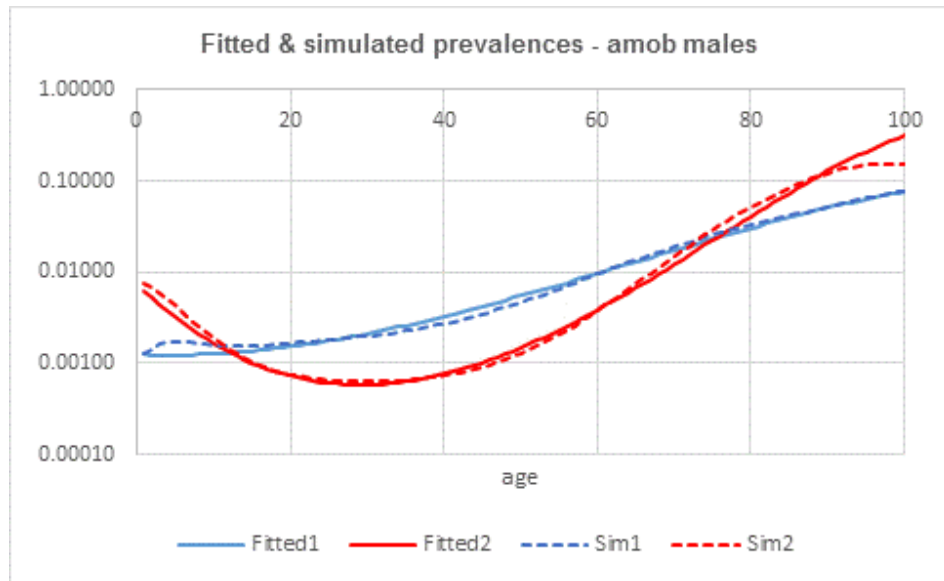
Table 6.10 Transition parameters for two-level needs (males)

Transition	Parameter	bcog	bemo
0 to 1	Inflexion age	111.62	109.60
0 to 1	Width factor	0.1406	0.1472
0 to 1	Height	<i>1.0000</i>	<i>1.0000</i>
0 to 1	Peak factor	0.3681	0.3705
0 to 1	Scale factor	0.0087	0.0087
1 to 0	Peak factor	0.2230	0.2257
1 to 0	Scale factor	0.0485	0.0487
Sum squares of ln(S/F)		1.97	2.03

Sums of squares of differences between ln (simulated / fitted) prevalences were the lowest for 2-level assistance needs variables (“bcog” and “bemo”), 1.97 and 2.03 respectively. Expectedly, sums of squares were much higher for 3-level assistance needs variables, ranging from 5.53 for “amob” to 19.5 for “bfam”.

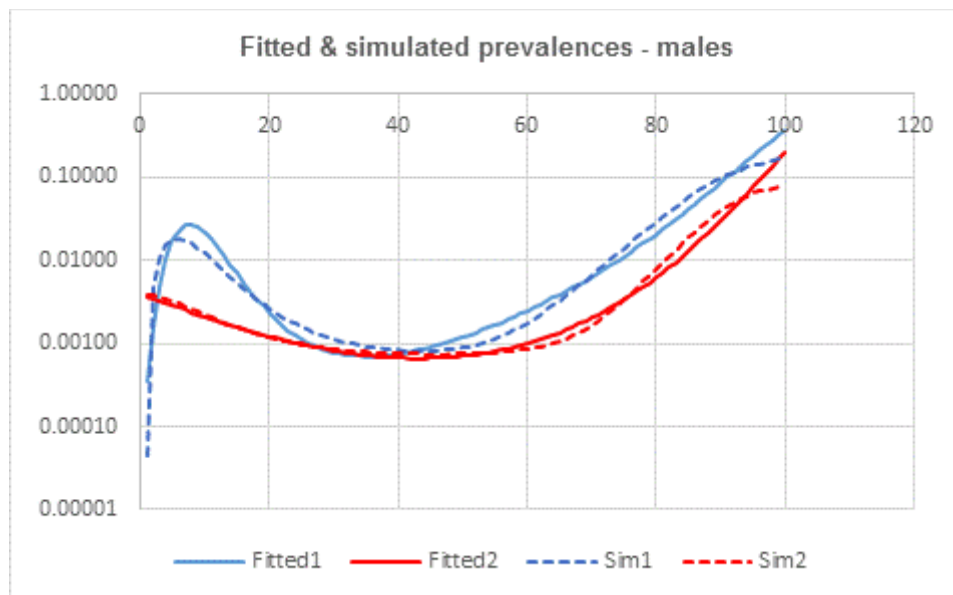
The next three graphs illustrate the differences between fitted and simulated prevalence rates for the selected assistance needs. For example, Figure 6.10 shows the fitted and simulated prevalence rates for levels 1 and 2 of the “need for assistance with mobility” (“*amob*”) which is a three-level assistance need variable. The fitted prevalences are from the models for “*amob1*”, and “*amob2*” in Table 6.6, whereas the simulated prevalences were obtained using the mortality models in Table 6.8 and the transition models in Table 6.9.

Figure 6.10 Prevalence rates for needs with assistance with mobility (males)



† Fitted/simulated 1 refers to “*amob1*”, fitted/simulated 2 refers to “*amob2*”

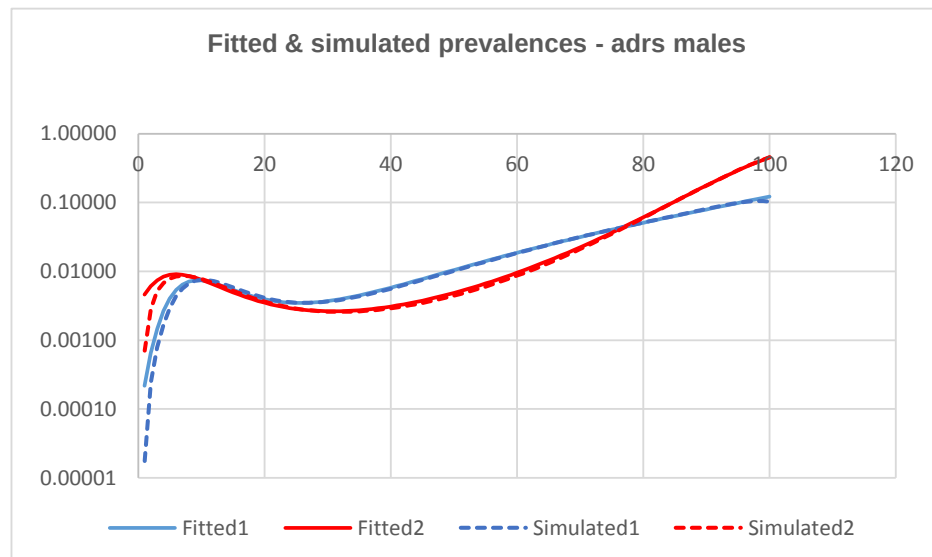
Figure 6.11 Prevalence rates for assistance needed with understanding family and friends



† Fitted/simulated 1 refers to “*bfam1*”, fitted/simulated 2 refers to “*bfam2*”

Similarly, Figure 6.11 shows the fitted and simulated prevalence rates for a two-level assistance need variable “bfam” (“assistance needs with understanding family and friends”).

Figure 6.12 Prevalence rates for needs with assistance with dressing (“adrs”)



† Fitted/simulated 1 refers to “adrs1”, fitted/simulated 2 refers to “adrs2”

Figure 6.12 shows the fitted and simulated prevalence rates for levels 1 and 2 of “need for assistance with dressing” (“adrs”). The fitted prevalences are those also shown in Figure 6.2, whereas the simulated prevalences were obtained using the mortality models in Table 6.8 and the transition models in Table 6.9.

6.6 Discussion

No previous Australian study has combined SDAC and ACFI data to obtain more information on an individual’s journey to and through residential care. In this chapter, it was demonstrated how Australian aged care data can be used to derive transition and mortality rates of older Australians. Although procedures presented here, due to data limitations, do not allow most of the standard statistical modelling techniques, the findings have practical value. In ideal circumstances, one data source would contain information on the entire personal trajectory from the moment of application for residential care to exit from the care arrangement. If this is not possible, the second-best solution is to aim at achieving a consistency in reporting between different data sources on Australian aged care. For example, the same classification methodology for the assistance needs of older Australians in SDAC, ACAP and ACFI data would enable a precise estimation and approximation of mortality and transition rates between the assistance needs variables. It has been demonstrated in this and in previous chapters that a

person's requirements for assistance are not only good predictors of care-related events or transitions, but may also be used to allocate the Government's subsidies for aged care.

Using the SDAC survey as an initial point on the trajectory is a reasonable choice because this survey is the only source that shows both the populations in residential aged care and in private-dwellings. Approximate equivalence relationships derived between SDAC and ACFI care needs allowed mortality rates to be estimated for persons not in residential care based on mortality rates for those in residential care. These assumptions were adjusted to balance the Australian national mortality rates.

From the perspective of the research hypotheses [Research Hypothesis 5; Research Question 3], Chapter 6 has examined whether Australian administrative data on aged care could be used to construct projection models. Results show that transition and mortality rates derived from ACFI care needs and based on the ACFI mortality model can be applied to SDAC assistance needs to derive plausible prevalence models, transition rates between care needs levels and mortality rates. The fitted coefficients of the SDAC assistance-needs mortality model were like that of ACFI mortality model. This implies that the allocation procedure between SFAC and ACFI care assistance needs variables has not worsened the overall fit. However, a more reliable projection model of aged care would need to be based on probabilities obtained from rigorous modelling performed on fully consistent data sources.

The findings in this chapter may also help Government to approximate future entry rates into residential aged care and assist individuals planning their financial affairs on entry to residential care. Nonetheless, a full projection of future residential aged care demand would require better links between the Survey of Disability Ageing and Carers (SDAC) and the residential care data in the National Aged Care Data Clearinghouse (ACFI).

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7. Direct Estimation of Life Expectancies and Transition Rates of Residential Care Residents

7.1. Introduction

Assistance needs of persons in residential aged care change over time. Changes are usually one-directional, leading to a functional decline and increased requirements for high-level assistance provision. A substantial body of literature (see 4.4.3) has demonstrated that functional abilities of aged care residents deteriorate under the influence of various chronic diseases (Broad et al 2011; Binder et al 2003; Flacker & Kiely 1998; Barker et al 1998) most of which are associated with a higher risk of nursing home placement (Ang et al 2015; Porock et al 2010). Age-related decrease in muscle strength, cardiovascular function or neuromuscular response times (Fiatarone-Singh & Mayer 2002; Rajeski & Mihalko 2001) also contribute to functional deterioration.

Disease progression, comorbidities and functional decline affect life expectancy of nursing home residents. Research evidence suggests that life expectancy in residential care is associated with age, sex, functional impairment, ADL performance, cognitive disability, low body mass index, medical frailty, poor nutrition and having diseases such as diabetes, respiratory infections, or congestive heart failure (Shah et al 2013; Kruse et al 2010; Lee et al 2009; Kiely & Flacker 2001; Dale et al 2001; Cohen-Mansfield et al 1999).

Predicting life expectancy in residential care may appear controversial (Got et al 2011) but it is an increasingly important issue (Heppenstall et al 2015). When provided at a high level and over a long period, residential care is costly and labour-intensive. If planning is not done properly, such activity strains the aged care workforce and the ability of workers to provide adequate care. Proper care planning is also important for care residents. Research evidence has shown that communicating with residents about their prognosis may assist them in planning and avoiding unnecessary hospital admissions and treatments (Dying Matters 2012). Life expectancy estimates help not only financial planning by residents and their families, but also can assist care providers to achieve a resident mix best suited to their staff and facilities.

Personal wellbeing of care residents, future workforce planning and costs estimation altogether can benefit from having accurate information on life expectancies and the dynamics of change in residents' care needs. The most important elements of information about 'inside-of-care' system are care needs, transition probabilities and duration of stay. All of these are recorded in

the Aged Care Funding Instrument (ACFI) unit records (AIHW 2015b). These data are generated through the assessments that are made soon after entry to residential care, and repeated as health changes occur. Once an ACFI rating has been received, mean life expectancies vary from 7 months to 7 years (AIHW 2015f), although individuals can live for much less or more than these means.

The ACFI assistance needs are used by the Australian Government to determine the subsidies for residential aged care providers to support care needs of the residents (Department of Health, 2015). The time spent in care with a certain set of assistance needs determines the final amount of the subsidy for a resident. Residential subsidy payments are clinically based on four levels for each of three domains - aids to daily living (ADL), behaviour (BEH) and complex health care (CHC).³⁸ Having a specific combination of assistance needs, such as being assessed as the highest in all 3 domains, also affects the nature of care provision. Therefore, both the providers and the Government are interested in knowing how long residents are expected to stay within specific combination of care assistance domains and what is the probability that these domains change.

Aims

Previous chapters (Figure 1.10) have provided evidence that ACFI assistance needs are good predictors of exit from residential care, that their level increases with time spent in care and that assistance needs may be used to determine life expectancy in residential care [Research Hypotheses 2-4]. This chapter broadens our understanding of functional decline in residential care by answering the following research questions: *What is the life expectancy in residential care for residents with a particular combination of care needs and how residents' assistance needs change with age and time spent in residential care* [Research Question 2]? Transitions between care needs levels, if reasonable, would also help in answering the question: *Can the Australian aged care data provide sufficient information for residential aged care projections* [Research Question 3]?

The aim in this chapter is to model deaths, and transitions between needs levels, for persons in residential aged care in Australia. Essentially, there are two steps:

³⁸ The ACFI instrument has two diagnostic sections (recording up to three mental or behavioural diagnoses and up to three other medical diagnoses), and its questions provide basic information that is related to fundamental care need areas, it is not a comprehensive assessment tool. Prior to 1 July 2014, the instrument determined an initial classification for overall care needs (high or low care) and a subsidy level relevant to them (AIHW 2015b).

- First, using a longitudinal file of 1.05 million ACFI ratings from the National Aged Care Data Clearinghouse (NACDC), we estimate transitions from different combinations of care assistance needs and construct statistical models to predict the occurrence of such changes.
- Second, we estimate life expectancies of aged care residents.

7.2. Data

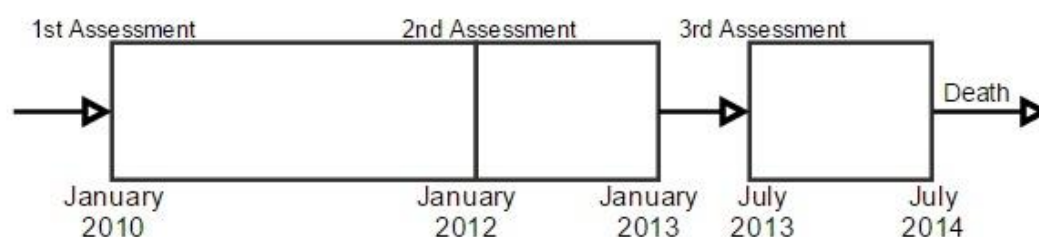
Data used in this chapter come from the National Aged Care Data Clearinghouse (NACDC) of the Australian Institute of Health and Welfare (AIHW). A longitudinal file of 1.05 million ACFI ratings (AIHW 2016a) contained a record of every ACFI assessment for each permanent care resident in the period between 20 March 2008 (introduction of the ACFI system) and 30 June 2015 (more details in 2.3.3 '*ACFI Longitudinal Data*'). These ACFI appraisals provided full information on the assistance needs in the three main domains: the daily living (ADL), the behaviour (BEH) and the complex health care (CHC). Each domain is measured at the scale from 0 to 3, with '3' being the highest level of assistance needs and '0' requiring no assistance at all (Department of Health 2013).

This comprehensive longitudinal data set captured each person's pathway inside the residential care system, including multiple assessments, temporary discharges to other care facilities, discharges to hospital, re-entries and modes of permanent exit from nursing home. Longitudinal data give high quality information that does not suffer from rising non-response rates, attrition and under reporting (Productivity Commission 2013), enabling the detection of changes in the features of the target population (IWH 2015). Permanent aged care residents, as the population of interest, undergo the assessments that may or may not change their recorded dependence levels. The sequence of such changes in care-need levels captured in the longitudinal ACFI data enables the direct estimation of transitions between combinations of assistance needs, together with eventual death. Transitions and deaths are the two crucial components that enable estimation of the life expectancy in residential care.

Several data challenges had to be tackled in preparation for the transition and life expectancy analyses. These problems include dealing with duplicate records, multiple and overlapping care episodes and inconsistencies around the start and the end of assessments. For example, discontinued unit records increase the complexity of the longitudinal analyses. Figure 7.1 shows a discontinued record of a person entering residential care in January 2010, receiving a revised

ACFI assessment in January 2012, leaving the facility in January 2013, re-entering residential care in July 2013 with a new ACFI assessment, and dying in July 2014. Furthermore, some aged care episodes are transposed in the data, with the first admission and separation recorded as the second episode for the person, not the first. Such cases were re-sequenced to avoid bias in the life expectancy and transition rate estimates.

Figure 7.1. An example assessment cycle for a hypothetical unit record



Sources: Author, October 2016.

To put the data in adequate form for methodological procedures, a few assumptions had to be made. For instance, personal cases with an exit from a nursing home followed by a re-entry after some months were treated as a continuous episode, with the domain values (ADL, BEH & CHC) at their last assessment. Other assumptions and data corrections include:

- Of the 1,052,887 records of ACFI assessments supplied, two had no entry dates, and were omitted;
- One person had no sex recorded, and was assumed to be female;
- Eight had no birth dates, and were assumed to have entered at age 84 (average entry age);
- 12,256 had the same assessment start and end dates, and were omitted;
- 33,664 had assessment start dates differing from the end date of their previous assessment, and the end date was changed to match the subsequent start date. Most of these cases had a start date a few months after the end date for the previous assessment.

7.3 Methods

Transition probabilities between all possible combinations of care assistance needs (see 7.3.2) and monthly probabilities of death (see 7.3.1) were analysed using a stepwise logistic

regression³⁹ (as described in Hosmer & Lemeshow 2000 p. 116). For example, we calculated the probabilities that a care resident with ADL1, BEH1 and CHC1 develops higher assistance needs (i.e. ADL2, BEH2 and CHC2). In total, our approach led to 36 logit models of the following form:

$$\log(odds) = \beta_0 + \beta_1 * x_1 + \dots + \beta_n * x_n \quad [\text{Eq. 7.1}]$$

where β refers to the estimated parameters (coefficients) and x_i represents the independent variables (age, care needs levels in 3 domains, year). The $\log(odds)$, or log of the odds ratio, is defined as $\ln \left[\frac{p}{1-p} \right]$. It expresses the natural logarithm of the ratio between the probability that an event of transition to different care needs level will occur, $P(Y = 1)$, to the probability that an event will not occur, $P(Y = 0)$. It is noteworthy that the model estimates (β) express the relationship between the independent and dependent variable on a log-odds scale. A coefficient of 0.030 would thus indicate that a one-unit increase in β_i is associated with a log-odds increase in the occurrence of the transition Y of 0.030. To get a clearer understanding of the constant effect of a predictor on the likelihood that an outcome will occur, odds-ratios can be calculated. This can be expressed as:

$$\text{odds}(Y) = \exp^{\beta_0 + \beta_1 * x_1 + \dots + \beta_n * x_n} \quad [\text{Eq. 7.2.}]$$

which is the exponentiated model. Alongside the odd-ratio, we also show predicted probabilities of the selected transitions between care needs (Y) at specific values of key predictors in the form of the following equation:

$$p = \frac{1}{1 + \exp^{-z}} \quad [\text{Eq. 7.2.}]$$

where z refers to the $\log(odds)$ regression equation. The same logistic regression method is also used to derive the monthly probability of death models.

The transitions and deaths are weighted to enable easier computation of the logistic models. For example, all the transitions between one specific combination of care assistance needs to another combination were grouped. Figures 7.3-7.5 show such aggregates for each of the main assistance domains separately.

³⁹ Logistic regression is a preferred method in this thesis. Even though it was possible to use discrete time hazards (i.e. in Table 7.3), the logistic regression is chosen to achieve consistency of models across the thesis.

The transition analyses relied on a few assumptions. Firstly, the cases who exit from residential care and then re-enter are treated as continuously being in residence with the domain values at their last assessment. Secondly, the likelihood that changes in two or three domains will occur at the same time, rather than independently, were ignored. Finally, the assumption was made that anyone who exited a nursing home but did not re-enter died at the date of exit.

7.3.1 Deaths

Logistic regression was used to fit models of monthly mortality rates. The three sets of independent variables used were:

- Age, sex, year, and dummy variables for the three highest levels of ADL, BEH and CHC
- Age, sex, year and dummy variables for the presence of different diseases
- Age, sex, year, and all the needs and disease dummy variables.

In each case, backwards stepwise regression (Hosmer & Lemeshow 2000 p. 116) was used to retain only those variables significant at the 5% level. Analyses were made using all 6 available years of data, and then only using the most recent year of data.

7.3.2 Transitions

Logistic regression was used to fit monthly transition probabilities between each ADL level. These transitional probabilities were conditional, in that they assumed no death had occurred in the month. The independent variables used for transitions between ADL levels were age, sex and dummy variables for the three highest levels of BEH and CHC. Similarly, the independent variables used for transitions between BEH and CHC levels were dummy variables for the three highest levels of the other domains. Analyses were made using only transition data from June 2014 to May 2015. Independent variables were included in transition models only if they were significant at the 5% level. Probabilities of remaining at a level were taken as 1 less the sum of the estimated probabilities of changing levels.

7.3.3 Life Expectancies

The life expectancy program assumes monthly transition rates, with the backwards estimation approach. For example, the life expectancy at month x when in state i , (notation $E_{x,i}$), was calculated as:

$$E_{x,i} = q_{x,i} / 24 + (1 - q_{x,i}) \times \sum Pr_{(x,i \text{ to } j)} \times [E_{(x+1,j)} + 1/12] \quad [\text{Eq. 7.4.}]$$

where $q_{(x,i)}$ is the probability of exit from state i between month x and $x + 1$ and $Pr_{(x,i \text{ to } j)}$ is the probability of transition from state i to j between month x and $x + 1$, where the summation is over the 64 possible values of j . In applying this equation, life expectancies were assumed to be 0 at age 115. A more exact version of this relationship is used in the construction of the Australian Life Tables 2010-12 (Australian Government Actuary 2014). The formula 7.4 closely reproduces the published life expectancy values across the whole age range.

The life expectancy program uses monthly transition rates. These are more accurately derivable than annual rates, as competing forces become less of a problem, and no incomplete records are lost. To derive monthly rates, the ACFI data were transformed, with each record now showing the values for each domain in one month, and their values in the next month if exit did not occur in the month.

In operational terms, our logistic analyses were conducted in the STATA 13 software (StataCorp 2013) and were cross-checked in the R software package “pscl” (Jackman 2015), including the model diagnostics. The life expectancy is calculated in C# (Microsoft Corporation 2013).

7.3.4 Limitations

The research approach used here has several limitations. For confidentiality reasons, all entry, assessment and exit dates were supplied to us as months and years, birthdates as years, and no geographic or facility data were supplied. Despite the limitations, the methods and data analysis proposed here represent a major advance on current research practice, offering the prospect of vastly increasing knowledge about the residential aged care system in Australia. The system dynamics are thoroughly examined using advanced quantitative tools, including transitions between the states, exit probabilities and life expectancy estimates. Such measures can better inform policy and practice, providing relevant and timely information. Systematic application of the methods proposed here can establish the evidence base and thereby increase the quality and efficiency of residential care.

7.4. Results

7.4.1 Changes in the ACFI system

The ACFI classification system was introduced on 20 March 2008, and by 30 June 2009 most of the residents had ACFI assessments. The growth in total numbers of persons with ACFI appraisals shown in Table 7.1 therefore largely reflects the increases in persons in residential aged care. A new combined assets and income test applied to entrants from 1 July 2014 and this resulted in unusually high numbers of entrants in 2013-14. The processing delays associated with this new test resulted in unusually high numbers of persons in respite care at 30 June 2015 with fewer persons in permanent residential care. Administrative changes such as the new combined assets and income test can have large short-term effects on statistics such as those in Table 7.1. Because of some recent residents not having received ACFI ratings, and some data adjustments, the total number of persons at 30 June 2015 in the table is about 1.4% below the actual total.

Table 7.1 Characteristics of persons with ACFI ratings

Date	30/6/09	30/6/10	30/6/11	30/6/12	30/6/13	30/6/14	30/6/15
Persons	157339	162994	165945	168056	169902	174559	169705
Females	111313	114601	116136	116660	117210	119633	115963
Mean age	84.0	84.1	84.2	84.3	84.4	84.5	84.6
Mean ADL	1.861	1.961	2.066	2.156	2.185	2.234	2.326
Mean BEH	1.868	2.002	2.136	2.235	2.266	2.286	2.373
Mean CHC	1.335	1.492	1.667	1.839	1.946	2.068	2.266
Infectious & parasitic	695	779	853	941	914	971	970
Neoplasms	11261	11466	11625	11694	11354	11128	10283
Diseases of the blood	3419	3232	2884	2623	2372	2260	2001
Endocrine, nutritional	32936	33454	33454	32494	32225	31993	30050
Dementia	81852	84339	86003	87349	87866	90481	88133
Mental & behavioural	69383	76282	81915	86464	90640	95998	97172
Nervous system	22042	22240	22060	22038	21811	21958	21332
Eye & adnexa	23253	23369	23226	22918	22473	22574	21366
Ear & mastoid	8996	9117	8938	8756	8362	8266	7357
Circulatory	92711	92798	90997	87982	84864	83352	77200
Respiratory	17264	17215	17345	17151	16933	16908	16025
Digestive system	15551	14931	14286	13471	12431	11613	10334
Skin & subcutaneous	5603	6064	6410	6607	6452	6305	5735
Musculoskeletal	70872	74862	77694	80459	82551	87102	88006
Genitourinary system	22338	25091	27490	29336	30667	32248	31995
Congenital	587	587	586	525	498	506	468
External causes	12575	13884	14707	15125	15413	15935	15654

Source: AIHW 2016a.

Increases in ACFI ratings from 30 June 2009 to 2015

Numeric ADL, BEH and CHC values were derived by taking 0 for 'nil', 1 for 'low', 2 for 'medium' and 3 for 'high'. Table 7.1 shows that mean ADL values were 1.861 at 30 June 2009, and 2.326 at 30 June 2015, an increase of 25%. Mean BEH values rose by 27% in the same period, and

mean CHC values by 70%. One reason for this trend may be that residential care providers have gradually adopted more liberal interpretations of the ACFI guidelines, and the audit and penalty processes have been inadequate to control this drift. The ACFI system was introduced because the previous classification system suffered from upwards compression (Andrews-Hall, Howe & Robinson 2007). Similar problems have been observed in Ontario (Hirdes & Kehyayan 2014). One of the problems examined in this chapter is the derivation of reasonable transition assumptions in the presence of continuing drift.

Healthier residents?

The proportion of residents with life-threatening diseases has reduced over the 6 years to 30 June 2015 as suggested in Table 7.1. The numbers of residents increased by 8%, but the numbers reported with neoplasms fell by 9%, the numbers with circulatory diseases fell by 17% and the numbers with respiratory diseases fell by 7%. The numbers reported with dementia increased by 8%, in line with the numbers of residents. By contrast, the numbers reported with mental and behavioural problems increased by 40%, those with musculoskeletal problems increased by 24%, and those with genitourinary diseases by 43%. Several hypotheses can be made to explain these implausible divergences (Cumpston & Jukic 2017):

- Improvements in public health and disease treatment have reduced the numbers of older persons with life-threatening diseases;
- Increased reporting of subsidy-enhancing conditions has left inadequate room for reporting other conditions (the data entry system provides room for only three physical conditions, as well as for three behavioural conditions);
- The increased ability of residential care providers to charge large entry deposits may have created a bias towards more wealthy entrants, with fewer life-threatening diseases.

Numbers of ACFI domain transitions July 2014 to May 2014

Table 7.2 shows the numbers with each domain value at the start of each month from July 2014 to May 2015, and the numbers of these in each possible value at the end of the month. For example, there were 588,314 residents with ADL level 2 at the start of a month, and by the end of the month 4 had dropped to ADL level 0, 531 to level 1, and 18,681 had risen to level 3. Most care residents keep the same level of assistance needs or move one level up after a re-appraisal. Transitions in June 2015 are not shown in Table 7.2 as no data were available on ACFI assessments at the end of that month. While transitions are in general to higher need levels,

there are some to lower needs.

Table 7.2 Numbers of transitions in each month from July 2014 to May 2015

Numbers at start	Numbers at end	Numbers at end	Numbers at end	Numbers at end	Numbers at end
	adl=0	adl=1	adl=2	adl=3	Total
adl=0	23,924	859	281	128	25,192
adl=1	62	341,696	10,210	4,680	356,648
adl=2	4	531	569,098	18,681	588,314
adl=3	2	76	1,064	894,392	895,534
Total	23,992	343,162	580,653	917,881	1,865,686
	beh=0	beh=1	beh=2	beh=3	Total
beh=0	110,451	2,174	1,813	1,150	115,588
beh=1	550	251,700	6,033	6,002	264,285
beh=2	191	1,293	379,874	11,448	392,806
beh=3	79	661	2,604	1089665	1093009
Total	111,271	255,828	390,324	1,108,265	1,865,686
	chc=0	chc=1	chc=2	chc=3	Total
chc=0	94,639	2,130	2,199	1,196	100,164
chc=1	265	356,698	8,144	9,625	374,732
chc=2	107	1,126	527,266	18,335	546,834
chc=3	30	360	1,687	841,880	843,957
Total	95,041	360,314	539,296	871,036	1,865,686

Source: AIHW 2016a.

7.4.2 Logistic models of monthly mortality rates

The logistic model coefficients in Table 7.3 were based on 306,812 deaths in the 6 years to 30 June 2015, and on 53,724 deaths in the 1 year period from 2014 to 2015. The models were fitted by backwards stepwise regression, omitting variables not significant at the 5% level. The first model in the table was based on the 6 years of data, allowing for sex (0 for male, 1 for female), age and year relative to 2014-15 (for example, 2009-2010 was coded as '-5'). Dummy (0,1) variables were included for each ACFI domain level, relative to the lowest possible value for the domain. The second model in Table 7.3 used the same independent variables as the first, except that only 2014-2015 exposures were considered. Models 3 and 4 did not include the assistance needs variables, and instead used (0,1) codes for the specific ICD diseases reported in ACFI assessments. Models 5 and 6 used both needs and diseases as independent variables. The coefficients are the fitted model values, rather than the exponentiated values sometimes reported as odds ratios.

Table 7.3 Coefficients of logistic models of mortality rates while in residential aged care

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variable	Needs	Needs	Diseases	Diseases	Needs & diseases	Needs & diseases
Based on:	6 year	1 year	6 year	1 year	6 year	1 year
female	-0.508**	-0.498**	-0.374**	-0.375**	-0.410**	-0.413**
Age	0.034**	0.033**	0.040**	0.040**	0.035**	0.035**
Year	-0.075**		0.011**		-0.066**	
adl1	0.454**	0.426**			0.453**	0.432**
adl2	1.127**	1.091**			1.126**	1.099**
adl3	1.772**	1.846**			1.789**	1.868**
beh1	-0.040**	-0.072				
beh2	-0.145**	-0.168**			-0.083**	-0.089**
beh3	-0.201**	-0.193**			-0.099**	-0.074**
chc1	0.218**	0.124**			0.227**	0.144**
chc2	0.383**	0.253**			0.390**	0.287**
chc3	0.931**	0.691**			0.913**	0.716**
Infectious diseases			0.202**			
head & neck cancer			1.004**	0.990**	0.976**	1.003**
stomach cancer			0.958**	0.981**	0.994**	1.074**
colorectal cancer			0.492**	0.461**	0.515**	0.521**
lung cancer			1.639**	1.523**	1.509**	1.470**
skin cancer			0.186**	0.169**	0.225**	0.277**
breast cancer			0.405**	0.423**	0.413**	0.487**
prostate cancer			0.475**	0.406**	0.462**	0.465**
brain cancer			1.373**	1.331**	1.109**	1.098**
non-Hodgkin's lymphoma			0.662**	0.562**	0.666**	0.644**
leukaemia			0.666**	0.640**	0.738**	0.739**
other malignant tumours			1.207**	1.119**	1.122**	1.105**
other neoplasms			0.549**	0.515**	0.520**	0.551**
anaemia			0.133**	0.150*	0.255**	0.269**
other diseases of blood			0.362**	0.307**	0.450**	0.434**
disorders thyroid gland			-0.018**		-0.057**	
dementia			0.194**	0.195**	-0.018**	
other mental disorders			0.030**	0.052**	-0.090**	-0.085**
nervous system diseases			0.022**		-0.128**	-0.103**
eye & adnexa diseases			-0.181**	-0.195**	-0.078**	-0.097**
ear & mastoid diseases			-0.239**	-0.288**		-0.056**
circulatory system diseases			0.037**	0.040**	0.063**	0.073
upper respiratory infections			0.223**		0.265**	
influenza & pneumonia			0.834**	0.734**	0.694**	0.653**
lower respiratory infections			0.301**	0.278*	0.375**	0.417**
other upper respiratory			-0.085			
chronic lower respiratory			0.312**	0.330**	0.371**	0.416**
other respiratory diseases			0.489**	0.537**	0.563**	0.641**
digestive system diseases			-0.115**	-0.131**	0.028**	
skin & subcutaneous tissue			0.172**	0.195**		0.096**
musculoskeletal & connective			-0.194**	-0.179**	-0.184**	-0.177**
genitourinary system diseases			0.116**	0.093**	0.035**	0.028
external causes				-0.051*	-0.140**	-0.140**
constant	-8.157**	-7.897**	-6.951**	-6.975**	-8.407**	-8.296**
LLR	0.0561	0.0493	0.0260	0.0233	0.0690	0.0611

† Reference categories: Gender (Male); Year (2014-2015); ADL, BEH & CHC (Not having an ADL, BEH & CHC); ICD (Not having an ICD);

‡ Results significant at the 0.1% level are marked **, 0.1% to 1% *, and 1% to 5% with no mark (all other variables).

As in the population out of residential care, females have lower mortality rates, and mortality rates increase with age. Increasing ADL and CHC levels have higher probabilities of death. Surprisingly, persons with higher BEH levels have slightly lower mortality rates, perhaps because dementia sufferers may need institutional care earlier than would have been necessary based on their physical needs. Some types of cancer considerably increase mortality rates, and some respiratory diseases also have substantial mortality increases. Using both needs and disease variables gives generally similar coefficients. The log-likelihood ratio of the model fitted to needs over the 6 years is 0.056, rising to 0.069 when disease variables are included.

7.4.3 Logistic models of monthly transition rates

Table 7.4 shows the coefficients of 36 logistic models fitted to data on transitions in July 2014 to May 2015. This short data period was chosen to minimise the effects of the long-term changes that have been occurring in ACFI assessments. The models were initially fitted by backwards stepwise regression, retaining coefficients significant at the 5% level. Where the coefficients fitted to ADL1, ADL2 and ADL3 appeared inconsistent with each other, they were omitted, and new models fitted. Similarly, inconsistent values for BEH1, BEH2 and BEH3, and for CHC1, CHC2 and CHC3 were omitted.

In nearly all cases, the age coefficients for upwards transitions were positive, and the age coefficients for downwards transitions were negative. This strongly suggests that deteriorations occur more often as persons' age, and improvements less often. In general, upwards transitions had positive coefficients for ACFI levels, and downwards transitions had negative coefficients for ACFI levels. For example, the transition from ADL level 1 to level 0 had large negative coefficients for BEH3, CHC2 and CHC3. Exceptions occurred for BEH level 0 to 1, 0 to 2 and 2 to 3, which had negative coefficients for CHC2 and CHC3. Models of CHC transitions had no BEH variables, but were strongly affected by ADL values.

Table 7.4 Logistic models for monthly transitions between assistance needs

Monthly transition assumptions - ADL								
change	age	beh1	beh2	beh3	chc1	chc2	chc3	constant
0 to 1	0.014**							-4.498**
0 to 2	0.021*							-6.231**
0 to 3	0.052**							-9.921**
1 to 0	-0.050**			-1.136*		-0.947*	-1.273	-3.598**
1 to 2	0.017**	0.242**	0.251**	0.185**				-5.138**
1 to 3	0.038**	0.216**	0.229**	0.466**				-7.808**
2 to 0								-11.899**
2 to 1	-0.030**		-0.345*	-0.782**	-0.388**	-0.582**	-1.094**	-3.352**
2 to 3	0.020**							-5.110**
3 to 0								-11.329**
3 to 1	-0.042**							-5.908**
3 to 2	-0.019**	-0.528**	-0.539**	-1.213**	-0.489	-0.911**	-1.357**	-3.125**
Monthly transition assumptions - BEH								
change	age	adl1	adl2	adl3	chc1	chc2	chc3	constant
0 to 1	0.010**					-0.148*	-0.433**	-4.724**
0 to 2	0.0062	0.326*	0.467**	0.302		-0.128	-0.299**	-4.907**
0 to 3								-4.600**
1 to 0			-0.230	-0.788**		-0.319*	-0.348*	-5.777**
1 to 2	0.010**							-4.582**
1 to 3								-3.762**
2 to 0			-0.468*	-1.211**				-7.105**
2 to 1								-5.713**
2 to 3	0.004**					-0.204**	-0.579**	-3.553**
3 to 0	-0.031**							-6.959**
3 to 1			-0.298*	-1.044**		-0.671**	-1.042**	-6.211**
3 to 2			-0.399**	-1.106**		-0.328**	-0.915**	-4.909**
Monthly transition assumptions - CHC								
change	age	adl1	adl2	adl3	constant			
0 to 1	0.012**				-4.853**			
0 to 2	0.019**				-5.410**			
0 to 3	0.022**	0.293	0.729**	0.917**	-6.730**			
1 to 0	-0.024**	-1.124**	-1.791**	-2.445**	-3.757**			
1 to 2	0.010**				-4.693**			
1 to 3	0.019**	0.492**	0.754**	0.793**	-5.903**			
2 to 0	-0.0205	-1.236**	-1.852**	-2.958**	-4.947**			
2 to 1	-0.010**	-0.579**	-0.987**	-1.638**	-4.279**			
2 to 3	0.013**	0.500**	0.597**	0.471**	-4.994**			
3 to 0	-0.040**				-6.902**			
3 to 1	-0.012**				-6.725**			
3 to 2			-0.632**	-1.581**	-5.123**			

† Results significant at the 0.1% level are marked **, 0.1% to 1% *, with all other variables, significant between 1% and 5%.

7.4.4 Life expectancies

A sample of the life expectancy estimates for both sexes and selected combinations of assistance needs is shown in Table 7.5. Females have longer life expectancies than males with the same assistance needs levels. Life expectancies drop as needs levels rise, and drop with age. For example, a female aged 85 assessed as level 1 in all three domains has an estimated life

expectancy of 4.18 years. If she is assessed at level 3 in all domains, her estimated life expectancy is 2.17 years.

Table 7.5 Sample life expectancy estimates

Sex	ADL	BEH	CHC	65	75	85	95	105
Male	0	0	0	6.44	5.02	3.88	2.98	2.27
Male	1	1	1	5.37	4.12	3.15	2.39	1.81
Male	2	2	2	4.15	3.17	2.41	1.84	1.40
Male	3	3	3	2.53	1.86	1.36	1.00	0.74
Female	0	0	0	8.17	6.39	4.96	3.82	2.91
Female	1	1	1	7.06	5.45	4.18	3.19	2.42
Female	2	2	2	5.79	4.44	3.40	2.60	1.99
Female	3	3	3	3.99	2.95	2.17	1.60	1.17

† The calculation of the life expectancy follows the equation 7.4, but with two assumptions. Firstly, those persons who exited but did not re-enter a residential care facility were assumed to be dead, and secondly, the equation ignores the likelihood of simultaneous changes in the domains.

Source: Calculated using AIHW, 2016a.

Life expectancy estimates with unit mortality loading

All the original life expectancy calculations in Table 7.5 were done without simulating the effects of diseases⁴⁰. Because most of the cancers have a coefficient of around 1 (head and neck cancer 1.003; $p < 0.001$, stomach cancer 1.074; $p < 0.001$, brain cancer 1.098; $p < 0.001$, other malignant tumours 1.105; $p < 0.001$), the loading of 1 is added to show the effect of diseases with a coefficient of 1. Table 7.6 shows life expectancy estimates obtained by adding 1.0 to the logistic mortality score, as percentages of the estimates without loadings in Table 7.5. For example, head and neck cancer is estimated in Table 7.3 to add about 1.003 to the logistic mortality score. A female aged 85 with all needs at level 3 and this form of cancer might be estimated to have a life expectancy of about 50% of the 3.4 years in Table 7.5, or about 1.7 years.

Table 7.6 Life expectancy estimates with unit mortality loading, as % of no-loading estimates

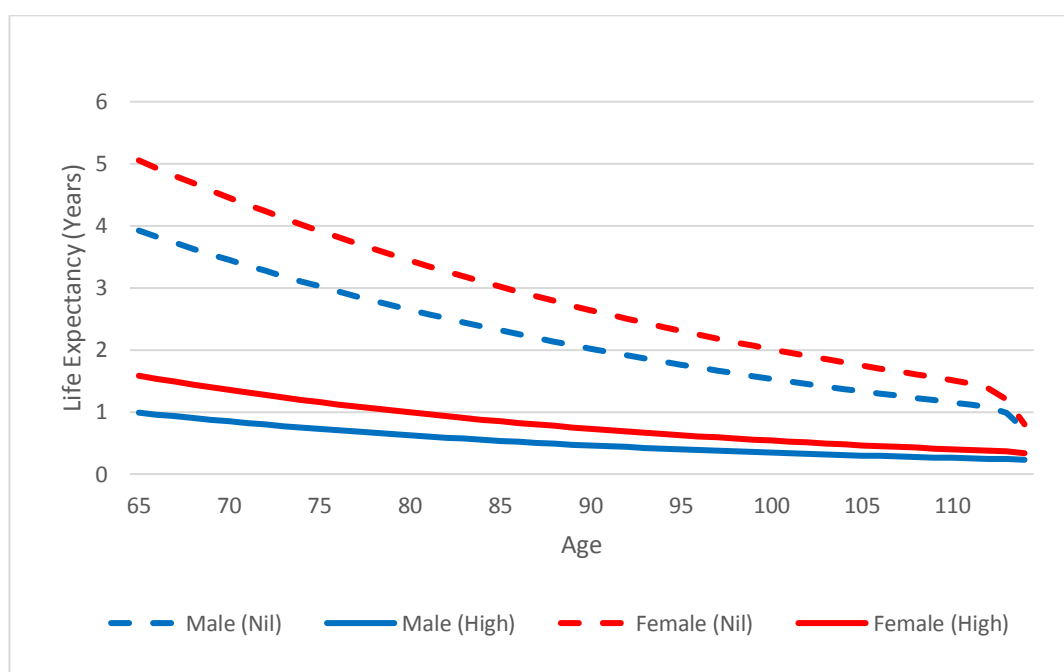
Sex	ADL	BEH	CHC	65	75	85	95	105
Male	0	0	0	61%	60%	60%	59%	59%
Male	1	1	1	56%	56%	55%	55%	55%
Male	2	2	2	49%	49%	49%	48%	48%
Male	3	3	3	39%	39%	39%	40%	41%
Female	0	0	0	62%	61%	61%	60%	60%
Female	1	1	1	57%	57%	56%	56%	56%
Female	2	2	2	51%	50%	50%	49%	49%
Female	3	3	3	40%	39%	39%	39%	40%

Source: Calculated using AIHW, 2016a.

⁴⁰ In terms of simulation, we can say the loading equals to 0.

Figure 7.2 shows the life expectancy estimates in residential care by sex and by assistance needs, with the two most extreme cases being compared. The “Nil” values are for persons with the lowest possible values for the ADL, BEH and CHC domains (0-0-0), whereas the “High” values represent persons with the highest possible values of these domains (3-3-3). Gender differences in life expectancies are obvious, with females expected to live longer than males with the same care needs levels. For example, females aged 80 assessed as having no needs for assistance are expected to live about 3.6 years compared to their male counterparts who are expected to live only about 2.7 years. Because life expectancies drop with age, differences between sexes and between extreme cases of assistance needs become less pronounced. For instance, at age 90, men with the ‘High’ assistance needs are expected to live only 3-4 months shorter than women with the same age and level of care needs.

Figure 7.2 Life expectancy estimates by sex and the level of assistance needs



† Life expectancies with included transitions between care assistance needs;

‡ Male/female (Low) refers to male/female with no assistance needs in any domain, whereas male/female (High) is male/female with the highest scores in all three domains (ADL = 3, BEH = 3 & CHC = 3)

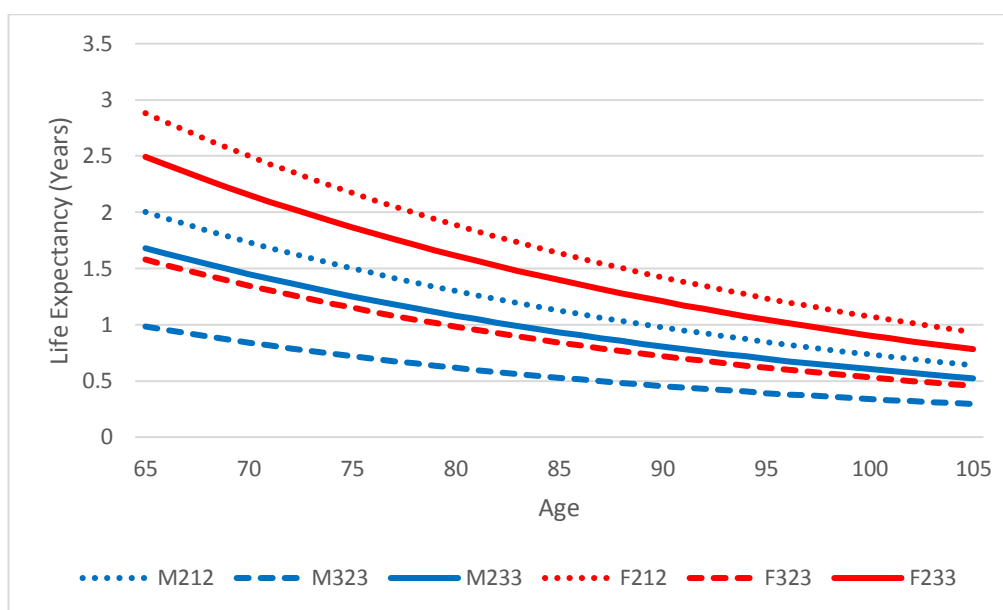
Source: Author, October 2016.

Using microsimulation to distribute estimates for months till death

The mortality model in the third column of Table 7.3, and the transition models in Table 7.4, were used to make 10,000 random simulations of months till death, for selected cases. These simulations confirmed the estimates in Table 7.5, and could be valuable in giving individuals probability distributions of how long they are likely to live. Simulated life expectancies for selected levels of assistance needs are shown in Figure 7.3. Besides already observed differences

in life expectancy between genders and change in life expectancy with age, we can observe how certain combination of assistance needs affect the estimated life expectancy. For example, both males and females with the combination of assistance needs '3-2-3' (ADL = 3, BEH = 2 and CHC = 3) are expected to live much shorter than those with the combination '2-3-3' (ADL = 2, BEH = 3 and CHC = 3). This means that having a higher level in the ADL domain, shortens the life expectancy in residential care more than having a higher level in the BEH domain, controlling for the CHC level. In a similar way, it is possible to simulate and compare each combination of care needs.

Figure 7.3 Simulated life expectancy estimates by sex and selected levels of care needs



† Simulated life expectancies with included transitions between care assistance needs;

‡ Male/female (212) refers to male/female with ADL = 2, BEH = 1, CHC = 2, male/female (323) is male/female with ADL = 3, BEH = 2, CHC = 3; male/female (233) is male/female with ADL = 2, BEH = 3, CHC = 3.

7.5 Discussion

This chapter has broadened our understanding of the residential aged care system in Australia by providing important evidence about: (1) *Changes in the ACFI system in the period 2008-2015*; (2) *Mortality rates*; (3) *Transition rates between the assistance needs* and (4) *Life expectancy in residential care*. These key pieces of evidence are necessary to fully understand the dynamics of functional decline of nursing home residents.

The ACFI system analysis has revealed the effects of aged care policies on system dynamics. For example, a high number of entries to residential care in the period from mid-2013 to mid-2014 is likely a consequence of a new assets and income test applied to persons entering care from 1

July 2014. Furthermore, the continuous upward trend in ACFI appraisals outcomes may be a result of more liberal interpretations of the ACFI guidelines by residential care providers and a lack of consistent audit and penalty processes to control the upward drift in ACFI scores.

Statistical models derived from longitudinal data on 1.05 million ACFI assessments addressed our research questions: (1) *What is the life expectancy for each combination of care assistance needs?* and (2) *How do the residents' assistance needs change in residential care?* Firstly, the model of mortality in residential care was derived (Table 7.3) showing association between mortality as an outcome, and age, gender, care assistance needs and diseases as predictors. Secondly, models of transitions between assistance needs (Table 7.4) were derived to show the likelihood of occurrence of each specific transition using demographics and other assistance needs as predictors. Finally, the results of the mortality and transition models were used to give estimates of life expectancy in residential care (Tables 7.5 & 7.6).

The results corroborated evidence from previous chapters that residents' assistance needs are good predictors of the probability of death in residential care and good predictors of the probability of transition towards other levels of care needs. Effects of diseases were also examined and put to the test. Simulation was used to show how adding a specific disease, such as cancer, can halve the life expectancy in residential care. Quantitative insights such as this can be used to test the effects of changes in disease incidence (i.e. scenario testing) on the demand for residential aged care.

The life expectancy and transition estimates may help policy makers to review the current occupancy and waiting times for long-term care and to predict future long-term care needs with better accuracy. These numerical measures can set the foundation for more precise estimates of the costs of residential care. Besides financial aspects, the estimates are relevant for providers of care services. For example, residential care providers could plan their workforce needs if they knew how certain assistance needs will progress with time spent in care and what these changes mean for an individual's life expectancy.

The procedures carried out in this chapter serve to indirectly examine *if Australian data on aged care can be useful for aged care projections* [Research Question 3]. The findings suggest that the ACFI longitudinal data provide sufficient details to model transitions between assistance needs levels and to estimate life expectancy in residential care. Administrative longitudinal data is free from non-response rates, under-reporting or attrition and, therefore, can be used to fit complex models. Millions of records resulting from each ACFI appraisal give high statistical power and

advantage over other techniques in terms of accuracy. However, the data showed continuing changes in reporting practices, making even the most recent data of limited value for projections.

The continuing changes in reporting practices and procedures are of considerable concern to the Australian Government, as they are falsely inflating the subsidy claims by providers of residential aged care (Cumpston & Jukic 2017). Possible system changes are higher penalties for misreporting, stronger audit procedures or external assessment systems. Although residential care systems differ widely between countries, the techniques in this chapter may still be of some value to governments, providers and residents in other countries.

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8. Conclusion

In Australia, as in many other ageing populations, aged care is an indispensable part of health and social policies. Since the 1950s, it has been a heavily subsidized segment of the Australian public sector, with an ongoing debate on the preferred pattern of service provision to older Australians. From the time of the fiscal crisis in the mid-1980s, the Government has attempted to regulate the system by shifting the balance of aged care towards the community and substituting residential care with home care (Kendig & Duckett 2001; Howe 1997). To inform the decision makers on the dynamics and structure of aged care, numerous statistical reports and overviews have been periodically generated. For example, the Australian Institute of Health and Welfare has sought to provide information about the patterns of service utilization in the aged care system, and the features of older Australians who use these services (Joenperä 2015). With the advancement of structural ageing, it is expected that an increasing number of older people will use aged care services by the time they reach the end of their life. However, the structure of future care utilization and the volume of each component of the aged care system is unknown.

Future aged care dynamics are usually estimated by looking at the past trends of usage of different care services. For example, in June 2015, approximately 176,967 people lived in residential aged care (AIHW 2016d), with this figure expected to increase to 1 million by 2050 if current trends remain (Commonwealth of Australia 2010). These estimates can only give a general direction of future changes but such predictions do not fully account for interdependency between pattern of disabilities and diseases and the sociodemographic characteristics of older Australians. As pointed out by numerous authors (Broad et al 2011; Chung et al 2009; Csesko & Reid 2009; European Commission 2008; Ovseiko 2007), predictions of long-term care demand can be very imprecise. Preferably, these predictions should be based on large administrative data sources and include transition probabilities accompanied by an extensive set of individual variables and perceived from the micro-perspective. Models that include rich information on transition probabilities, life expectancy and individual predictors may allow future scenarios to be simulated and tested.

Research has found that various enabling, predisposing and health factors are associated with the propensity of being in receipt of formal or informal care. Yet, the value of many studies has been constrained by use of cross-sectional comparisons between populations receiving informal care and residential or formal institutional care (Kendig et al 2010). To date, however, there

have been no studies quantifying and modelling the detailed residential care trajectory of older Australians. Furthermore, the synchronized influence of individual sociodemographic, health and other factors on the probability of aged care events has not yet been fully examined. It is well documented, however, that complex associations, such as those between disease patterns, disabilities, assistance needs and carer availability are strongly associated with the probabilities of older people receiving a specific form of aged care.

This study provides a more complete picture of the Australian aged care system. Models derived in previous chapters are important for several reasons. Firstly, these models approximate the probability of each of the key events on an individual's trajectory towards nursing home care, including application for an aged care assessment, approval for residential care, admission to care, and the probability of change of individual's assistance needs inside residential care facilities. Secondly, all the predictors of care-related events used in these models are well grounded in the research findings on aged care processes. Finally, despite some limitations that were already mentioned, these models were derived from the extensive Australian data on aged care. Multiple data sets used to derive models of the aged care events, especially those data sources that include the entire population of older Australians (*Aged Care Assessment Program* data and *Aged Care Funding Instrument* data), give reliable information on the processes affecting the population in the aged care system.

8.1 Policy and theoretical importance of the findings?

The need for residential care, observed as a sequence of care-related events, arises with age-related morbidity, disability and lack of access to informal care provision. The prevalence of age-related disability, as reported by the Australian Institute of Health and Welfare, is clearly increasing (AIHW 2012b; 2014b; 2016b). Until now, however, it has not been well documented how disabilities, diseases and socio-demographic characteristics of older persons affect the probabilities of older people approaching the official aged care system. For instance, it has not been examined what the chances are that a hypothetical widowed male, aged 71, diagnosed with dementia, and high needs for assistance with self-care is approved for an admission to residential care. Moreover, it has not been estimated with great precision how long the same person will stay in residential care and how quickly his assistance needs will change while being in a nursing home.

This research has attempted to redress the existing research gaps by providing models of important events on aged care trajectories and by identifying individual circumstances

associated with each of these events. Having in mind the differences in quality of each model due to data availability and extensiveness, the following relationships have been identified between the predictors and the care events (Table 8.1): With increasing age, older Australians are more likely to apply for care, have a better chance to be approved to receive residential care, and have a higher likelihood of being admitted to institutional care. Not surprisingly, older age increases the probability of death in nursing homes, expressed as a force of mortality. Compared to males, females are less likely to apply for care assessment and have a lower chance of being approved for residential aged care. Being female decreases, in relative terms, the force of mortality in residential care. In terms of the other main sociodemographic predictors of care events, having a partner or carer, as a proxy to informal care provision, expectedly decreases the probability of being in care and the chance of applying for aged care assessment.

Table 8.1 Direction of association between main predictors and events

	Events					
	Being in Care	Application	Approval	Admission	Exit	Death
Age	↗	↗	↗	↗	↔	↗
Female	↔	↘	↘	↔	↘	↘
Partner/Carer	↘	↘	↔	-	-	-
ADL	↗	↗	↗	-	↗	↗
BEH	↘	-	-	-	↘	↘
CHC	-	-	-	-	↗	↗
Diseases	↗	-	↗	-	↗	↗

† Interpretation of directional signs: ↗ (Increase in / having a predictor, increases the probability of event happening); ↘ (Increase in / having a predictor, decreases the probability of event happening); ↔ (Predictor included in the model, but without effect); '-' (Predictor was not available in the model);

‡ Reference category for categorical predictors (Female, Partner/Carer, ADL, BEH and CHC and Diseases) is not being in any of those categories. "Diseases" relate to most of the diseases (having higher level of comorbidity) and thus, each model requires separate interpretation. Having some diseases can decrease the probability of experiencing care related event;

§ Models are the following: Being in Care (Table 4.2); Application (Table 5.7, Model A), Approval (Table 5.8, Model B), Admission (Table 5.9, Model A), Exit (Table 4.4) and Death (Table 7.3, Model 6).

As consistently reported in the research literature⁴¹, assistance needs were found to be the most important predictors of the events on the residential care trajectory – application, approval, entry and exit. In mortality analyses, care needs were also the dominant factors associated with individual life expectancy. Those residents who enter a nursing home with higher care needs on average stay shorter than those residents who enter with lower care needs, which indicates a major role of these facilities in end-of-life care provision. However, most of the models showed that needs for assistance with the activities of daily living (ADL) and needs for assistance with complex health care (CHC) have a different influence on the probability of certain care events

⁴¹ A brief literature review has been shown in Chapter 1.4 (*"Decisions and Events: What are the triggers?"*), whereas the full review of factors associated with care-related events is in Chapter 4.4 (*"Conceptual Models and Hypotheses"*).

when compared to needs for assistance in the behavioural domain (BEH). For example, a person with higher needs for assistance with the activities of daily living is more likely to be in residential care and has a higher probability of making an application for care assessment and a higher chance of being approved for residential care. In terms of assistance needs as the predictors of death inside aged care, the difference again exists between ADL and CHC on one side, and the BEH on the other. Higher needs for assistance with daily living activities (ADL) and higher complex health care needs (CHC) are associated with earlier death inside residential care, whereas higher needs for assistance in the behavioural domain (BEH) postpone death within residential care.

Degenerative, multiple or chronic conditions were found to be significant predictors of being in residential care and being approved for placement in a nursing home. Persons who suffer from such conditions or diseases become more dependent and unable to live independently at home. As shown by the results in the mortality model, diseases such as cancers, respiratory infections and genitourinary conditions can drastically shorten an individual's life expectancy in residential care. Some diseases, such as mental and nervous system diseases, are negatively associated with the probability of death. It can be speculated that, in contrast to individuals who suffer from diseases such as cancers, those older Australians with mental diseases, on average, tend to enter nursing care in a better physical condition.

These findings are important since changes in disability and disease patterns of older Australians are likely to be the future drivers of residential aged care dynamics in Australia. Even though disability patterns have been stable over the last few decades, and can be classified as one area of stability within the residential care system, the baby boomer generation is progressing towards very old ages. The prevalence of more serious disability conditions at these very old ages might push the baby boomers towards institutional aged care.⁴² However, an increasing policy focus upon co-ordinated care and management of complex conditions within the home and community care arrangements may have a protective role against an increased influx of persons to residential care.

Despite the Government's continuous efforts and strategies to enable older Australians to remain in their own homes (Kendig et al 2010) by stimulating home and community care (Wells

⁴² Future residents in nursing homes are expected to have greater acuity levels, especially due to increase in prevalence of conditions such as dementia. By 2025 it is expected to be roughly 235,000 Australians with dementia (Access Economics 2010). If there will not be a cure to prevent or reverse the effects of dementia, that would mean 43 additional people with dementia per day for the next 5,478 days.

& Regan 2013; Kendig & Duckett 2001), many older Australians are expected to enter institutional aged care at some point in their life. Nursing homes, therefore, will remain a necessity for many people due to complex care needs that cannot be provided out of institutional care (Gaugler et al 2007; Aguero-Torres et al 2001). By quantifying the statistical associations between care events and their predictors, such as diseases, disabilities or sociodemographic characteristics, the findings presented in this study allow an examination of the potential effects of changes in diseases and disability patterns of older Australians on the residential care system.

Apart from providing an explanation of the associations between the main events on the residential aged care trajectory and their predictors, results from this study are important for other reasons. Designed as a comprehensive model of residential aged care processes in Australia, this study enables policy makers to examine the dynamics of progression of older Australians towards aged care as a multi-stage process comprised of several phases. Each critical moment in this process has been regulated and recorded in the administrative data. This gives the Government the ability to examine the characteristics of persons at each critical moment in the system and therefore to promptly respond to the needs of older Australians. For example, precise estimates of the life expectancy inside residential care, for each category of individual care needs, gives a tool for better care workforce planning and more accurate estimation of necessary subsidies.

Another strong point of this research is that it sheds new light on residential care in Australia. Previous studies have perceived residential care just as one of the several absorbing states or resulting care arrangements in which older Australians can end. In contrast, this study looks at residential care as a comprehensive system in which each person advances through a series of critical events and where each transition is driven by a set of predisposing sociodemographic, health and other characteristics at the level of an individual. For that reason, the findings of this study may give older Australians and their families insights into the usual care trajectories for persons with similar characteristics. For example, information on the probabilities of an older person being approved for residential care as a recommended long-term care arrangement may enable older Australians to anticipate their own odds of being given the same recommendation. For the current residents in nursing homes, better insights on usual dynamics of functional decline and early information on life expectancy may assist financial planning and help the families of these residents to make better decisions in terms of asset management or to plan alternative end-of-life care arrangements.

Finally, this study draws primarily on the extensive Australian administrative data on aged care. Large data sets, such as Aged Care Assessment Program (ACAP) or Aged Care Funding Instrument (ACFI) provide the richest source of microdata⁴³ on the aged care system currently available in Australia. The first data source contains information about every older Australian who applied to receive either residential care or a home and community long-term care arrangement, whereas the second data set has information on every person who entered residential care, including all changes in assistance needs during the time spent in residential care. Using microdata on aged care about individual persons can have many positive impacts on aged care policies. For example, Caldwell (1983 p. 61) noted that *“policy analysis payoffs accumulate exponentially when the level of spatial disaggregation becomes even finer than the state level”*. These administrative microdata sources are complemented with the national Survey of Disability, Ageing and Carers (SDAC) and other forms of administrative data (ACFI boxes) to enable the examination of the full aged care trajectory. Models derived by combining these sources provide a realistic picture of Australian aged care experiences at the individual level. Nevertheless, this study has also identified certain gaps in the current data system that should be further examined.

8.2 Gaps in current data system that needs to be filled in to understand residential care system of Australia?

One of the research aims in this study was to determine whether Australian data can be used to model the full range of residential care trajectories. As previously mentioned, the process of data acquisition was an interesting and erratic journey, with different sources becoming available at different times during this Ph.D. research. As a consequence, the methodological approach had to be modified as new data became available. This included combining information coming from different points in the residential care system to broaden the understanding of residential care trajectories. During this process, at least three problems have become apparent: Firstly, there is a linkage gap in microdata between approvals for and admissions to residential care. Secondly, an inconsistency in measurement of the same features (i.e. care needs) of older Australians has been noticed across different data sources. Finally, the data itself is not always accessible for research purposes – a clear contrast to the Government’s regulations and recommendations.

8.2.1 Problem with unlinked data

⁴³ Microdata are data about entities, not aggregates. For example, microdata could be about individual persons, dwellings or aged care homes.

Older Australians seeking Commonwealth-funded aged care, whether at home or in residential care, must be approved through the Aged Care Assessment Process (ACAP). Once admitted to residential care, the Commonwealth subsidies payable for the person are determined by the Aged Care Financing Instrument (ACFI). In 2015, the Australian Institute of Health and Welfare (AIHW) maintained an aged care database with 59 data tables, in all containing 1214 different data fields (AIHW 2015g). The complete ACAP data table is comprised of 177 fields, whereas the ACFI table has 110 fields.⁴⁴ In total, there are approximately 250,000 records of ACAP assessments each year, and about 200,000 ACFI appraisals every year. In this study, I utilized large extracts from these data tables, including 846,543 ACAP records and 1,052,887 ACFI appraisals. After some data editing, realistic modelling outcomes confirm that these data can be regarded as being of good quality, with many potential private and government uses.

As outlined earlier, the databases on aged care assessments and aged care admissions are not linked. Indeed, the Australian Institute of Health and Welfare (AIHW) has no automatic links to match ACAP and ACFI assessments for the same person. This appears to reflect the absence of such links in the Department of Health's ACAP and ACFI data, which has serious consequences for the administration of the *Aged Care Act 1997*. For example, the current uneven distribution of aged care beds between the 72 Aged Care Planning Regions (ACPRs) suggests that, in some regions, persons needing residential care are not able to find a vacancy. The present lack of links between the ACAP and ACFI data means that there is no easy way to identify if a person with an ACAP approval for residential care is not receiving that care for a valid reason. The limited available evidence suggests that persons with few assets, or with disabilities not given high ACFI subsidies, may be missing out.

The missing linkage between ACAP and ACFI reflects the nature of data given to the Australian Institute of Health and Welfare (AIHW) by the Department of Health (DoH). One way of dealing with this problem is that AIHW use the limited personal information it holds and try to link ACAP and ACFI data. This was attempted in the Pathways project (AIHW 2016e; Karmel et al 2010) that linked 2003-04 ACAP assessments for over 100,000 Australians to 2002-03 to 2005-06 service usage data for community care and residential care⁴⁵, and to deaths data. Although the

⁴⁴ The code name for the ACAP data table is "AIHW_ASSESSMENT_DETAILS_ACAP", and for the ACFI data table "AIHW_ASSESSMENT_DETAILS_ACFI" (AIHW 2015g). Fields refer to variables collected on each selected characteristic of the subjects of the assessments.

⁴⁵ This study dates before the removal of the distinction between high-level care (nursing homes) and low-level care ('hostel'-type of assisted living).

Pathways study allowed investigation of aged care programme usage for 2 years following the completion of an aged care assessment, it was a costly process. Perhaps a much better solution would be for ACAT teams to remain in contact with persons approved for care until these older Australians receive care or an acceptable alternative. Data would then be available promptly on the measures need to help the *Aged Care Act 1997* meet its objectives.

In the *Submission to the Productivity Commission Inquiry on Data Availability and Use*, Cumpston (2016 p. 7) suggests several changes that, if adopted, may increase the efficiency of the National Aged Care Data Clearinghouse, including: *capital investment in the creation of Confidentialised unit record files and longitudinal files (as recommended by the Productivity Commission in 2011), more frequent data updates, continuity in data releases, capital investment in software able to meet online data requests without breaching confidentiality and some other measures*. Similar procedures have already been adopted by the Australian Bureau of Statistics (ABS). For example, the “DataLab” feature (ABS 2017) enables high-end clients who want to undertake interactive (real time) complex analysis of microdata to conduct analyses in the secure environment.

The results of this study suggested that the robustness and accuracy of statistical models derived from two unlinked data sets heavily depend on the quality of data and the consistency of measures in each individual data set. For example, models of the probability of application for care assessment and the probability of admission to residential care given approval, derived from two unlinked data sets, show much poorer fits and lower accuracy compared to the models of the probability of approval for care, that were derived from a single data set. However, even if data sets are not linked due to the high costs or confidentiality issues, small interventions into data collection or coding procedures can make a positive difference. The next paragraphs address data inconsistency and suggest how the existing Australian data on aged care could be modified.

8.2.2 Inconsistency in measurement and recording

As outlined before, the needs for assistance are the most important predictors that older people will require some sort of informal or formal care. Results shown in this study suggest that care needs are associated with all events on an individual’s trajectory towards residential care. A further argument about the importance of assistance needs is the fact that these measures of individual care needs are used by the Australian Government to allocate funding and subsidies for both home and community care, and residential care. In countries, such as Australia, where

aged care data is fragmented, it is even more important that the measures of care needs are consistently recorded across various data sets.

Contrary to initial expectations about a certain level of synchronicity between administrative data sources, this study has revealed that each source of data used to derive models of care events contained different measures of assistance needs. This proved to be a big obstacle that required the complex process of derivation of compatible codes between these data sets. For example, to derive models of the probability of application for aged care assessment using unlinked SDAC and ACAP data, the SDAC assistance codes had to be converted into the ACAP assistance codes. Luckily, these two data sources had roughly similar definitions of their corresponding care needs variables. Without substantial investment, the code definitions for these two data sets could be aligned. Such alignment would be of a great importance since the Survey of Disability, Ageing and Carers (SDAC) is the foundation from which government and care providers can gain information on the personal care needs of older Australians. Assistance requirements, as we could have seen throughout this research, relatively quickly translate into an expressed demand for aged care assessment.

Similar inconsistencies exist between ACAP and ACFI data. These two data sets, unlike SDAC, are collected on behalf of the same government body, and they are stored at the same location⁴⁶. However, the Aged Care Assessment Program (ACAP) does not explicitly record whether a person requires assistance with some complex health care needs. It is also not easy to draw a clear distinction within ACAP data on the exact variables that relate to a person's behavioural care needs. Consequently, it is difficult to precisely detect any system changes from the point of assessment until the point of formal admission to residential aged care. As outlined in previous chapters, the Aged Care Funding Instrument (ACFI) appraisal outcomes determine the total costs of subsidies for each person. This means that the Commonwealth Government would benefit from having timely information on individual needs for assistance at the point of aged care assessment, prior to formal entry to a residential care setting. To enable such prompt information, the ACAP program data would need to collect variables that correspond or at least cover the main domains in the ACFI program (ADL, BEH and CHC).

With little additional effort, Australian data on aged care can be synchronised to collect and measure the same types of assistance needs at different points in the system. Future attempts to link data should also consider consistent set of rules for measurement of assistance needs.

⁴⁶ In July 2017, the ACAP and ACFI data sets were stored within the National Aged Care Data Clearinghouse (NACD), whereas the SDAC was stored in the Australian Bureau of Statistics (ABS).

For example, it would be highly beneficial if the SDAC, ACAP and ACFI data sets had a unique set of internal variables that comprise each of the three main domains of personal assistance needs – activities of daily living, behaviour and complex health care needs. Even if these data sets (ACAP and ACFI) remain unlinked, the inclusion of identical variables would open wider possibilities for probabilistic linkage procedures, such as the one used here in the models of the probability of admission to residential care. The existence of these common assistance needs variables would be very beneficial, as it shows that ‘linkage’ using a very limited set of common variables results in models with a poor fit and performance. It is important to keep in mind that the main intention in this study, in terms of data, was not to establish rigorous linkages, but rather to evaluate the existing potential for linkage.

8.2.3 Access to data

Inadequate access to data is also very costly for industry (ACFA 2016). Lack of data on the unmet need for residential aged care, for instance, increases the risk for providers seeking to expand or build new nursing home facilities. This may narrow the regions they choose to invest in, increase their financing costs, or make investment in other industries more attractive. Established aged care providers may have better data than potential new entrants, effectively restricting competition. Inadequate public-sector data can also be very costly for individuals. The present lack of data on unmet need for aged care appears to have led to under-provision of residential care, and to access difficulties for persons without substantial assets.

For researchers, fragmented or erratic data release may hinder efficiency or decrease the quality of research undertakings. In the case of this study, data arrived in a rather erratic way. Consequently, the structure of the project had to be altered several times, and some methods were adapted at the expense of robustness. Regardless of the obstacles, the models shown in this study shed new light on individuals’ progressions towards aged care, showing the probability of each critical step on the residential care trajectory. Without access to ACAP and ACFI data, such modelling would not be possible.

Australian governmental policy has recommended giving maximum access to public sector data, at no cost to the user unless such information is publicly identifiable or there are costs associated with tailoring the data for publication (Commonwealth of Australia 2015 p. 35). These directions

are in line with earlier recommendations by the Productivity Commission⁴⁷ for the establishment of a national clearing house (NACDC) that would serve as a central repository agency for Australian aged care data (Productivity Commission 2011). Even though these data are currently located at the Australian Institute of Health and Welfare, the clearinghouse could also be potentially placed within the Department of Health. As already outlined, one obvious reason for this change is that the Department of Health provides all the aged care data to the NACDC and, at the same time, it is responsible for planning of grants, subsidies and supply caps in aged care.

By addressing the gap in data usage, this study demonstrated that having access to high quality information can provide good value for all stakeholders in the aged care system. Only by using data, certain deficiencies and inconsistencies, that would otherwise be overlooked, become apparent. For example, researchers or other users of public data could provide feedback to data providers that may be beneficial for further linkages or to improve the quality of information. One example of constructive feedback is a recommendation that ACAP and ACFI assistance needs definitions should be synchronized. Similarly, collecting the approximate ACFI and ACAP ratings in the SDAC survey would allow these ratings to be probabilistically linked. These and other useful insights were only made possible by accessing and utilizing several data sources to capture individuals' movements through the aged care system. The purpose of the following section is to examine how Australian data on aged care can be used in predicting the future dynamics and structure of the aged care system.

8.3 How we can use existing data for further analysis such as projections of aged care?

Ageing of the Australian population inevitably increases the demand for aged care and health care services. Accordingly, the Australian Government needs to plan now to ensure the future needs of the ageing population are met. Furthermore, both the aged care and health care workforce could benefit from timely planning measures based on the prediction of future demand for residential care. Providers of residential care need estimates of demand in local areas to help them assess whether building a new facility will give reasonable returns on their investment. Because nearly 65% of the residential aged care market is funded by taxpayer money (ACFA 2015), Government also must assure sustainable financial arrangements. Most recent projections of the demand for and costs of care take account of the projected size of

⁴⁷ The June 2011 report called *"Caring for older Australians"* (Productivity Commission 2011) led to the establishment of the NACDC which has been operated by the Australian Institute of Health and Welfare (AIHW) since July 2013.

future populations and their age and sex distribution (Swartz 2013; Martikainen et al 2009; OECD 2015; 2006; Murray & Lopez 1997), but the potential effects of predisposing health and sociodemographic factors, legislation and other determinants are usually not incorporated.

In terms of considering policies and estimating future costs of long-term care, it is of utmost importance to understand the determinants of the aged care process (Martikainen et al 2009). The existence of associations between these determinants and the main care events can affect future needs for residential aged care. Results from this study indicate that existing data can be used to estimate the care trajectories of elderly Australians and, therefore, to derive projections of aged care in Australia. Projection of aged care demand in Australia should also include socioeconomic complexity as an important determinant and heterogeneity across local areas. This is to account for the fact that drivers of the demand differ at a local level. Ideally, this projection would also allow for further expansions. For example, it is worth considering how potential Government interventions such as changes in the supply of beds⁴⁸, may impact the demand for nursing home places.

From previous chapters, we have seen that nearly 200,000 older Australians live in permanent residential care, with an additional 70,000 users of various home and community care services. As discussed, aged care users can make numerous transitions within and between different parts of the system. For example, an individual can be a home care user, transition to residential aged care and exit the system to the community, hospital or through death. Understanding factors that prompt movements in the system and measuring the dynamics and the volume of personal transitions is key to successful planning and management of the aged care system. For example:

- Identifying areas for increased demand can assist with aged care workforce planning;
- Identifying time spent in different parts of the system and their transitions can facilitate better financial costing and planning;
- Identifying future client needs can assist providers to understand and achieve a resident mix best suited to their staff and facilities.

The data and methods demonstrated in this study could be used to develop a simulation model to track and project an individual's entry to, movement through, and exit from the Australian

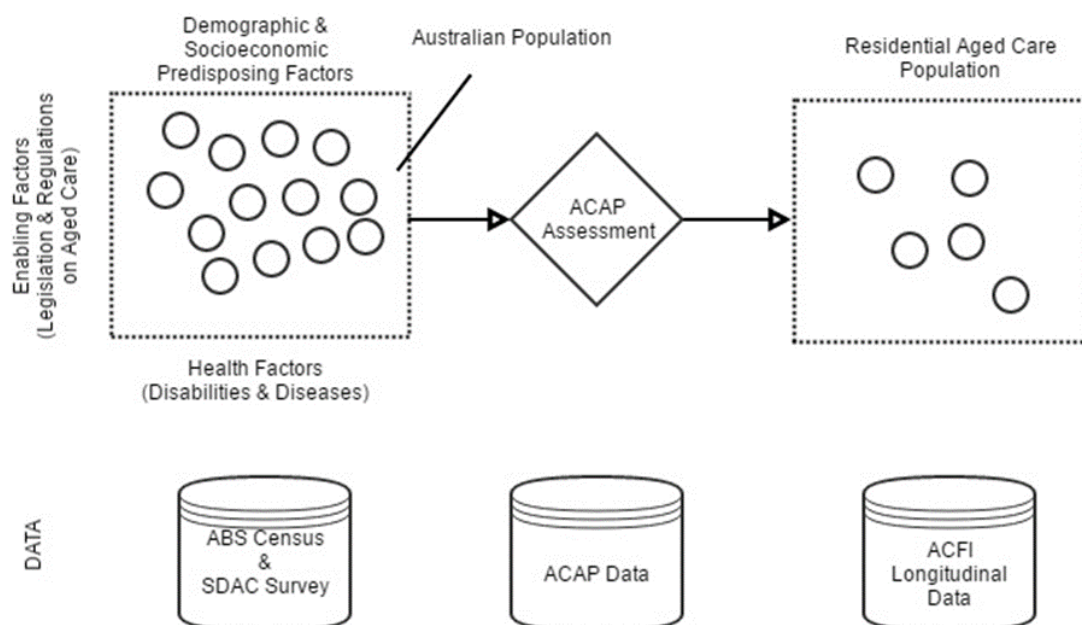
⁴⁸ During 2016-17 the Department of Health has outsourced several tenders for uncapping residential aged care sector as a mechanism to relax the supply side. This indicates that the uncapping could occur soon and may consequently increase the choices for new entrants to residential care (Cutler, Bailey & Cumpston, 2016).

aged care system. The purpose of this chapter is to suggest how the complex pathways of elderly Australians through aged care could be further examined and used to project future population movements through the aged care system. This adds further arguments to address the final research question on whether Australian data can be used to simulate and project aged care experience of older Australians.

8.3.1 Towards the projections of entry, transitions within, and exit from the aged care system: a general approach

Findings in this study – the transition probabilities and personal trajectories of older Australians – are expected to be combined with ABS data to derive projections of the demand for aged care services in Australia. This should include the demand for home and community care and for permanent residential care. For example, groups of elderly Australians at risk of moving towards different aged care arrangements could be identified. The Australian Bureau of Statistics (ABS) has several data sources that provide information on demographic and socioeconomic features of the Australian population, allowing the construction of economic and demographic variables designed to measure differences in care needs. Because we can determine the profile of those older Australians who apply for residential aged care assessment (from the ACAP data), and we know the profile of elderly Australians outside of care, we can derive transition probabilities for a set of individual population features (age, sex, socioeconomic status, disability, disease) from population to aged care (Figure 8.1). Such analysis will enable the projection of entry to home and residential care.

Figure 8.1 Transitions and data sources for simulation models and projections of aged care



Source: Author, July 2017.

Future planning of the aged care system in Australia needs to be based on accurate information. As previously outlined, the most important forms of information about the system are assistance needs, transition probabilities and duration of stay in care. For residential care, these personal details are recorded in the Aged Care Funding Instrument (ACFI) unit record files. These data are being continuously generated through the assessments that are done soon after entry to residential care, and repeated as health changes occur. To be able to predict future residential care needs and costs, it is necessary to estimate how long residents will stay in care and how their needs will change over time.

As underscored in Chapter 7, transitions between care needs (ACFI levels) in residential care will be derived from longitudinal data that covers an entire period from the introduction of ACFI appraisals (2008) until 2017. The transition analysis will result in a set of statistical models that include all possible transitions between all levels of each care domain (ADL – activities of daily living, BEH – behavioural needs and CHC – complex health care needs).

Projections of demand for community and home care, on the other hand, will be derived using Aged Care Assessment Program (ACAP), ABS demographic data and the Survey of Disability, Ageing and Carers (SDAC). The last source provides information on older Australians who use home and community care packages. The population at risk of moving into care arrangements

will be identified and probabilities of transitions to home care will be derived using stochastic links between these data sets.

8.3.2 Projection techniques⁴⁹

Because common data is used to answer disparate questions, there are advantages in having a single large model structure, rather than using numerous small models that risk introducing inconsistencies and errors. The scope of the proposed projection is such that the model design needs to accommodate considerable client information, while allowing for interactions between components of the aged care system. Having this in mind, there are three broad modelling approaches that would be suitable for this projection:

- 1. Macrosimulation (or cell based) modelling strategies**

- Where aged care clients are aggregated into like subgroups for the purpose of projecting pathways through the system;

- 2. Microsimulation (or individual based) modelling**

- Where each individual unit (i.e. each current and potential client) is projected separately.

- 3. Hybrid approaches (a mix of micro and macro approaches)**

8.3.2.1 Macrosimulation

In macrosimulation or cell-based models, the individual units of interest, namely aged care clients, are placed into like subgroups (i.e. based on features such as gender, age, illness type) and projections for each group are performed. The results for one individual in each group are assumed to hold for all individuals in that group, and the results would then be combined to produce an overall picture of the future distribution of the required outputs. Subgroups may be relatively detailed (i.e. male, 75 to 80 year olds, in residential care), and therefore numerous, however the key point is that the subgroups do not represent individual aged care clients.

A deficiency in this approach is that the variability in characteristics between individuals, beyond that allowed for in determination of the initial subgroups, is not accommodated in the modelling. All units within each subgroup are considered identical for projection purposes. This may overlook variability that has a material effect on results. The extent to which this has an

⁴⁹ This section of Chapter 8 uses materials from the research proposal for the construction of an aged care simulation model, made at the University of Melbourne (McDonald, Temple & Jukic, 2017). The proposed title is: *“Development of an aged care simulation model”*.

impact on model outputs will depend on the number or size of the subgroups and specific factors used to distinguish subgroups – if the subgroups are small and numerous (i.e. if multiple factors with multiple levels are used and separate projections are based on each set of subgroup characteristics), this will better preserve the variability within the aged care client population.

One advantage, however, of macrosimulation modelling is the lower levels of data needs and generally lower processing requirements – which will be key to determining whether to model certain behaviours through micro or macrosimulation. One example may be the marital status of aged care clients. As living arrangements are important correlates of access to aged care, it will be necessary to project the marital status of the client base (Temple 2007). Heretofore empirical studies have utilized static macrosimulation (or propensity models) (ABS 1999; McDonald & Kippen 1998), microsimulation models (Hooimeijer & Heida 1995; Hooimeijer & Oskamp 1999) or dynamic macro-simulation (Holmberg 1987; Murphy 1991; van Imhoff & Keilman 1991; Nishioka et al 2000; Mason & Shima 1986; McDonald, Kippen & Temple 2006) techniques to project households, individual living arrangement types and marital status. In creating an Australian level model of living arrangements, McDonald (2001) noted:

“Methodological sophistication and elegance increases as the model shifts through these approaches from propensity models to dynamic microsimulation. On the other hand, the difficulty of obtaining input data and computational complexity also increases as we shift from propensity models (macrosimulation) to dynamic microsimulation” (McDonald 2001 p. 6).

Examples of current macrosimulation models used in policy analysis are included below in Table 8.2.

Table 8.2 Macrosimulation Models.

Name	Parameters	Institution
MoDEM 2.0 (Modified Demographic and Economic Model)	Population, labour force, hours worked, Gross Domestic Product (GDP)	Productivity Commission
OzHouse and HaPPE (Household and Population Projection Evaluation) Tool	Population, living arrangements, households, tenure and dwellings.	National Housing Supply Council, The Treasury.
Grant to NOM Calculator	Population by Visa grant status, Net Overseas Migration Population movements.	Department of Immigration and Citizenship

Source: McDonald, Temple & Jukic, 2017.

8.3.2.2 Microsimulation

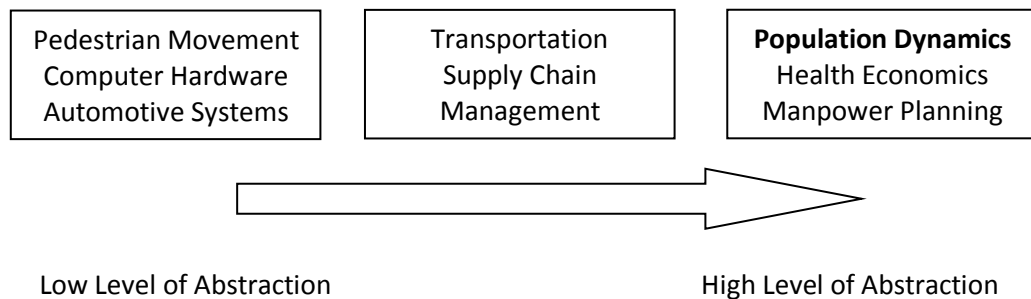
Can microsimulation be a potential solution? As the number of sub-groups in a cell based model increases such that each individual unit is projected separately, the model becomes known as a microsimulation model. Microsimulation is a dynamic type of simulation that models real-world processes and aims to assist informed decision making. Advocated and introduced in the late 1950s by Guy Orcutt (1957) within the discipline of economics, microsimulation is a tool to fix the aggregate or macro models that failed to accurately represent a diversity within socio-economic systems. Early developers and policy modellers used such a conceptual framework to model interactions and interdependencies between the design of specific policies (i.e. change in the tax system, laws, healthcare, benefits schemes etc.) and individual reactions to change in these policies (Birkin & Wu 2012). Simply, it was a tool to test potentially complex policy options in a realistic setting. Therefore, this type of model should be considered as a potential method for predicting future demand for aged care in Australia.

Microsimulation is a highly data-demanding and computationally intensive procedure. As Orcutt et al (1986) pointed out, modelers need detailed information about the initial state of all microunits in the analysis, such as individual persons or families. This means that data collection and storage requirements are high. The growth of microsimulation modelling in the last few decades has been possible due to the revolution in personal computing and continued development of processor speeds and memory (Birkin & Wu 2012; Holm et al 1996). This type of modelling is beneficial whenever a system made up of smaller scale units is examined, regardless of the level of abstraction or complexity (Spielauer 2012). Microsimulation, broadly speaking, is carried out by projecting the individual decision-making units, such as persons, households or firms. Given a set of exogenous variables and constraints, this type of approach allows modellers to produce results at an aggregate level, at a sub-group level, but also at an individual unit level. In contrast to some more traditional mathematical models based on aggregate or averaged data, microsimulation can maintain visibility of certain processes which are otherwise blurred in the mathematical models. Apart from these benefits, an additional strong point of microsimulation is that it produces the results based on repeated random experiments rather than on the average indicators.

Figure 8.2 gives examples of processes that could be modelled using a microsimulation concept with an emphasis on gradual increase of the abstraction level from the left to the right side. Population processes (i.e. entry to, progression through and exit from residential care), require

extremely high level of abstraction and belong to high-complexity processes. It is noteworthy that the 'micro' prefix in a *microsimulation* essentially corresponds to how researchers simulate the systems which means that they still simulate a 'macro' system (ibid. 2012).

Figure 8.2 Simulated processes and the level of abstraction



Source: Author, 2014.

As opposed to more 'speculative' streams such as agent-based modelling, microsimulation is not primarily used to build or investigate models and theories, but to empirically ascertain the consequences of approximated probabilities (Billari & Prskawetz 2003). Therefore, this type of model fully relies on transition rates derived in an initial stage through conventional (statistical) modelling. In other words, such a method assumes that rates will pertain over period captured in the model. The statistical models derived in Chapters 4-7 give the information on probabilities, transition rates and statistical parameters that describe the residential care system in Australia. This type of information is necessary to develop a projection of the Australian residential aged care system and such information can be also used for simulation purposes.

Martin Spielauer (2012) argues that microsimulation is a preferred method of modelling if:

“(1) individual units are different, but only when these differences matter and, if grouping of the individuals by some common features would be too complicated due to too many possible combinations; (2) behaviours are too complex at the macro level and better understood at the micro level and (3) if individual histories matter” (Spielauer 2012, p. 15).

These three characteristics underscored by Spielauer are well displayed in the aged care system. As already outlined, microsimulation looks at individuals, rather than groups of individuals. The focus on individual units (persons, households or other entities) means microsimulation models

are dependent on microdata throughout the model-building process, even though the extent of reliance depends on the complexity of the model.

The primary classification of microsimulation models is based on whether and how they model time (Dekkers & Belloni 2009 p. 7.). Therefore, these simulation models can be dynamic or static (Spielauer 2007; Harding 2007; Dekkers & Legros 2006). The time feature of the model refers to the methods used to 'age' a microdata base to create a synthetic file for a future year. A static ageing method understands changing certain variables on the original microdata to produce a file with the features expected in the future year (person weights, labour force status, income etc.). In other words, static models do not include time, and therefore only simulate 'overnight' effects of a change in policy (Dekkers & Belloni 2009). As suggested by Merz (1993; 1994), if time is not modelled, then the model can be valid only for a specific cross-sectional data period. In contrast, in a dynamic microsimulation model the individuals are 'aged' in the microdata (each person) that is, they are projected into the future one period at a time, where periods can be as short as days or much longer. In each projection period of a dynamic simulation, there is a probabilistic decision whether these individuals will change status (i.e. move from home and community care to a nursing home, withdraw from aged care assessment, be discharged into hospital, die etc.). Even though these two types of simulation are technically different, their simulation properties are very similar (Dekkers 2015; O'Donoghue 2001).

Governments often need to choose policies that consider the circumstances of persons in many different scenarios. For many decades, governments have used static microsimulation, based on records of individual taxpayers, to estimate the consequences of proposed changes in tax policy. Big businesses are increasingly using '*big data*' on individuals for marketing and product design. The Australian government provides much of the income of home and community care firms, and residential care providers, and wants to ensure that needs are met economically. Residential care providers make large capital investments and need to ensure reasonable returns to their owners. Residents pay substantial amounts to providers and, like providers, must make difficult financial decisions on entry to care.

A microsimulation model could be a way to help older Australians make choices about their future. For example, persons entering residential aged care need to make important choices about their finances. These elderly Australians could benefit from knowing approximately how long persons with similar care needs are expected to live in residential care (i.e. life expectancy) or whether they can expect rapid changes in their functional needs. Longitudinal data following persons in residential care, as shown in previous chapters, can provide the life expectancy

estimates of individuals needed for a microsimulation model. As already underscored, such a simulation model may also help residential care providers make decisions about dwelling design and the choice of entrants. Government regulators might be helped with their decisions on permit allocations and subsidy rates. Furthermore, this type of simulation model could be designed to estimate the effect of a program change (i.e. change of rules for aged care assessments) on the future numbers of older Australians under different aged care arrangements.

A general-purpose microsimulation model of older Australians, therefore, could be beneficial to all those involved in the aged care process - the Australian government, private care providers, older Australians and their relatives. These models need to have multiple users, to meet the usually high development costs, and to ensure their ongoing viability. Where no microsimulation model exists for a sector, it can be difficult for potential users to assess the merits of a proposed model. However, it is extremely hard to anticipate whether construction of a microsimulation model is going to be feasible, can this model be validated and whether the data examined in this study is fully adequate. Therefore, it is necessary to briefly discuss these issues.

Construction and validation of microsimulation models are a costly processes. It is estimated that the three US models (MINT, CBOLT and POLSIM) had development costs exceeding US\$6 million (Harding 2007). The author underscored that budgets of this magnitude had also been involved in the Canadian DYNACAN model, the Norwegian MOSART model and the Swedish SESIM model. Substantial annual funds are also needed to update data and meet new needs. If possible, these models should be designed to serve multiple purposes and to have many possible users, who can help fund ongoing development. Because collection and microsimulation of additional data fields are costly, it is important to have early identification of those data sources which are most likely to be generally useful.

Large-scale microsimulation models⁵⁰ have been developed and are in use internationally for the design and evaluation of public policy, and are increasingly being used for projecting and costing public policy programs in Australia. Examples of current microsimulation models used in policy analysis within Australia are included below in Table 8.3.

⁵⁰ A comprehensive review of microsimulation models is presented in Li & O'Donoghue (2013).

Table 8.3 Microsimulation models

Name	Parameters	Institution
HECS doubtful debt model	Population of students with HECS debts, outstanding debt, repayments, assessable income, HECS scheme rules	Developed by the Australian Government Actuary for use by Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education.
AHURI-3M (AHURI Housing Market Microsimulation model)	Population, households, rental properties, taxes and costs, tenure	Australian Housing and Urban Research Institute
APPSIM	Births, deaths, migration, marriage, divorce, education, health status, wages, labour force participation, etc.	National Centre for Social and Economic Modelling (NATSEM)

Source: McDonald, Temple & Jukic, 2017.

Because microsimulation models simulate the experiences of individuals, they need data about individuals, not about large groups of individuals. The evidence showed that available data can be useful, but in most cases these data are not in a suitable format for the derivation of the transition probabilities needed for microsimulation (Li & O'Donoghue 2013). For example, the quality and sample size of the longitudinal microdata (such as HILDA – '*Household, Income and Labour Dynamics in Australia Survey*') (Summerfield et al 2014) can be a great challenge when estimating transition probabilities. As underscored by Harding (2007), the HILDA data set has a relatively small sample size, and only limited health information is available. Persons living in residential care are excluded.

One of the aims in this thesis was to use and combine different data sets to model the system of residential care and to extract information (i.e. transition rates, probabilities etc.) needed in a projection model of the Australian residential aged care system. For example, in the second part of Chapter 4, multi-state analogues (development tables and projection arrays) are used to estimate transition rates between different levels of care needs, using limited administrative data. The data acquired routinely during the administration of the Australian government's aged care legislation, as repeatedly suggested in this study, can be a powerful source of information on older Australians and their pathway through aged care. Moreover, this study suggested that a microsimulation could be one of the next steps for prediction of the future demand for aged care. The central part of this study (Chapters 4-7) has shown how these data sets and different statistical procedures can be used to prepare the path for a more comprehensive model.

8.3.2.3 What would be the best approach for future modelling and projection?

Ideally, the future model of Australian aged care would use a hybrid approach – a combination of the benefits of micro-simulation and macro-simulation models. It means that the transitions between different stages (phases) of aged care experience of an individual (i.e. between general population and different segments of aged care system) would be modelled at an individual or micro level. The micro projection will show how various subpopulations (i.e. elderly Australians with similar characteristics of their socio-demographic and health factors) progress throughout aged care system and how many individuals will end up in each stage, as well as estimates of deaths and exits from the system. The projection variables of such a hybrid model will include a range of demographic, economic and health factors.

This proposed modelling framework would provide a fuller picture of a complex system such as Australian aged care and it would give better estimates of older Australians in each phase of the system. The hybrid simulation model would be able to track and project an individual's entry to, movement through, and exit from the Australian aged care system. By providing more accurate distributions of the aged care population in these different phases of the care system (i.e. in home or community care, in residential care, in other forms of care, or in private dwellings etc.),, such a hybrid model would inform aged care policies and decision makers, and provide better value for all users and stakeholders in Australian aged care. Like the statistical models shown in this study, the hybrid projection model would also use comprehensive unit record data sets – both cross-sectional (ACAP) and longitudinal (ACFI) to calculate probabilities of individual transitions towards care and through the residential and home care system. The time frame of these data sets would be extended to include the most recent period, until 2017. These data sets on aged care would be backed up by Australian Bureau of Statistics data⁵¹ sources on the general Australian population. Finally, I consider that this type of projection would be robust enough to give a full picture of the Australian aged care experience.

8.4 Limitations of this study and recommendations for further studies

On several occasions in this study it has been reiterated that data constraints largely determined the methodological approach. In this research, I have used the limited data publicly available,

⁵¹ The Australian Bureau of Statistics (ABS) have several useful data sources for future projection models. The 2016 census provided information on age profiles, indigenous status, cohabitation, education, income and housing ownership for each Statistical Area Level 2 (SA2), allowing the construction of socio-economic indices specifically designed to measure differences in care needs. Number of deaths are also available for each SA2 for each calendar years.

together with various analytical methods, to show the potential value of the full data. As it was evident from previous chapters, a large amount of data about persons in different parts of the aged care system is available in Australia. Unfortunately, these data sources are sometimes not linked, or defined in comparable terms. The current difficulties in linking data from aged care assessment program, home care and residential care pose a substantial problem. For example, the lack of routine links between ACAP data (i.e. approvals) and care data (i.e. admissions and entries to nursing homes) greatly hampers analyses of demand and affects the accuracy of statistical models. The predictive power of the proposed projection could be enhanced if we can identify the progression from home based care to residential care. The link between two segments of the aged care system could not be precisely identified from the available data, but it can be valuable in undertaking future research.

One limitation of this study is that it focuses heavily on a single stream of the aged care system – residential aged care, and only briefly touches upon other aged care streams. This narrow focus is, at the same time, a strength of this study as it allows more thorough analyses of institutional care. In their key piece, Kendig et al (2010) suggested that when elderly Australians require care, it is largely provided in home care settings and most elderly never enter nursing home facilities. Even though this statement is true, residential care will be an unavoidable pathway for many older Australians, due to health factors, financial reasons and inability of informal care to satisfy all the demand for care (Hugo 2007).

Spatial heterogeneity in underlying demography, socio-economic conditions and availability of care services, necessarily implies differences in the aged care trajectories at the subnational level. However, due to confidentiality concerns, the lower spatial levels – geographical locations (i.e. postcode, SA2 identifiers etc.) for persons in permanent residential care facilities or for older Australians undergoing aged care assessments were not available in the data sources supplied for this research. In Chapter 3, it was shown that the distribution of operational places (beds) and provision ratios markedly vary by states and territories which means that some indication of the future growth rate for demand at the location is also necessary. These detailed spatial analyses and projections at the local level can be beneficial for the Australian Department of Health and particularly for the grant allocation process for each aged care planning region.

Analysis of unmet demand for aged care services is another important research domain that has not been covered in this study. Identifying individuals who have unmet demand for residential care would require systematic follow-up of persons receiving an age care approval for residential care, to determine the reasons for any subsequent non-entry to residential care. Non-entry may

be for some valid reason, such as receipt of adequate home care, or early death. But non-entry of classes of persons, such as those in remote areas, or with dementia, or with little money, may reflect a badly designed system of incentives for providers. One limitation of such an approach is that data that would allow researchers to estimate unmet demand for aged care services is not systematically collected (ACFA 2015 p. 96), although the analysis of unmet demand has been recommended in the *“Living Longer, Living Better”* Bill (Australian Government 2013) and in the report *“Caring for older Australians”* (Productivity Commission 2011). The ratio of admissions to residential care as a percentage of the ACAP approvals for such care that is currently used is a relatively imprecise measure.

For this study, some socio-economic measures and variables that are relevant for modelling of aged care events were not available. For example, income and other social and economic variables (i.e. whether person receives full pension etc.) may affect demand for residential care. Further studies may also wish to examine whether the elderly who accumulated wealth through continual increase in property prices and compulsory superannuation contributions will have greater financial capacity to pay for community and home care services or a high-end permanent nursing facility. Other potential drivers of care decision making that also may be relevant at the local level, such as internal mobility and property price fluctuations in cities such as Sydney and Melbourne were not discussed. It may be speculated that the current high property prices across Australia (i.e. not just in cities, but also in the areas out of major cities) may force people to stay at the same place as price differentials are not so pronounced any more. This may lead to more baby boomers staying in their cities rather than migrating towards other suburban, regional or coastal areas. However, all these speculations assume that the current trends will persist and that the Australian economy will avoid future downturns.

Projecting future demand for residential aged care was not part of this study, but it should be a logical upgrade of all previous steps. Nationally relevant projection of aged care, as suggested in previous sections of this chapter, is a matter of the utmost importance for policies and aged care users. Mortality estimates and transition rates resulting from the modelling of the aged care process conducted in previous chapters, could be linked with the geographical data, and may be used to project the demand for residential care at many locations, as well as the characteristics of elderly Australians who are likely to be seeking residential care in those locations. This projection model, should use demographic and socio-economic factors, disability and morbidity, but it should also account for ongoing policy initiatives (i.e. continuing shift towards home and community care), cultural differences (i.e. different patterns of care usage between Indigenous population, second generation overseas migrants from Europe, Asian migrants and Australian

born persons) and geographical differences (i.e. remoteness which affects supply of beds in nursing homes).

Noting these limitations, results from this study are important as they provide evidence about the existing associations between the characteristics of older Australians and the key events on these persons' aged care trajectories. Despite the inability to link fragmented blocks of Australian data, this study further advanced our understanding of the aged care system in its entirety – starting from the general Australian population outside of care and ending with the examination of events at the end of the aged care trajectory. Future studies of aged care in Australia could extend the analysis to other segments of aged care (i.e. home and community arrangements) or to project the demand for care at the subnational level using a broader set of information on older Australians.

8.5 Final words

Australia, like many other developed countries, is facing a daunting challenge: structural ageing of its population. In the context of demographic ageing, aged care has increased its importance in the national policy agenda over the last several decades. Residential care is a constituent part of the Australian aged care system where many older Australians spend their late years of life hoping to achieve appropriate levels of care. Even though most older people never use residential care, those elderly Australians who enter this type of care must undergo a series of aged care events. Some of these events, such as the aged care assessment program appraisal (ACAP), are regulated by government legislation. Understanding of the Australian residential aged care system from an individual's perspective is thus important both to those older Australians undergoing a series of aged care events, and to the Government to make sure that adequate care is provided to people when they need it.

This study has shone a new light on Australian residential care, providing a novel view of this complex segment of the aged care system. Residential care has been commonly perceived from an aggregate or macro perspective. This approach either leads to an estimation of the future number of people in nursing homes by taking a proportion of the total number of older Australians that, 'on average', use residential care services or it leads to the projection of future utilization of residential care based on previous trends. Even though the Australian Government has set a target or a threshold on the proportion of older persons that 'should' be in nursing homes, as a part of its care substitution agenda, this target might not be met in the future. Relying on the population aggregates and recent trends alone does not provide an accurate

understanding of the aged care system. This implies a necessity to alter research methods, examining residential aged care from an individual's (or micro) perspective, as a series of steps that elderly Australians take within the aged care system.

The purpose of this research was to examine the residential aged care system in Australia – entry to, progression through and exit from residential care – from an individual perspective, utilizing rich administrative and survey data on aged care. The aged care trajectories of older Australians have been perceived from the micro perspective, analysing residential care as a dynamic multi-stage process. Such a novel view has enabled a solid understanding of associations between aged care events and individual features of older people progressing towards institutional care. A series of important characteristics associated with each care-related event were identified. Knowing how age, gender, marital status, availability of carers, diseases, disabilities, and other factors change or affect the likelihood of an elderly person progressing towards and through residential care is important for many reasons. Apart from being beneficial to Government or care providers, these findings can help elderly Australians to plan their aged care process. For example, persons who have developed a set of functional needs (i.e. need for assistance with bathing, toileting or walking) may wish to know where people with similar needs usually meet their care needs and what is the chance of residential care being recommended as the long-term care setting. Upon entry to a nursing home, elderly Australians and their families could also benefit from knowing approximately how long persons with similar care needs may stay in care and how quickly these care needs change.

Besides understanding of the aged care trajectories, this study gave a glimpse of potential future drivers of the demand for residential aged care in Australia. In the upcoming years, the following determinants are likely to shape the dynamics of Australian aged care: changes in demographic composition due to the advancement of structural ageing, social and economic characteristics of older Australians, changes in their disease and disability patterns, geographical differentials (i.e. remoteness), and changes in aged care policies and regulations. This implies that projections and future models of aged care need to incorporate the effects of these determinants. However, the accuracy of such models and projections will depend heavily on the quality and accessibility of aged care data. Indeed, to ascertain the true dynamics and structure of the aged care system, a continuous stream of high quality information is necessary. Indicators and measures, such as life expectancies, transition probabilities and statistical associations between individual features of older Australians and their likelihood of being in a specific phase of aged care process, all depend on adequate data collection and processing.

Policy analysis shows that a wide range of reforms to the aged care sector implemented by the Australian Government over the last 50 years has partially shifted the emphasis from residential care to community and home care. Pressures to supplement and complement institutional care with non-institutional types of care are likely to continue over the coming years, but the possible success of such replacement is uncertain. The evidence from this study shows that a large group of older Australians with a specific combination of their individual features – sociodemographic, functional, health and other characteristics – are much more likely to follow a trajectory towards institutional care. This group of persons could not satisfy their care needs while staying at home, suggesting that residential care is likely to stay as a necessity for many elderly Australians, despite the long-term government policies.

Yet, it can be speculated that, if the current levels of wealth of older Australians are maintained, the baby boomer generation might reduce the demand for care in the short-term. This relationship between economic factors and an individual's 'choice' of a type of care arrangement should be further examined in future research. For example, it is uncertain to what extent it is possible to re-direct a stream of older people towards community and home care if we consider a growing prevalence of serious functional limitations at older ages. Analysing relationships between older age and disability, Hugo (2007) suggested that the home and community care packages capable of replacing nursing homes as the living arrangement for disabled elderly would not be financially feasible. This is consistent with findings of Kendig and Duckett (2006, p. 34) who have noted that the current funding arrangements for residential care are probably unsuitable over the medium term. Results presented in this study attempted to clarify this uncertainty and contribute to our understanding of the aged care process, showing how individual trajectories of older individuals towards aged care are associated and shaped by a wide range of predisposing, enabling and health factors. As noted by Kendig et al (2012):

"The planning and delivery of care systems require knowledge on the ways in which individuals access available services that are funded by a range of health and community services (Kendig et al 2012 p. 375)."

Indeed, national and state funding programmes will keep publishing aggregate statistics on the profiles of users of the available aged care and health care services in Australia. Yet, this approach can only give a final 'snapshot' of older people at the point when they have already accessed services. To fully examine how older Australians reached the critical point in time when aged care becomes inevitable, a dynamic approach is needed. Models of residential care presented in this study provide much needed transition probabilities, life expectancy estimates

and other measures that constitute a good source of information for all stakeholders in the aged care sector.

Finally, apart from the models of residential care and the key predisposing, health and enabling factors associated with care events, this study gives clear recommendations to the Government, to data collection and provision authorities and to policy makers on how to adapt the recording system and make it more efficient, accurate and cost-effective. The results discussed provide implications for both community and residential aged care policies. In absolute terms, expressed as the total number of its users, residential care is still the largest segment of the Australian aged care system. It is very costly and increasingly difficult to manage and organize in a sustainable manner. As structural ageing in Australia continues, many older people are approaching the age when the risk of being in need for residential aged care is high. This implies that the pressures on residential care, perceived as an increase in demand and costs, are expected to grow.

Organizing sustainable aged care in the context of advanced ageing and increasing costs is not only a challenge, but also at the same time an opportunity. Aged care is now among the fastest growing employment sectors in Australia. Any positive changes in the sector aiming to improve the quality of life of older Australians should be welcomed. I hope the findings presented in this study and its novel way of examining the system will extend our understanding of the residential care process and its underlying forces.

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Appendix 1

ACAP Variables	
<u>AIHW ASSESSMENT DETAILS ACAP</u>	
Box3	
ASSESSMENT_ID	Unique identifier (ACAP assessment) <i>Always includes prefix ACAP (e.g. ACAP0000000001)</i>
RECIPIENT_ID	Unique identifier (Recipient) <i>Always includes prefix ACAP (e.g. ACAP0000000001)</i>
STATE	Australian state in which the person lives
LETTNAME	Record linkage key
SEX	Sex 1 = Male 2 = Female
LIVARR	Living arrangements in which person lives 0 = Not applicable 1 = Lives alone 2 = Lives with family 3 = Lives with others 9 = Not stated/inadequately described
CARECORE	Carer co-residency status 0 = Not applicable 1 = Co-resident carer 2 = Non-resident carer 9 = Not stated/inadequately described
CAREREL	Relationship of the carer to the person for whom they care. 0 = Not applicable 1 = Wife/female partner 2 = Husband/male partner 3 = Mother 4 = Father 5 = Daughter 6 = Son 7 = Daughter-in-law 8 = Son-in-law 9 = Other relative—female 10 = Other relative—male 11 = Friend/neighbour—female 12 = Friend/neighbour—male 13 = Private employee (not organised by formal services) 99 = Not stated/inadequately described
HC1 – HC10	4-digit code for each health condition based on the ICD-10-AM
ALSELF	Whether the person has activity limitations related to self-care activities, and has been assessed by the ACAT team as needing the assistance or supervision of another person with daily self-care tasks such as eating, showering/bathing, dressing and toileting. 1 = Yes and 2 = No.
CASELF	Whether the person was receiving current assistance [ALSELF]. 1 = Yes and 2 = No.

ALMOVE	Whether the person has activity limitations related to movement activities, and has been assessed by the ACAT team as needing the assistance or supervision of another person with activities such as changing body position, carrying, moving, manipulating objects or getting in or out of bed or a chair. 1 = Yes and 2 = No.
CAMOVE	Whether the person was receiving current assistance [ALMOVE]. 1 = Yes and 2 = No.
ALMOVIN	Whether the person has activity limitations related to moving around places at or away from home, and has been assessed by the ACAT team as needing the assistance or supervision of another person with walking or related activities. 1 = Yes and 2 = No.
CAMOVIN	Whether the person was receiving current assistance [ALMOVIN]. 1 = Yes and 2 = No.
ALCOMM	Whether the person has activity limitations related to communication, and has been assessed by the ACAT team as needing the assistance or supervision of another person with understanding others, making oneself understood by others. 1 = Yes and 2 = No.
CACOMM	Whether the person was receiving current assistance [ALCOMM]. 1 = Yes and 2 = No.
ALHEALTH	Whether the person has activity limitations related to health care tasks, and has been assessed by the ACAT team as needing the assistance or supervision of another person with medications, injections, dressing wounds, using medical machinery, manipulating muscles or limbs etc. 1 = Yes and 2 = No.
CAHEALTH	Whether the person was receiving current assistance [ALHEALTH]. 1 = Yes and 2 = No.
ALTRANS	Whether the person has activity limitations related to transport, and has been assessed by the ACAT team as needing the assistance or supervision of another person with activities such as using public transport, getting to and from places away from home or driving. 1 = Yes and 2 = No.
CATRANS	Whether the person was receiving current assistance [ALTRANS]. 1 = Yes and 2 = No.
ALSOCIAL	Whether the person has activity limitations related to social and community participation, and has been assessed by the ACAT team as needing the assistance or supervision of another person with activities such as shopping, banking, recreation, cultural or religious activities, attending day centres, managing finances and writing letters. 1 = Yes and 2 = No.
CASOCIAL	Whether the person was receiving current assistance [ALSOCIAL]. 1 = Yes and 2 = No.
ALDOM	Whether the person has activity limitations requiring domestic assistance, and has been assessed by the ACAT team as needing the assistance or supervision of another person with activities such as washing, ironing, cleaning and formal linen services. 1 = Yes and 2 = No.

CADOM	Whether the person was receiving current assistance [ALDOM]. 1 = Yes and 2 = No.
ALMEALS	Whether the person has activity limitations related to meals, and has been assessed by the ACAT team as needing the assistance or supervision of another person with meals, including the delivery of prepared meals, help with meal preparation and managing basic nutrition. 1 = Yes and 2 = No.
CAMEALS	Whether the person was receiving current assistance [ALMEALS] 1 = Yes and 2 = No.
ALHOME	Whether the person has activity limitations related to home maintenance, and has been assessed by the ACAT team as needing the assistance or supervision of another person with activities such as maintenance of the person's home, garden or yard to keep home in a safe and habitable condition. 1 = Yes and 2 = No.
CAHOME	Whether the person was receiving current assistance [ALHOME]. 1 = Yes and 2 = No.
ALOTHER	Whether the person has activity limitations related to other tasks, and has been assessed by the ACAT team as needing the assistance or supervision of another person with any other tasks or activities of daily living. 1 = Yes and 2 = No.
CAOTHER	Whether the person was receiving current assistance [ALOTHER]. 1 = Yes and 2 = No.
ALUTD	Whether the need for assistance or supervision of another person with tasks or activities related to activity limitations is unable to be determined. 1 = Yes and 2 = No.
CAUTD	Whether it was unable to be determined if the person was receiving current assistance [ALUTD]. 1 = Yes and 2 = No.
ALNONE	Whether the person has been assessed by the ACAT team as having no limitation needing the assistance or supervision of another person. 1 = Yes and 2 = No.
CANONE	Whether the person was not receiving current assistance or supervision of any tasks or activities of daily living at the time of their comprehensive ACAP assessment. 1 = Yes and 2 = No.
ALNS	Whether the need for assistance or supervision of another person with tasks or activities related to activity limitations is not stated. 1 = Yes and 2 = No.
CANS	Whether it was not specified if the person was receiving current assistance or supervision of any tasks or activities of daily living at the time of their comprehensive ACAP assessment. 1 = Yes and 2 = No.
SRCSELF-SRCOTHER	A range of variables that reveal the sources of current assistance with all tasks and daily activities [see CASELF – CAOTHER]

0 = Not applicable: Recorded for people who were permanent residents of residential aged care services or multipurpose services.
 1 = Formal: Includes assistance organised, provided or delivered by agencies, irrespective of whether the person providing the assistance is a paid worker or a volunteer. Includes assistance by private agencies.
 2 = Informal: Assistance provided by family, friends or neighbours.
 9 = Not stated/inadequately described.
 12 = Both informal and formal

GACACP-GANS

Whether person received government support

RANA-RANS

A range of variable that reveal whether assistance of formal services for self-care activities is recommended for the person by the Aged Care Assessment Team as part of their care plan.

RECOMLTA

Recommended long-term care

1 = Private residence
 2 = Independent living within a retirement village
 3 = Supported community accommodation
4 = Residential aged care service—low level care
5 = Residential aged care service—high level care
 6 = Hospital
 7 = Other institutional care
 8 = Other
 99 = Not stated/inadequately described

APPRESI

Approval item: Residential Care (Permanent)

0 = Not approved
 1 = Low
 2 = High

NOAPP

Approval item: No Approval (Whether requested care approved?)

1 = YES (not approved)
 2 = NO (approved)

REASSEN

Reason for ending assessment. The situation that signalled the end of the person's comprehensive assessment.

1 = Assessment complete
 2 = Assessment incomplete—client withdrew
 3 = Assessment incomplete—client died
 4 = Assessment incomplete—client transferred to another ACAT
 5 = Assessment incomplete—client's medical condition unstable, requires acute care before comprehensive assessment
 6 = Assessment incomplete—client's functional status unstable, rehabilitation care required before comprehensive assessment
 7 = Other reason
 9 = Not stated/inadequately described.

DATEASE

Assessment end date. The date on which the comprehensive assessment of the person ends.

APPDATE

The date the assessment is either approved or not approved by the delegate.

AIHW ASSESSMENT⁵²

⁵² AIHW ASSESSMENT Box (AIHW Aged Care Clearing House: Drop 2 - 22/01/2014) is a broad category that includes ACFI, ACAP, RCS etc. However, not all types of assessments are linked.

Box2

ASSESSMENT_ID	A unique identifier for the assessment. It is built from a concatenation of: SOURCE_SYSTEM and
SOURCE_SYSTEM_ASSESSMENT_ID	eg SPARC2976228
RECIPIENT_ID	The recipient of the assessment. eg SPARC0999200
ASSESSMENT_CATEGORY	The category for the assessment. For ACFI: nil, low, medium and high.
ASSESSMENT_ID	A unique ID number automatically assigned to an appraisal <i>Has a source system prefix</i> eg SPARC2791082
ASSESSMENT_ID	RCS Residential Classification Scale Assessment Only for residential aged care eg SPARC1234567
ASSESSMENT_START_DATE	For ACFI it is date of appraisal, for ACAP it is effective start date of approval. Time variable (format: DD/MM/YYYY)
ADMISSION_DATE	The date of the client's admission into care. Time variable (format: DD/MM/YYYY)

AIHW ACFI ASSESSMENT

Box1

ASSESSMENT_ID	A unique identifier for the assessment. It is built from a concatenation of: SOURCE_SYSTEM and
SOURCE_SYSTEM_ASSESSMENT_ID	eg SPARC2976228
ACFI_CATEGORY ACFI category	The ACFI assessment category: nil, low, medium or high for each of 3 domains: ADL, BEH and CLC (eg HLM, NNN, MNN). This ACFI then determines the level of care a care recipient receives. / 64 combinations /
ADL_LEVEL	Specifies the assisted daily living domain corresponding to the first character of the ACFI category. (N, L, M, H)
ADL_SCORE	Score
BEH_LEVEL first	Specifies the behavioural daily living domain corresponding to the character of the ACFI category. (N, L, M, H)
BEH_SCORE	Score
CHC_LEVEL	Specifies the complex care domain corresponding to the first character of the ACFI category. (N, L, M, H)
CHC_SCORE	Score

AIHW RECIPIENT⁵³

Box5

RECIPIENT_ID	Recipient ID with a source system prefix CACP1234567 or SPARC1234567 = 2 source systems: CACP and SPARC
MARITAL_STATUS_CODE	Marital status code (SPARC) 1 - 1 D - Divorced M - Married (Registered or De facto) O - O P - Separated S - Never married W - Widowed X - Unable to determine Y - Y

AIHW RECIPIENT SERVICE

Box6

RECIPIENT_ID	Same as in AIHW_RECIPIENT table
ADMISSION_DATE DD/MM/YYYY. the	Date of recipient's admission. Time variable: Moving/transferring from one type of place to another within same service/facility will involve <i>two records</i> with <i>differing admission dates</i> , but the <i>same entry date</i> .
ENTRY_DATE / EXIT_DATE	Their combination gives a continuity of service record.
ADMISSION_TYPE_CODE	Type of admission to a service (permanent or respite) B = BENEFIT RESPITE P = PERMANENT
DISCHARGE_CODE	Reason that the recipient was discharged from the service 1 - TO HOSPITAL 2 - TO HOSTEL 3 - TO OTHER NURSING HOME 4 - DEATH 5 - RETURN TO FAMILY OR HOME 6 - OTHER 7 - CARE RECIPIENT TERMINATED SERVICE 8 - CARE RECIPIENT MOVED OUT OF SERVICE AREA 9 - PROVIDER CEASED PROVIDING SERVICE A - RETURN TO THE COMMUNITY WITH HACC B - RETURN TO THE COMMUNITY WITH CACP C - RETURN TO THE COMMUNITY WITH EACH D - RETURN TO THE COMMUNITY WITH ED E - RETURN TO THE COMMUNITY WITH TC F - RETURN TO THE COMMUNITY, WITHOUT SUPPORT G - CLIENT MOVED TO OTHER TC SERVICE
CARER_CODE	Specifies whether the recipient has a carer 1 – Co-Resident carer 2 – No co-resident carer

⁵³ AIHW RECIPIENT table/box (AIHW 2014) is a wide category that provides connection other sources in the Clearing House (ACFI, ACAP, RCS).

AIHW ASSESSMENT DETAILS ACFI

Box 4

ASSESSMENT_ID

ID of ACFI appraisal
eg SPARC2791082
= Reference to AIHW_ASSESSMENT (Box 2)

Q01 - Q14

and

Assessment of Care Needs in Different Domains (Q01-Q014)
Sub-domains (Q01_R1 ...).
= Nutrition (Eating; Readiness to eat)
= Mobility (Transfers, Locomotion)
= Personal Hygiene (Dressing, Washing, Grooming)
= Toileting (Toilet, Toilet completion)
= Continence of Urine and Faeces
= Cognitive skills (Cognitive Impairment Scale)
= Wandering (Yes, No, Inappropriate places, Interfering)
= Verbal behaviours (and subgroups)
= Physical behaviours (and subgroups)
= Depression and dysthymia (mood disturbance) + Cornell

Scale

= Taking medication issues
= Complex Health Care (CHC)
= Mental diagnoses

Values: 0,1,2,3 or 0,1,2 or A,B,C,D.
Link ACAP ACFI.

Appendix 2

Table A3.1 People in permanent residential aged care, by care need domain, sex, care need rating and age group, at 30 June 2014

Care Need Domain Rating	>65	65-69	Age Group 70-74	75-79	80-84	85+	Total
Males							
<i>ADL</i>							
High	1504	1375	2136	3285	4938	10797	24035
Medium	975	954	1436	2101	3216	7401	16083
Low	789	835	1168	1586	2344	5806	12528
Nil	112	98	117	141	185	469	1122
<i>Total</i>	<i>3380</i>	<i>3262</i>	<i>4857</i>	<i>7113</i>	<i>10683</i>	<i>24473</i>	<i>53768</i>
<i>BEH</i>							
High	2137	2026	2977	4313	6117	12353	29923
Medium	755	689	1060	1532	2432	6005	12473
Low	373	403	588	925	1524	4271	8084
Nil	115	144	232	343	610	1844	3288
<i>Total</i>	<i>3380</i>	<i>3262</i>	<i>4857</i>	<i>7113</i>	<i>10683</i>	<i>24473</i>	<i>53768</i>
<i>CHC</i>							
High	1345	1286	1945	2936	4402	9807	21721
Medium	823	863	1323	1907	2901	6789	14606
Low	875	844	1216	1750	2650	6228	13563
Nil	337	269	373	520	730	1649	3878
<i>Total</i>	<i>3380</i>	<i>3262</i>	<i>4857</i>	<i>7113</i>	<i>10683</i>	<i>24473</i>	<i>53768</i>
Females							
<i>ADL</i>							
High	1508	1385	2423	4835	9562	37069	56782
Medium	828	866	1550	3102	6595	23623	36564
Low	452	631	1144	2075	4361	15030	23693
Nil	48	54	88	162	291	927	1570
<i>Total</i>	<i>2836</i>	<i>2936</i>	<i>5205</i>	<i>10174</i>	<i>20809</i>	<i>76649</i>	<i>118609</i>
<i>BEH</i>							
High	1887	1890	3230	6124	11931	40284	65346
Medium	564	575	1095	2098	4440	18042	26814
Low	287	337	619	1399	3062	12725	18429
Nil	98	134	261	553	1376	5598	8020
<i>Total</i>	<i>2836</i>	<i>2936</i>	<i>5205</i>	<i>10174</i>	<i>20809</i>	<i>76649</i>	<i>118609</i>
<i>CHC</i>							
High	1224	1240	2169	4295	8683	32200	49811
Medium	792	808	1434	2827	5749	22386	33996
Low	622	680	1265	2421	5149	17944	28081
Nil	198	208	337	631	1228	4119	6721
<i>Total</i>	<i>2836</i>	<i>2936</i>	<i>5205</i>	<i>10174</i>	<i>20809</i>	<i>76649</i>	<i>118609</i>
Total Persons							
<i>ADL</i>							
High	3012	2760	4559	8120	14500	47866	80817
Medium	1803	1820	2986	5203	9811	31024	52647
Low	1241	1466	2312	3661	6705	20836	36221
Nil	160	152	205	303	476	1396	2692
<i>Total</i>	<i>6216</i>	<i>6198</i>	<i>10062</i>	<i>17287</i>	<i>31492</i>	<i>101122</i>	<i>172377</i>
<i>BEH</i>							
High	4024	3916	6207	10437	18048	52637	95269
Medium	1319	1264	2155	3630	6872	24047	39287
Low	660	740	1207	2324	4586	16996	26513
Nil	213	278	493	896	1986	7442	11308
<i>Total</i>	<i>6216</i>	<i>6198</i>	<i>10062</i>	<i>17287</i>	<i>31492</i>	<i>101122</i>	<i>172377</i>
<i>CHC</i>							
High	2569	2526	4114	7231	13085	42007	71532
Medium	1615	1671	2757	4734	8650	29175	48602
Low	1497	1524	2481	4171	7799	24172	41644
Nil	535	477	710	1151	1958	5768	10599
<i>Total</i>	<i>6283</i>	<i>6247</i>	<i>10155</i>	<i>17466</i>	<i>31837</i>	<i>101122</i>	<i>172377</i>

†Excludes people who did not have an assessment current as at 30 June

Source: AIHW 2015f.

Appendix 4.1

The probability of being in care: Model testing

[1] Goodness-of-fit

McFadden's adjusted R² is 0.799.

Measures of Fit for logit of agedcare

(Efron's R², Count R², and Adj Count R² not calculated if pweight used)

Log-Lik Intercept Only:	-1.062e+06	Log-Lik Full Model:	-213647.761
D(77548):	427295.522	LR(21):	1696339.222
		Prob > LR:	0.000
McFadden's R ² :	0.799	McFadden's Adj R ² :	0.799
Maximum Likelihood R ² :	1.000	Cragg & Uhler's R ² :	1.000
McKelvey and Zavoina's R ² :	0.999	Efron's R ² :	.
Variance of y*:	2805.007	Variance of error:	3.290
Count R ² :	.	Adj Count R ² :	.
AIC:	5.509	AIC*n:	427339.522
BIC:	-445812.449	BIC':	-1.696e+06

[2] Box-Tidwell test

Box-Tidwell test showed that no transformations were needed.

```
Iteration 0: Deviance = 9497.683
Iteration 1: Deviance = 9497.67 (change = -.0127631)
Iteration 2: Deviance = 9497.67 (change = -.0004298)
-> gen double Iage__1 = X^1.0236-4.65932238 if e(sample)
-> gen double Iage__2 = X^1.0236*ln(X)-7.004559793 if e(sample)
      (where: X = age/10)
```

[Total iterations: 2]

Box-Tidwell regression model

Logistic regression	Number of obs	=	77570
	LR chi2(22)	=	49306.67
	Prob > chi2	=	0.0000
Log likelihood = -4748.835	Pseudo R2	=	0.8385

agedcare	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Iage__1	.974076	.2904903	3.35	0.001	.4047256	1.543427
Iage_p1	-.0004059	.100274	-0.00	0.997	-.1969393	.1961274
female	-.0632368	.0601256	-1.05	0.293	-.1810808	.0546073
married	-1.292379	.065311	-19.79	0.000	-1.420387	-1.164372
wnase	.9798881	.0968173	10.12	0.000	.7901296	1.169647
nasem	.4411919	.1006152	4.38	0.000	.2439897	.6383941
lvlbb	.7850305	.1041543	7.54	0.000	.5808918	.9891692
lvlcc	1.409035	.1077994	13.07	0.000	1.197752	1.620318
lvlff	.4138162	.1123523	3.68	0.000	.1936098	.6340226
lvlhh	1.048498	.0820075	12.79	0.000	.8877661	1.20923
lvlpp	.8440793	.0905828	9.32	0.000	.6665402	1.021618
dementia	.6511448	.0949277	6.86	0.000	.4650899	.8371998
diabetes	.0341647	.0791678	0.43	0.666	-.1210014	.1893308
schizo	1.058023	.1856574	5.70	0.000	.6941415	1.421905
depress	.9702455	.0789447	12.29	0.000	.8155168	1.124974
retard	-.7812599	.2102579	-3.72	0.000	-1.193358	-.3691619
epilepsy	.6138708	.1734239	3.54	0.000	.2739662	.9537754
multiple	.6839845	.2757492	2.48	0.013	.1435259	1.224443
paralysis	.9464222	.305358	3.10	0.002	.3479316	1.544913
heart	.3781836	.0706094	5.36	0.000	.2397917	.5165756
urinary	.5557373	.146623	3.79	0.000	.2683615	.8431131
headinj	-.2076339	.0977669	-2.12	0.034	-.3992534	-.0160143
_cons	-5.972167	.0968252	-61.68	0.000	-6.161941	-5.782393

age	.104194	.0022018	47.32	Nonlin. dev.	0.060	(P = 0.806)
p1	1.023632	.1037133				

Deviance: 9497.670.

[3] Multicollinearity

Collinearity between age and age-square existed as shown in the first test table (below). After age-square has been removed from the model, the VIF dropped and the 'Tolerance' increased.

Variable	VIF	SQRT VIF	Tolerance	R- Squared
female	1.03	1.02	0.9673	0.0327
age	20.41	4.52	0.0490	0.9510
agesquare	22.55	4.75	0.0443	0.9557
married	1.43	1.19	0.7016	0.2984
wnase	6.00	2.45	0.1667	0.8333
nasem	4.68	2.16	0.2138	0.7862
lvlbb	1.99	1.41	0.5018	0.4982
lvlcc	9.88	3.14	0.1012	0.8988
lvlff	8.65	2.94	0.1156	0.8844
lvlhh	4.53	2.13	0.2206	0.7794
lvlpp	4.40	2.10	0.2271	0.7729
dementia	2.27	1.51	0.4413	0.5587
diabetes	1.08	1.04	0.9273	0.0727
schizo	1.04	1.02	0.9574	0.0426
depress	1.27	1.13	0.7899	0.2101
retard	1.08	1.04	0.9292	0.0708
epilepsy	1.05	1.03	0.9516	0.0484
multiple	1.01	1.01	0.9880	0.0120
paralysis	1.02	1.01	0.9804	0.0196
heart	1.26	1.12	0.7965	0.2035
urinary	1.05	1.02	0.9540	0.0460
headinj	1.04	1.02	0.9623	0.0377
Mean VIF	4.49			

Variable	VIF	SQRT VIF	Tolerance	R- Squared
female	1.03	1.02	0.9677	0.0323
age	1.89	1.37	0.5290	0.4710
married	1.26	1.12	0.7964	0.2036
wnase	5.99	2.45	0.1668	0.8332
nasem	4.67	2.16	0.2140	0.7860
lvlbb	1.99	1.41	0.5018	0.4982
lvlcc	9.80	3.13	0.1020	0.8980
lvlff	8.64	2.94	0.1157	0.8843
lvlhh	4.52	2.13	0.2211	0.7789
lvlpp	4.40	2.10	0.2273	0.7727
dementia	2.25	1.50	0.4444	0.5556
diabetes	1.08	1.04	0.9275	0.0725
schizo	1.04	1.02	0.9621	0.0379
depress	1.26	1.12	0.7915	0.2085
retard	1.07	1.03	0.9355	0.0645
epilepsy	1.05	1.02	0.9552	0.0448
multiple	1.01	1.00	0.9902	0.0098
paralysis	1.02	1.01	0.9813	0.0187
heart	1.23	1.11	0.8101	0.1899
urinary	1.05	1.02	0.9546	0.0454
headinj	1.03	1.02	0.9675	0.0325
Mean VIF	2.73			

Appendix 4.4

Regression Diagnostics: Log-linear model (log force of exit from residential care)

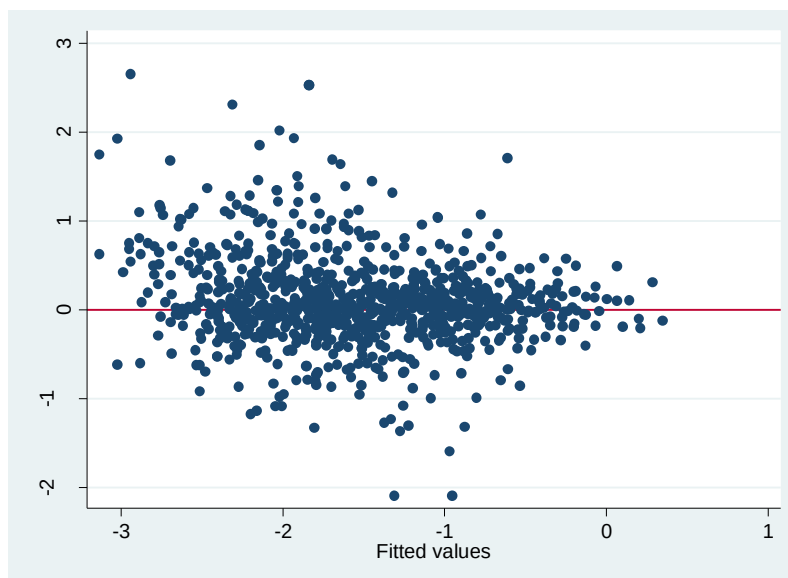
Multicollinearity test: Variance inflation factor (VIF) for the independent variables. Removing insignificant variable 'age' from the model reduced VIF from 35.1 to 2.7. Tolerance levels are also adequate and not close to 0.

Variable	VIF	1/VIF
beh3	4.29	0.233000
chc3	3.78	0.264235
chc2	3.56	0.281185
beh2	3.33	0.300432
chc1	3.19	0.313618
beh1	2.66	0.376472
adl3	2.23	0.448079
adl2	1.78	0.560795
agesquare	1.06	0.942031
sexf	1.05	0.951235
Mean VIF	2.69	

Ramsey regression specification-error test for omitted variables:

```
Ramsey RESET test using powers of the fitted values of logfrequency
Ho: model has no omitted variables
      F(3, 888) =      6.63
      Prob > F =      0.0002
```

Residuals vs Fitted Values Plot:



In relative terms, residuals are equally distributed around 0. No obvious pattern visible.

Covariance matrix of coefficients of regress model:

e (V)	sexf	adl2	adl3	beh1	beh2
sexf	.00026567				
adl2	-.00004291	.00055681			
adl3	-.00001413	.00037494	.00058784		
beh1	.00001945	-.00013359	-.00012757	.00109607	
beh2	.0000553	-.00010413	-.00016201	.00062962	.00094341
beh3	.00005538	-.00019766	-.00015241	.00065231	.00066246
chc1	.00006705	-.00021045	-.00022052	.00005282	.00007819
chc2	.00006607	-.00016513	-.00017744	.00002945	.00002228
chc3	.00009561	-.00024047	-.00030839	.00005192	9.257e-06
agesquare	-1.520e-09	-3.122e-09	-1.282e-08	1.020e-08	4.982e-10
_cons	-.00021536	.00001407	.00008432	-.00066732	-.00061913
e (V)	beh3	chc1	chc2	chc3	agesquare
beh3	.00084958				
chc1	4.170e-06	.00092196			
chc2	-.0000367	.00069021	.0009235		
chc3	-.00003392	.00073247	.00070332	.00111514	
agesquare	3.410e-08	-3.857e-09	-5.370e-09	1.047e-08	4.850e-11
_cons	-.00080041	-.00058424	-.00055507	-.00066333	-3.624e-07
e (V)	_cons				
cons	.00394544				

Appendix 5.7

The probability of application for residential aged care: Model A testing

[1] Goodness-of-fit

McFadden's R2 is 0.397.

Measures of Fit for logit of application

Log-Lik Intercept Only:	-607961.991	Log-Lik Full Model:	-366636.079
D(4303958):	733272.157	LR(9):	482651.825
		Prob > LR:	0.000
McFadden's R2:	0.397	McFadden's Adj R2:	0.397
Maximum Likelihood R2:	0.106	Cragg & Uhler's R2:	0.431
McKelvey and Zavoina's R2:	0.502	Efron's R2:	0.260
Variance of y*:	6.603	Variance of error:	3.290
Count R2:	0.971	Adj Count R2:	0.087
AIC:	0.170	AIC*n:	733292.157
BIC:	-6.501e+07	BIC':	-482514.349

[2] Multicollinearity

There is no problem with multicollinearity between the variables. Both the VIF ('Variance Inflation Factor') and 'Tolerance' show reasonable values. Mean VIF is very low (1.33).

Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R- Squared
application	1.00	1.00	1.0000	0.0000
female	1.00	1.00	1.0000	0.0000
age60	1.67	1.29	0.6000	0.4000
age65	1.67	1.29	0.6000	0.4000
age70	1.67	1.29	0.6000	0.4000
age75	1.67	1.29	0.6000	0.4000
age80	1.67	1.29	0.6000	0.4000
partner	1.00	1.00	1.0000	0.0000
adlself	1.00	1.00	1.0000	0.0000
adltrans	1.00	1.00	1.0000	0.0000
Mean VIF	1.33			

[3] Area under the ROC curve (c-statistic)

C-statistic is a summary measure of how well a model discriminates between cases and non-cases. I obtained c-statistic of **0.935**. For comparison, if c-statistic was 0.5, it would mean that model does no better than random chance, i.e. it's worthless. Therefore, 0.935 is very high value.

Logistic model for application

number of observations = 4303968
area under ROC curve = 0.9356

[4] Specificity/Sensitivity

The overall rate of correct classification is estimated to be 90.39, with 90.85% of the normal weight group correctly classified (specificity) and 76.41% of the low weight group correctly classified (sensitivity).

Logistic model for application

Classified	True		Total
	D	~D	
+	104873	381259	486132
-	32386	3785450	3817836
Total	137259	4166709	4303968

Classified + if predicted $\Pr(D) \geq .05$
True D defined as application $\neq 0$

Sensitivity	$\Pr(+ D)$	76.41%
Specificity	$\Pr(- \sim D)$	90.85%
Positive predictive value	$\Pr(D +)$	21.57%
Negative predictive value	$\Pr(\sim D -)$	99.15%
False + rate for true ~D	$\Pr(+ \sim D)$	9.15%
False - rate for true D	$\Pr(- D)$	23.59%
False + rate for classified +	$\Pr(\sim D +)$	78.43%
False - rate for classified -	$\Pr(D -)$	0.85%
Correctly classified		90.39%

[5] Comparison of the models A, B & C [AIC & BIC]

	AIC	BIC	LLR
Model A	733292.157	-482514.349	0.401
Model B	730427.429	-449057.225	0.364
Model C	657511.076	-327677.317	0.313

The main argument why Model A is preferred over Models B & C is a loss of records in a matching procedure between SDAC and ACAP data sets (Table 5.6) and higher McFadden R^2 value in Model A, compared to Models B & C. AIC and BIC information criteria gave opposite results which may be due to introduction of errors during the matching procedure. Even though AIC values are lower in Models B & C, BIC values get higher, in comparison to Model A.

Appendix 5.8

The probability of application for residential aged care: Model A, B & C comparison, with full test diagnostics for Model B

[1] Comparison of the models A, B & C [AIC & BIC]

Model A

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	599719	-415252.6	-323324.2	17	646682.5	646874.6

Note: N=Obs used in calculating BIC; see [\[R\] BIC note](#)

Model B

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	599719	-415252.6	-313853.3	35	627776.6	628172.3

Note: N=Obs used in calculating BIC; see [\[R\] BIC note](#)

Model C

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	599719	-415252.6	-311623.6	42	623331.1	623805.9

Note: N=Obs used in calculating BIC; see [\[R\] BIC note](#)

[2] Goodness-of-fit [Model B]

McFadden R² is 0.24.

Measures of Fit for logit of apprescare

Log-Lik Intercept Only:	-415252.578	Log-Lik Full Model:	-313853.319
D(599684):	627706.637	LR(34):	202798.518
		Prob > LR:	0.000
McFadden's R2:	0.244	McFadden's Adj R2:	0.244
Maximum Likelihood R2:	0.287	Cragg & Uhler's R2:	0.383
McKelvey and Zavoina's R2:	0.419	Efron's R2:	0.287
Variance of y*:	5.661	Variance of error:	3.290
Count R2:	0.725	Adj Count R2:	0.428
AIC:	1.047	AIC*n:	627776.637
BIC:	-7.351e+06	BIC':	-202346.175

[3] Multicollinearity

There is no problem with multicollinearity between the variables. Both the VIF ('Variance Inflation Factor') and 'Tolerance' show reasonable values. Mean VIF is very low (1.31). The tolerance values approach 1 for most of variables included in the model.

Variable	VIF	SQRT VIF	Tolerance	R- Squared
apprescare	1.41	1.19	0.7092	0.2908
female	1.15	1.07	0.8704	0.1296
age60	1.06	1.03	0.9451	0.0549
age65	1.11	1.06	0.8978	0.1022
age70	1.17	1.08	0.8577	0.1423
age75	1.22	1.10	0.8199	0.1801
age80	1.23	1.11	0.8127	0.1873
carer	1.53	1.24	0.6516	0.3484
partner	1.30	1.14	0.7677	0.2323
adlself	1.96	1.40	0.5091	0.4909
adlmove	1.34	1.16	0.7441	0.2559
adlmoving	1.68	1.30	0.5944	0.4056
adlcomm	1.16	1.08	0.8596	0.1404
adlhealth	2.06	1.43	0.4866	0.5134
adltrans	3.03	1.74	0.3298	0.6702
adlsocial	2.59	1.61	0.3866	0.6134
adlother	1.01	1.01	0.9870	0.0130
icd1	1.01	1.00	0.9948	0.0052
icd2	1.05	1.03	0.9488	0.0512
icd3	1.02	1.01	0.9837	0.0163
icd4	1.12	1.06	0.8907	0.1093
icd5	1.19	1.09	0.8394	0.1606
icd6	1.06	1.03	0.9459	0.0541
icd7	1.09	1.04	0.9189	0.0811
icd8	1.09	1.05	0.9141	0.0859
icd9	1.40	1.18	0.7164	0.2836
icd10	1.05	1.02	0.9524	0.0476
icd11	1.06	1.03	0.9424	0.0576
icd12	1.02	1.01	0.9819	0.0181
icd13	1.20	1.09	0.8356	0.1644
icd14	1.08	1.04	0.9291	0.0709
icd15	1.00	1.00	0.9986	0.0014
icd16	1.07	1.03	0.9349	0.0651
icd17	1.27	1.13	0.7868	0.2132
icd18	1.00	1.00	0.9960	0.0040
Mean VIF	1.31			

[4] Area under the ROC curve (c-statistic)

C-statistic is a summary measure of how well a model discriminates between cases and non-cases. I obtained c-statistic of **0.796**. For comparison, if c-statistic was 0.5, it would mean that

model does no better than random chance, i.e. it's worthless. Therefore, 0.796 is reasonably high value.

Logistic model for apprescare

number of observations = 599719
area under ROC curve = 0.7961

[5] Specificity/Sensitivity

The overall rate of correct classification is estimated to be 70.96, with 72.98% of the normal weight group correctly classified (specificity) and 69.41% of the low weight group correctly classified (sensitivity).

Logistic model for apprescare

Classified	True		Total
	D	~D	
+	215142	77917	293059
-	96215	210445	306660
Total	311357	288362	599719

Classified + if predicted $\Pr(D) \geq .6$
True D defined as apprescare $\neq 0$

Sensitivity	$\Pr(+ D)$	69.10%
Specificity	$\Pr(- \sim D)$	72.98%
Positive predictive value	$\Pr(D +)$	73.41%
Negative predictive value	$\Pr(\sim D -)$	68.62%
False + rate for true ~D	$\Pr(+ \sim D)$	27.02%
False - rate for true D	$\Pr(- D)$	30.90%
False + rate for classified +	$\Pr(\sim D +)$	26.59%
False - rate for classified -	$\Pr(D -)$	31.38%
Correctly classified		70.96%

Appendix 5.9

The probability of admission to residential aged care: Model A & B comparison, with full test diagnostics

[1] Comparison of the models A & B [AIC & BIC]

Model A

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	110810	-76626.28	-76303.44	7	152620.9	152688.2

Note: N=Obs used in calculating BIC; see [\[R\] BIC note](#)

Model B

Akaike's information criterion and Bayesian information criterion

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
.	110810	-76626.28	-75498.38	14	151024.8	151159.4

Note: N=Obs used in calculating BIC; see [\[R\] BIC note](#)

AIC and BIC slightly decrease in Model B, compared to Model A.

[1] Goodness-of-fit [Model A]

McFadden's adjusted R^2 is extremely low: 0.004.

Measures of Fit for logit of admission

Log-Lik Intercept Only:	-76626.283	Log-Lik Full Model:	-76303.441
D(110803):	152606.882	LR(6):	645.684
		Prob > LR:	0.000
McFadden's R2:	0.004	McFadden's Adj R2:	0.004
Maximum Likelihood R2:	0.006	Cragg & Uhler's R2:	0.008
McKelvey and Zavoina's R2:	0.007	Efron's R2:	0.006
Variance of y*:	3.313	Variance of error:	3.290
Count R2:	0.540	Adj Count R2:	0.024
AIC:	1.377	AIC*n:	152620.882
BIC:	-1.134e+06	BIC':	-575.991

[2] Multicollinearity [Model A]

There is no problem with multicollinearity between the variables. Both the VIF ('Variance Inflation Factor') and 'Tolerance' show reasonable values. Mean VIF is very low (1.48). The tolerance values are also reasonable (0.6).

Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R- Squared
admission	1.00	1.00	1.0000	0.0000
female	1.00	1.00	1.0000	0.0000
age60	1.67	1.29	0.6000	0.4000
age65	1.67	1.29	0.6000	0.4000
age70	1.67	1.29	0.6000	0.4000
age75	1.67	1.29	0.6000	0.4000
age80	1.67	1.29	0.6000	0.4000
Mean VIF	1.48			

[3] Area under the ROC curve (c-statistic) [Model A]

C-statistic is a summary measure of how well a model discriminates between cases and non-cases. I obtained c-statistic of **0.54**. For comparison, if c-statistic was 0.5, it would mean that model does no better than random chance, i.e. it's worthless. Therefore, 0.54 is very low value.

Logistic model for admission

```
number of observations = 110810
area under ROC curve   = 0.5399
```

[4] Specificity/Sensitivity [Model A]

The overall rate of correct classification is estimated to be 53.73, with 52.66% of the normal weight group correctly classified (specificity) and 54.67% of the low weight group correctly classified (sensitivity). As expected for this model, the specificity values are relatively low.

Logistic model for admission

Classified	True		Total
	D	~D	
+	32025	24728	56753
-	26549	27508	54057
Total	58574	52236	110810

```
Classified + if predicted Pr(D) >= .52
True D defined as admission != 0
```

Sensitivity	Pr(+ D)	54.67%
Specificity	Pr(- ~D)	52.66%
Positive predictive value	Pr(D +)	56.43%
Negative predictive value	Pr(~D -)	50.89%
False + rate for true ~D	Pr(+ ~D)	47.34%
False - rate for true D	Pr(- D)	45.33%
False + rate for classified +	Pr(~D +)	43.57%
False - rate for classified -	Pr(D -)	49.11%
Correctly classified		53.73%

[1] Goodness-of-fit [Model B]

McFadden's adjusted R^2 is very low: 0.015.

Measures of Fit for logit of admission

Log-Lik Intercept Only:	-76626.283	Log-Lik Full Model:	-75498.383
D(110796):	150996.766	LR(13):	2255.799
		Prob > LR:	0.000
McFadden's R2:	0.015	McFadden's Adj R2:	0.015
Maximum Likelihood R2:	0.020	Cragg & Uhler's R2:	0.027
McKelvey and Zavoina's R2:	0.025	Efron's R2:	0.020
Variance of y*:	3.374	Variance of error:	3.290
Count R2:	0.564	Adj Count R2:	0.075
AIC:	1.363	AIC*n:	151024.766
BIC:	-1.136e+06	BIC':	-2104.797

[2] Multicollinearity [Model B]

There is no problem with multicollinearity between the variables. Both the VIF ('Variance Inflation Factor') and 'Tolerance' show reasonable values. Mean VIF is very low (1.61). The tolerance values are also reasonable (between 0.57 and 1).

Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R- Squared
admission	1.00	1.00	1.0000	0.0000
female	1.00	1.00	1.0000	0.0000
age60	1.67	1.29	0.6000	0.4000
age65	1.67	1.29	0.6000	0.4000
age70	1.67	1.29	0.6000	0.4000
age75	1.67	1.29	0.6000	0.4000
age80	1.67	1.29	0.6000	0.4000
state2	1.75	1.32	0.5714	0.4286
state3	1.75	1.32	0.5714	0.4286
state4	1.75	1.32	0.5714	0.4286
state5	1.75	1.32	0.5714	0.4286
state6	1.75	1.32	0.5714	0.4286
state7	1.75	1.32	0.5714	0.4286
state8	1.75	1.32	0.5714	0.4286
Mean VIF	1.61			

[3] Area under the ROC curve (c-statistic) [Model B]

C-statistic is a summary measure of how well a model discriminates between cases and non-cases. I obtained c-statistic of **0.58**. For comparison, if c-statistic was 0.5, it would mean that

model does no better than random chance, i.e. it's worthless. Therefore, 0.58 is relatively low value.

Logistic model for admission

```
number of observations = 110810
area under ROC curve   = 0.5754
```

[4] Specificity/Sensitivity [Model B]

The overall rate of correct classification is estimated to be 56.39, with 35.08% of the normal weight group correctly classified (specificity) and 75.41% of the low weight group correctly classified (sensitivity). As expected for this model, the specificity values are relatively low.

Logistic model for admission

Classified	True		Total
	D	~D	
+	44165	33914	78079
-	14409	18322	32731
Total	58574	52236	110810

Classified + if predicted $\Pr(D) \geq .5$
 True D defined as admission $\neq 0$

Sensitivity	$\Pr(+ D)$	75.40%
Specificity	$\Pr(- \sim D)$	35.08%
Positive predictive value	$\Pr(D +)$	56.56%
Negative predictive value	$\Pr(\sim D -)$	55.98%
False + rate for true ~D	$\Pr(+ \sim D)$	64.92%
False - rate for true D	$\Pr(- D)$	24.60%
False + rate for classified +	$\Pr(\sim D +)$	43.44%
False - rate for classified -	$\Pr(D -)$	44.02%
Correctly classified		56.39%

Appendix 6.7

Linear regression model of the log of the force of mortality based on SDAC assistance needs variables

[1] Goodness-of-fit

McFadden's adjusted R^2 is very high: 0.951.

Measures of Fit for regress of lnforce

Log-Lik Intercept Only:	-3279.209	Log-Lik Full Model:	114632.136
D(78025):	-229264.271	LR(13):	235822.690
		Prob > LR:	0.000
R2:	0.951	Adjusted R2:	0.951
AIC:	-2.937	AIC*n:	-229236.271
BIC:	-1.108e+06	BIC':	-235676.245

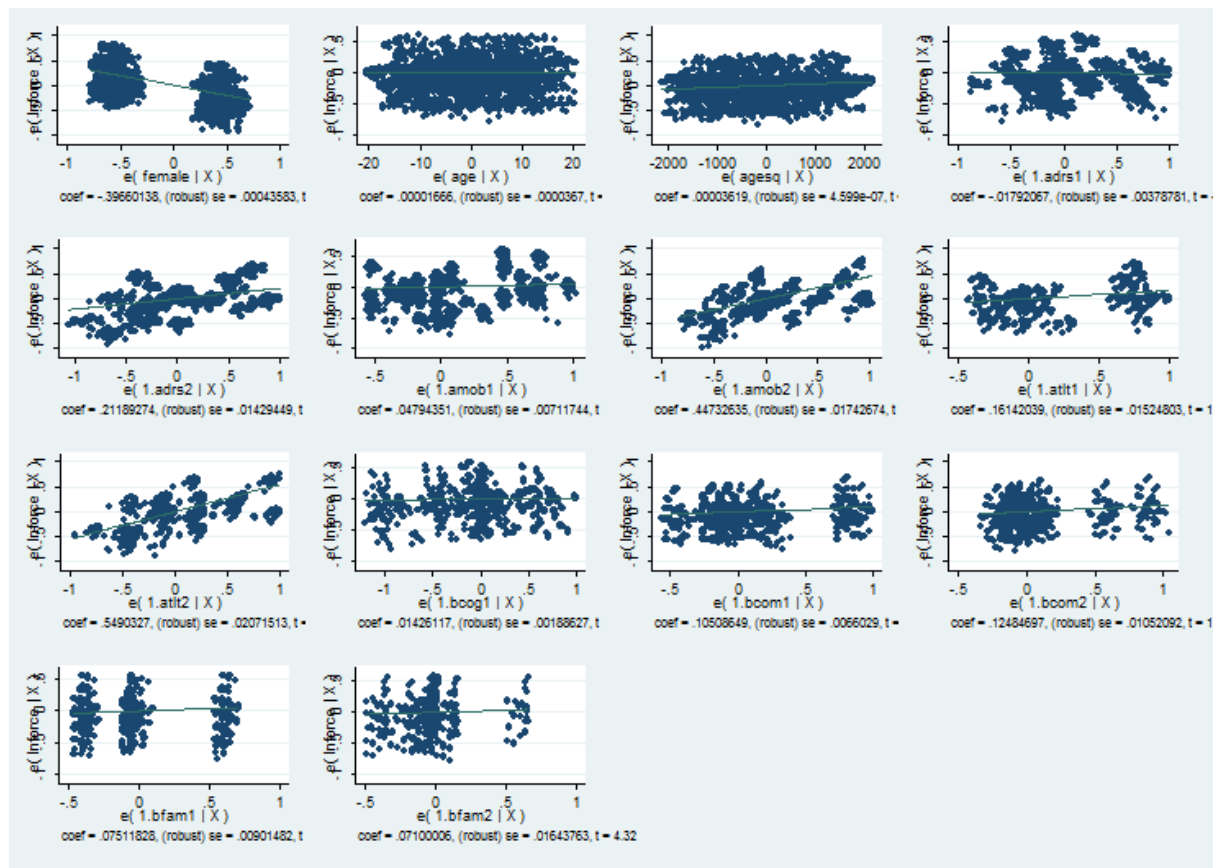
[2] Multicollinearity

There is no problem with multicollinearity between the variables. The VIF ('Variance Inflation Factor') is very low (1.74). Expectedly, if both age and agesquare are included in the model the VIF is higher (3.39).

Variable	VIF	1/VIF	Variable	VIF	1/VIF
atlt2	2.98	0.336000	agesq	13.11	0.076267
adrs2	2.76	0.362076	age	12.79	0.078175
amob2	2.44	0.409894	atlt2	2.98	0.335806
bcom2	2.03	0.492540	adrs2	2.76	0.361794
bfam2	1.82	0.549026	amob2	2.44	0.409230
bcom1	1.62	0.616551	bcom2	2.03	0.492291
bfam1	1.62	0.617918	bfam2	1.82	0.549025
bcog1	1.45	0.691871	bcom1	1.63	0.614559
amob1	1.31	0.765633	bfam1	1.62	0.617835
atlt1	1.30	0.771391	bcog1	1.45	0.691485
adrs1	1.27	0.788700	amob1	1.31	0.765555
agesq	1.07	0.933512	atlt1	1.30	0.770722
female	1.00	0.997099	adrs1	1.27	0.788245
			female	1.00	0.996998
Mean VIF	1.74		Mean VIF	3.39	

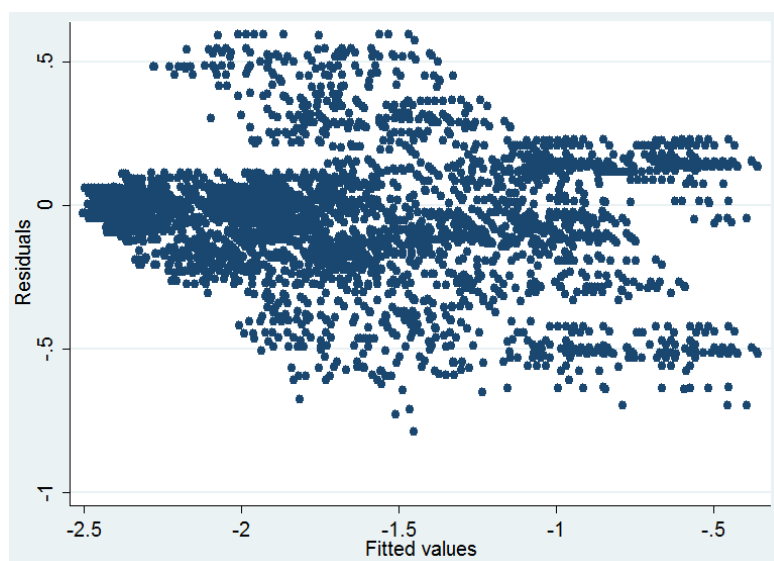
[3] Influential observations

Partial regression plots for each variable in the model do not reveal major discrepancies. Although there are some smaller groups of observations that do not follow the pattern, large number of overall observations



[4] Normality of residuals

The distribution of residuals shows a pattern, but such pattern is not unexpected given the fact that (1) ln (force of mortality) model was used, (2) large number of dummy variables for assistance needs were used. In multiple regressions normality of residuals is only required for valid hypothesis testing, but not for estimation of unbiased regression coefficients. Predictors variables in multiple linear regression also do not have to be normally distributed (i.e. binary variables such as assistance needs).



Appendix 6.8

Developmental Table Example (“*adrs*” or “*need for assistance with dressing*”)

Age	Prevalence Fitted Level 0	Prevalence Fitted Level 1	Prevalence Fitted Level 2	Mortality rate All	Mortality rate Level 1	Mortality rate Level 2	Deaths Level 1	Deaths Level 2	Transitions Level 0	Transitions Level 1	Recoveries Level 1	Recoveries Level 2	Simulated at start Level 1
0	0.99690	0.00005	0.00305	0.00412	0.01021	0.01523	0.00000	0.00005	0.00001	0.00000	0.00000	0.00000	0.00005
1	0.99520	0.00022	0.00458	0.00035	0.00420	0.00670	0.00000	0.00002	0.00119	0.00000	0.00000	0.00005	0.00006
2	0.99323	0.00065	0.00612	0.00021	0.00202	0.00340	0.00000	0.00001	0.00175	0.00016	0.00013	0.00008	0.00128
3	0.99110	0.00146	0.00743	0.00013	0.00111	0.00195	0.00000	0.00001	0.00193	0.00039	0.00037	0.00011	0.00282
4	0.98897	0.00265	0.00839	0.00013	0.00068	0.00124	0.00000	0.00000	0.00190	0.00058	0.00062	0.00015	0.00410
5	0.98704	0.00403	0.00893	0.00012	0.00047	0.00087	0.00000	0.00000	0.00176	0.00066	0.00081	0.00019	0.00495
6	0.98554	0.00536	0.00909	0.00011	0.00035	0.00066	0.00000	0.00000	0.00156	0.00066	0.00092	0.00023	0.00543
7	0.98463	0.00642	0.00895	0.00010	0.00028	0.00053	0.00000	0.00000	0.00134	0.00061	0.00096	0.00027	0.00565
8	0.98430	0.00710	0.00859	0.00010	0.00023	0.00046	0.00000	0.00000	0.00114	0.00053	0.00095	0.00030	0.00570
9	0.98450	0.00740	0.00810	0.00009	0.00021	0.00041	0.00000	0.00000	0.00095	0.00045	0.00092	0.00032	0.00565
10	0.98508	0.00738	0.00754	0.00009	0.00019	0.00038	0.00000	0.00000	0.00078	0.00037	0.00087	0.00033	0.00555
...	...	...	...	...	...	...	...	...	...	...	...	...	...
91	0.71998	0.08311	0.19691	0.17820	0.16115	0.31490	0.01424	0.06031	0.03316	0.03218	0.00000	0.00004	0.08838
92	0.69493	0.08680	0.21827	0.19583	0.18139	0.34836	0.01659	0.06924	0.03593	0.03483	0.00000	0.00004	0.09145
93	0.66783	0.09065	0.24152	0.21361	0.20393	0.38394	0.01927	0.07846	0.03900	0.03761	0.00000	0.00004	0.09450
94	0.63865	0.09466	0.26669	0.23106	0.22890	0.42140	0.02231	0.08759	0.04244	0.04048	0.00000	0.00003	0.09747
95	0.60739	0.09884	0.29377	0.24777	0.25639	0.46038	0.02572	0.09622	0.04631	0.04343	0.00000	0.00003	0.10033
96	0.57409	0.10320	0.32271	0.26334	0.28643	0.50045	0.02952	0.10391	0.05070	0.04643	0.00000	0.00003	0.10305
97	0.53885	0.10774	0.35341	0.27743	0.31900	0.54112	0.03370	0.11027	0.05568	0.04949	0.00000	0.00003	0.10565
98	0.50180	0.11249	0.38570	0.28972	0.35397	0.58183	0.03829	0.11513	0.06129	0.05261	0.00000	0.00002	0.10817
99	0.46317	0.11744	0.41938	0.29989	0.39113	0.62203	0.04328	0.11852	0.06755	0.05579	0.00000	0.00002	0.11064
100	0.42320	0.12261	0.45418	0.31255	0.43017	0.66116	0.04863	0.12068	0.07447	0.05904	0.00000	0.00002	0.11305

(Continues; next page, starting from the last column to the right)

Age	Continued	Simulated at start Level 2	Simulated - fitted Level 1	Simulated - fitted Level 2	SS error (S-F)^2 Level 1	SS error (S-F)^2 Level 2	SS error (S-F)^2 ! & 2	ln(S/F)^2 Level 1	ln(S/F)^2 Level 2	ln(S/F)^2 ! & 2
0	...	0.00305	0.00000	0.00000	0.000000	0.000000	0.000000	0.000	0.000	0.000
1	...	0.00302	-0.00016	-0.00157	0.000000	0.000002	0.000002	1.784	0.175	1.959
2	...	0.00296	0.00063	-0.00316	0.000000	0.000010	0.000010	0.464	0.529	0.993
3	...	0.00302	0.00136	-0.00441	0.000002	0.000019	0.000021	0.432	0.809	1.241
4	...	0.00330	0.00145	-0.00508	0.000002	0.000026	0.000028	0.191	0.869	1.061
5	...	0.00373	0.00092	-0.00520	0.000001	0.000027	0.000028	0.042	0.763	0.805
6	...	0.00420	0.00007	-0.00490	0.000000	0.000024	0.000024	0.000	0.598	0.598
7	...	0.00462	-0.00078	-0.00433	0.000001	0.000019	0.000019	0.017	0.437	0.454
8	...	0.00495	-0.00141	-0.00364	0.000002	0.000013	0.000015	0.049	0.304	0.353
9	...	0.00518	-0.00175	-0.00292	0.000003	0.000009	0.000012	0.073	0.200	0.273
10	...	0.00530	-0.00183	-0.00224	0.000003	0.000005	0.000008	0.081	0.124	0.205
...	...	...	...	...	...	...	...	...	...	...
91	...	0.19152	0.00527	-0.00539	0.000028	0.000029	0.000057	0.004	0.001	0.005
92	...	0.19877	0.00465	-0.01949	0.000022	0.000380	0.000402	0.003	0.009	0.011
93	...	0.20434	0.00385	-0.03718	0.000015	0.001382	0.001397	0.002	0.028	0.030
94	...	0.20786	0.00282	-0.05883	0.000008	0.003461	0.003469	0.001	0.062	0.063
95	...	0.20901	0.00149	-0.08476	0.000002	0.007184	0.007186	0.000	0.116	0.116
96	...	0.20763	-0.00015	-0.11508	0.000000	0.013244	0.013245	0.000	0.194	0.194
97	...	0.20379	-0.00209	-0.14962	0.000004	0.022386	0.022391	0.000	0.303	0.303
98	...	0.19788	-0.00432	-0.18783	0.000019	0.035280	0.035299	0.002	0.445	0.447
99	...	0.19053	-0.00680	-0.22885	0.000046	0.052374	0.052420	0.004	0.622	0.626
100	...	0.18253	-0.00957	-0.27166	0.000092	0.073797	0.073889	0.007	0.831	0.838

† Omitted rows between ages 11 and 90.

‡ Prevalences for levels 1 and 2 were taken from the SDAC prevalences logistic model.

§ Mortality rates for all persons are from "ALT" (Australian Life Tables 2010-12).

(Continued from the previous page)

Glossary

ABS	Australian Bureau of Statistics
ACAP	Aged Care Assessment Program
ACAT	Aged Care Assessment Team. A multidisciplinary team of health professionals responsible for determining the care needs and services an individual may require. ACATs are known as Aged Care Assessment Services (ACAS) in Victoria.
ACFA	Aged Care Funding Authority
ACFI	Aged Care Funding Instrument which measures person's care needs once inside permanent residential facilities.
ACPR	Aged Care Planning Region
AIFS	Australian Institute for Family Studies
AIHW	Australian Institute of Health and Welfare
CACP	Community Aged Care Package
DCSH	Department of Community Services and Health
DHS	Department of Human Services
DoH	Department of Health (Previously "Department of Health and Ageing")
DoHA	Department of Health and Ageing
DSS	Department of Social Services
EACH	Extended Aged Care at Home
EACHD	Extended Aged Care at Home (Dementia)
HACC	Home and Community Care
LTC	Long Term Care. In most countries, apart from Australia it is synonym for residential aged care.
NACDC	National Aged Care Data Clearinghouse
NMDS	National Minimum Data Set
RAC(H)	Residential aged care (home)
Residential Aged Care	Facilities (other than hospitals) which provide accommodation and aged care as a package to people requiring ongoing health and nursing care due to chronic impairments and a reduced degree of independence in activities of daily living (ADL).
Respite Care	Care given as an alternative care arrangement with the primary purpose of giving the carer or a care recipient a short-term break from their usual care arrangement.
SA2	Statistical Areas Level 2
SDAC	Survey of Disability, Ageing and Carers

Bibliography

Aarsland, D. (2016) Cognitive impairment in Parkinson's disease and dementia with Lewy bodies. *Parkinsonism and Related Disorders*, 22(1): 144-148.

Aarsland, D., Larsen, J.P., Tandberg, E. & Knut, L. (2000) Predictors of Nursing Home Placement in Parkinson's Disease: A Population-based prospective study. *Journal of the American Geriatrics Society*. 48(8): 938-942.

Abello A., Kelly, S. & King A. (2002) Demographic projections with DYNAMOD-2. Technical Paper no. 21. Canberra: NATSEM.

ACFA (2016) Fourth Report on the Funding and Financing of the Aged Care Industry.

ABS (1999) Household and Family Projections, 1996 to 2021. Cat. No. 3236. Canberra.

ABS (2011) Census of Population and Housing, Age in Five Year Groups by State, AGE5P Canberra: Australian Bureau of Statistics.

ABS (2012a) Survey of Disability, Ageing and Carers. Confidential Unit Record Files. 2012.

ABS (2012b) Survey of Disability, Ageing and Carers. No. 4430.0, Disability, Ageing and Carers, Australia: Summary of Findings, 2012.
<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4430.0Explanatory+Notes5002012> [Accessed: 20/05/2015]

ABS (2012c) Reflecting a Nation: Stories from the 2011 Census, Canberra: Australian Bureau of Statistics.

ABS (2013) Population projections Australia 2012 to 2101. Catalogue Number 3222.0, Canberra.
<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/3222.0> [Accessed: 15/01/2015]

ABS (2014) Survey of Disability, Ageing and Carers. FREQUENCIES_PER file supplied as part of the SDAC data. Canberra: Australian Bureau of Statistics.

ABS (2014a) 3101.0 - Australian Demographic Statistics. Table 59. Estimated residents' population by single year of age, Australia. Canberra: ABS.
<http://www.abs.gov.au/AUSSTATS/ABS@Archive.nsf/log?openagent&3101059.xls&3101.0&Time%20Series%20Spreadsheet&78B00A6EA7F04030CA257DB100162590&0&Jun%202014&18.12.2014&Latest>
[Accessed: 25/02/2017]

ABS (2015) Australian Demographic Statistics, June 2015. Catalogue Number 3101.0. Canberra: ABS.

ABS (2016) Life tables, States, Territories and Australia, 2013-2015. No. 3302.0.55.001. Canberra: ABS.

ABS (2016b) Disability, Ageing and Carers, Australia: Summary of Findings. Catalogue Number 4430.0. Canberra: ABS.

ABS (2017) Data Lab. Canberra: Australian Bureau of Statistics.
[http://www.abs.gov.au/websitedbs/D3310114.nsf/home/CURF:+About+the+ABS+Data+Laboratory+\(ABSDL\)](http://www.abs.gov.au/websitedbs/D3310114.nsf/home/CURF:+About+the+ABS+Data+Laboratory+(ABSDL))
[Accessed: 01/06/2017]

Access Economics (2015) The economic value of informal care in 2015. Sydney: Deloitte.
<http://www.carersaustralia.com.au/storage/Access%20Economics%20Report.pdf> [Accessed: 09/01/2017]

ACFA (2015) Aged Care Financing Authority - Third report on the funding and financing of the aged care sector, Canberra: Australian Government.
https://www.dss.gov.au/sites/default/files/documents/10_2015/2015_report_on_the_funding_and_financing_of_the_aged_care_sector.pdf [Accessed: 22/06/2016]

Agresti, A. (2007) *An Introduction to Categorical Data Analysis* (2nd edition). New York: Wiley.

Aguero-Torres, H., von Straus, E., Vitanen, M. et al (2001) Institutionalization in the elderly: the role of chronic diseases and dementia. Cross-sectional and longitudinal data from a population based study. *Journal of Clinical Epidemiology*, 54: 795-801.

- AIHW (1998)** Nursing Homes in Australia 1996-97: A Statistical Overview. Canberra: AIHW.
- AIHW (2004)** Carers in Australia: assisting frail older people and people with a disability. Cat. no. AGE 41. Canberra: AIHW.
- AIHW (2007)** Older Australia at a glance: 4th edition. Cat. no. AGE 52. Canberra: AIHW.
<http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=6442454209> [Accessed: 19/02/2015]
- AIHW (2010)** National best practice guidelines for collecting Indigenous status in health data sets. Cat. no. 29. Canberra: AIHW.
<http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=6442458761> [Accessed: 25/02/2017]
- AIHW (2010b)** Residential aged care in Australia 2008-09: a statistical overview. Aged Care Statistics Series 31. Canberra: AIHW.
- AIHW (2011a)** Dementia among aged care residents: first information from the Aged Care Funding Instrument. Aged care statistics no. 32. Cat. no. AGE 63. Canberra: AIHW.
- AIHW (2011b)** Residential aged care in Australia 2009-10: a statistical overview. Aged care statistics series no. 35. Cat. no. AGE 66. Canberra: AIHW.
- AIHW (2011c)** Aged care packages in the community 2009-10: a statistical overview. Aged care statistics series no.34. Cat. no. AGE 65. Canberra: AIHW.
- AIHW (2012a)** Residential aged care in Australia 2010-11: a statistical Overview. Aged care statistics series no. 36. Cat. no. AGE 68. Canberra: AIHW.
<http://www.aihw.gov.au/workarea/downloadasset.aspx?id=10737422896> [Accessed: 27/10/2014]
- AIHW (2012b)** Dementia in Australia. Cat. no. Age 70. Canberra: AIHW.
- AIHW (2012c)** Changes in life expectancy and disability 1998 to 2009. Canberra: AIHW.
<http://www.aihw.gov.au/WorkAreaDownloadAsset.aspx?id=60129542184> [Accessed: 11/11/2015]
- AIHW (2013a)** Aged Care Assessment Program De-identified Data. ACAP unit record file. National Aged Care Data Clearing House. Canberra: AIHW. *Under the certificate of release available only to the author.*
- AIHW (2013b)** Residential aged care in Australia 2011-12, Data Cubes on ACFI admissions and separations 1 July 2011 to 30 June 2012, and on ACFI for residents at 30 June 2012. Canberra: AIHW.
<http://www.aihw.gov.au/aged-care-data-cubes/> [Accessed: 02/05/2015]
<https://reporting.aihw.gov.au/Reports/openRVUrl.do> [Accessed: 01/10/2015]
- AIHW (2013c)** Movement between hospital and residential aged care 2008–09. Data Linkage Series no 16. Canberra: AIHW.
<http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129544618> [Accessed: 24/02/2017]
- AIHW (2013d)** Residential aged care and community - People from culturally and linguistically diverse backgrounds. Canberra: AIHW.
<http://www.aihw.gov.au/aged-care/residential-and-community-2012-13/diverse-background/>
 [Accessed: 24/02/2017]
- AIHW (2014)** Aged Care Clearing House, ACFI Data, Drop 2. Canberra: AIHW.
Under the certificate of release available only to author.
- AIHW (2014b)** Residential aged care and aged care packages in the community 2012-13. Supplementary tables: Residential aged care. Canberra: AIHW.
- AIHW (2015)** Accessing aged care services. Residential and community care 2012-13. Canberra: AIHW.
<http://www.aihw.gov.au/aged-care/residential-and-home-care-2013-14/separations/> [Accessed: 15/04/2015]
- AIHW (2015b)** Care needs in residential aged care. ACFI assessments. Online materials.
<http://www.aihw.gov.au/aged-care/residential-and-home-care-2013-14/care-needs/> [Accessed: 20/10/2015]
- AIHW (2015c)** Use of aged care services before death. Data linkage series no. 19. Cat. no. CSI 21. Canberra: AIHW.
- AIHW (2015d)** Aged Care Assessment Program Data Dictionary Version 1.0. Canberra: AIHW.

AIHW (2015e) National Aged Care Data Clearing House. Australian Institute of Health and Welfare. Canberra: AIHW.
<http://www.aihw.gov.au/national-aged-care-data-clearinghouse/> [Accessed: 01/10/2015]

AIHW (2015f) Residential aged care and aged care packages in the community 2013-14. Supplementary tables: Residential aged care. Canberra: AIHW.

AIHW (2015g) AIHW_Metadata_Documentation_v2.0_Final.xls. September 8 release. Canberra: AIHW.

AIHW (2016a) Detailed ACFI data on permanent residents in care 30 June 2009 – 30 June 2015: a csv. file. National Aged Care Data Clearinghouse. Canberra: AIHW.

AIHW (2016b) Residential and home care 2013-14. Canberra: AIHW.
<http://www.aihw.gov.au/aged-care/residential-and-home-care-2013-14/services-and-places/>
[Accessed: 17/05/2016]

AIHW (2016c) Improving access to data on length of stay in aged care in Australia: a feasibility study into options for a dynamic data display tool. *Working paper 2/2016*. Canberra: AIHW.

AIHW (2016d) Residential Aged Care and Home Care 2014-15 Supplementary Data. Canberra: AIHW.

AIHW (2016e) Introduction to Pathways in Aged Care 2014. Cat. no. AGE 79. Canberra: AIHW.

AIHW (2017) Aged Care Overview. Canberra: AIHW.
<https://www.aihw.gov.au/reports-statistics/health-welfare-services/aged-care/overview>
[Accessed: 09/09/2017]

Ajzen, I. (1991) The theory of planned behaviour. *Organizational Behaviour and Human Decision process*, 50: 179-211.

Akaike, H. (1974) A New Look at the Statistical Model Identification. *I.E.E. Transactions on Automatic Control*, 19: 716-723.

Allison, P. (2013) What's the Best R-Squared for Logistic Regression? *Statistical Horizons*, February 2013.

Allen, K., Bednarik, R., Campbell, L. et al (2011) Governance and finance of long-term care across Europe (Overview Report - Work Package 6). Vienna: Interlinks.

Allen I. & Perkins E. (1995) *The future of family care for older people*. London: HMSO.

Alston, M. (2007) Globalisation, rural restructuring and health service delivery in Australia: Policy failure and the role of social work? *Health and Social Care in the Community*, 15(3): 195-202.

Andel, R., Hyer, K. & Slack, A. (2007) Risk factors for nursing home placement in older adults with and without dementia. *Journal of Aging and Health*, 19: 213-228.

Andersen, R.M. (1968) Families' use of health services: a behavioural model of predisposing, enabling and need components. [*Dissertation*] West Lafayette: Purdue University.

Andersen R.M., McCutcheon, A., Aday, L. et al (1983) Exploring dimensions of access to medical care. *Health Services Research*, 18: 49-73.

Andersen R.M. (1995) Revisiting the behavioural-model and access to medical-care – does it matter? *Journal of Health and Social Behaviour*, 36: 1-10.

Andersen, R.M. & Davidson, P.L. (2001) Improving access to care in America: individual and contextual indicators. In: Andersen, R.M., Rice, T.H. & Kominski, E.F. (Eds.) *Changing the U.S. health care system: key issues in health services, policy, and management*, pp. 3-30. San Francisco: Jossey-Bass.

Andrews, A.O., Bartels, S.J. & Peacock, W.J. (2009) Increased risk of nursing home admission among middle aged and older adults with schizophrenia. *American Journal of Geriatric Psychiatry*, 17(8): 697-705.

Andrews-Hall, S., Howe, A. & Robinson, A. (2007) The dynamics of residential aged care in Australia: 8-year trends in admission, separations and dependency. *Australian Health Review*, 31(4): 611-622.

- Ang, Y. et al (2006)** Functional decline of the elderly in a nursing home. *Singapore Medical Journal*, 47(3): 219-224.
- Angel, J.L., Angel, R.J., Aranda, M.P. & Miles, T.P. (2004)** Can the family still cope? Social support and health as determinants of nursing home use in the older Mexican-origin population. *Journal of Aging and Health*, 16(3): 338-354.
- Antonovsky, A. (1993)** The structure and properties of the sense of coherence scale. *Social Science & Medicine*, 36: 725-733.
- Antonucci, T.C. (2001)** Social relations: An examination of social networks, social support and sense of control. In: Birren J. E., Schaie, K. W. (Eds.) *Handbook of the psychology of aging* (6th ed., p. 453). San Diego: Academic Press.
- Arendts, G. & Howard, K. (2010)** The interface between residential aged care and the emergency department: a systematic review. *Age and Ageing*. 39(3): 306-312.
- Australian Government (1997)** *Aged Care Act 1997*. Office of Legislative Drafting and Publishing. Attorney-General's Department. Canberra: Australian Government.
- Australian Government (2013)** *Living Longer. Living Better Act 2013*. Aged Care Reform Package. Canberra: Australian Government.
- Australian Government (2014)** Five Steps to Entry into an Aged Care Home. Canberra: Department of Social Services. https://www.dss.gov.au/sites/default/files/documents/01_2015/5_steps_accessible.pdf [Accessed: 01/01/2015]
- Australian Government (2017)** My Aged Care. Aged Care Homes. Canberra: Australian Government. <https://www.myagedcare.gov.au/aged-care-homes> [Accessed: 30/07/2017]
- Australian Government Actuary (2014)** Australian life tables 2010-2012. Canberra [Accessed: 02/01/2017]
- Australian Parliament (2013)** Aged Care Living Longer, Living Better Bill. Canberra: The Parliament of the Commonwealth of Australia. http://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r4980 [Accessed: 21/04/2016]
- Australian Treasury (2015)** Australia to 2055: future challenges. Intergenerational Report. http://www.treasury.gov.au/~media/Treasury/Publications%20and%20Media/Publications/2015/2015%20Intergenerational%20Report/Downloads/PDF/2015_IGR.ashx [Accessed: 04/04/2015]
- Axelsson, B. & Christensen, S.B (1996)** Place of death correlated to sociodemographic factors. A study of 203 patients dying of cancer in a rural Swedish county in 1990. *Palliative Medicine*, 10:329-335.
- Banaszak-Holl, J., Fendrick, A.M., Foster, N.L. et al (2004)** Predicting nursing home admission: Estimates from a 7-year follow-up of a nationally representative sample of older Americans. *Alzheimer Disease and Associated Disorders*, 18(2): 83-89.
- Barker, W.H., Boriisute, H. & Cox, C. (1998)** A study of the impact of influenza on the functional status of frail older people. *Arch Intern Med*, 158:645-50.
- Begg, S., Vos, T. et al (2007)** Burden of disease and injury in Australia 2003. Canberra: AIHW.
- Bell, M. & Cooper, J. (2016)** Measuring Spatial Variations in Wellness Among Australia's Rural Aged. In: Wilson, T., Charles-Edwards, E., Bell, M. (Eds.) *Demography for Planning and Policy: Australian Case Studies*, pp. 155-174. Applied Demography Series, Cham: Springer.
- Benjamin, A.E. (1999)** A normative analysis of home care goals. *Journal of Aging and Health*, 11(3): 445-468.
- Bharucha, A.J., Pandav, R., Shen, C. et al (2004)** Predictors of nursing home admission: a 12-year epidemiological study in the US. *Journal of American Geriatric Society*, 52: 434-439
- Bigby, C, Bowers, B. & Webber, R. (2010)** Planning and decision making about the future care of older group home residents and transition to residential aged care. *Journal of Intellectual Disability Research*, 55(8): 777-789.
- Billari F.G. & Prskawetz, A. (2003)** Agent-Based Computational Demography: Using Simulation to Improve Our Understanding of Demographic Behaviour, Berlin-Heidelberg: Springer.

- Binder, E.F., Kruse, R.L., Sherman, A.K. et al (2003)** Predictors of short-term functional decline in survivors of nursing home-acquired lower respiratory tract infection. *J Gerontol A Biol Sci Med Sci*, 58A:60-7.
- Birkin, M. & Wu, B. (2012)** A Review of Microsimulation and Hybrid Agent-Based Approaches. In: Heppenstall A.J. et al (eds.) *Agent-Based Models of Geographical Systems*, New York: Springer. p. 51-68
- Bittman, M., Hill, T., & Thomson, C. (2007)** The impact of caring on informal carers' employment, income and earnings: A longitudinal approach. *Australian Journal of Social Issues*, 42(2), 255–277.
- Bloom, D.E., Canning, D., Fink, G. & Finlay, J.E. (2010)** The Cost of Low Fertility in Europe. *European Journal of Population*, 26:141-158.
- Bongaarts, J. (2006)** How Long Will We Live? *Population and Development Review*, 32(4): 605-628.
- Bongers, M. L. et al (2016)** Multistate Statistical Modelling: A Tool to Build a Lung Cancer Microsimulation Model That Includes Parameter Uncertainty and Patient Heterogeneity. *Med Decision Making*, 36(1): 86-100.
- Bonsdorff, M., Rantanen T., Laukkanen, P. et al (2006)** Mobility limitations and cognitive deficits as predictors of institutionalization among community-dwelling older people. *Gerontology*, 52(6): 359-365.
- Booth, H. (2009)** The changing face of the Australian population: growth in centenarians. Letter to the Editor, *Medical Journal of Australia*, 190(3): 165-166.
- Booth, H. (2010)** Living longer – prospects for longevity in Australia. *Australian Literary Review*, 1 December 2010.
- Bostick, J.E., Rantz, M.J, Flesner, M.K. & Riggs, C.J. (2006)** Systematic Review of Studies of Staffing and Quality in Nursing Homes. *Journal of the American Medical Directors Association*, 7(6): 366-376.
- Borowski, A. & McDonald, P. (2007)** The dimensions and implications of Australian population ageing. In: Borowski, A., Encel, S. and Ozanne, E. (Eds.) *Longevity and Social Change in Australia* (pp 15-39), New South Wales: University of NSW Press.
- Borschev, A. & Filippov, A. (2004)** From System Dynamics and Discrete Event to Practical Agent Based Modelling: Reasons, Techniques, Tools. Proceedings' of the 22nd International Conference of the System Dynamics Society, July 25-29, Oxford.
- Branch, L.G. & Jette, A.M. (1982)** A prospective study of long-term care institutionalization among the aged. *American Journal of Public Health*, 72: 1373-1379.
- Breuer, B., Wallenstein, S., Feinberg, C. et al (1998)** Assessing life expectancies of older nursing home residents. *J Am Geriatr Soc*, 46: 954-961.
- Broad, J., Boyd, M. & Kerse, N. et al (2011)** Residential aged care in Auckland, New Zealand 1988–2008: do real trends over time match predictions? *Age and Ageing*, 40(4): 487-494.
- Broad, J., Gott, M., Hongsoo, K., et al (2013)** Where do people die? An international comparison of the percentage of deaths occurring in hospitals and residential care settings in 45 populations, using published and available statistics. *International Journal of Public Health*, 58: 257-267.
- Broad, J., Ashton, T., Gott, M. et al (2015)** Likelihood of residential aged care use in later life: A simple approach to estimation, with international comparison. *Australian and New Zealand Journal of Public Health*. 39: 374-379.
- Brodsky, H. & Cumming, A. (2010)** Dementia services in Australia. *Geriatric Psychiatry*, 25(9): 887-995.
- Broese van Groenou, M.I., Penninx, B. and Deeg, D.J. (2003)** Socio-economic inequalities in health decline and mortality in an older population. *Aging*, 15: 174-183.
- Brouwers L., Ellegard, L. M., Janslov, N., et al (2014)** Simulating the need for health and elderly care in Sweden – a model description of SESIM-LEV. In G. Dekkers, M. Keegan & C. O'Donoghue (Eds.) *New pathways in microsimulation*, pp. 41-59. Surrey: Ashgate Publishing Limited.
- Brown, L. & Harding, A. (2002)** Social Modelling and Public Policy: Application of Microsimulation Modelling in Australia. *Journal of Artificial Societies and Social Simulation*, 5(4), 6.

- Brown, L., Nepal, B., Booth, H. et al (2011)** Dynamic modelling of ageing and health: DYNOPTA microsimulation model. *NATSEM working paper* 11/14. Canberra: University of Canberra.
- Bull C.N. (1998)** Aging in rural communities. *National Forum*, 78(20): 38-41.
- Byrne, D., Goeree, M., Hiedemann, B. & Stern, S. (2009)** Formal Home Health Care, Informal Care, and Family Decision-Making. *International Economic Review*, 50(4): 1205-1242.
- Cai, Q., Salmon, W. & Rodgers, M. (2009)** Factors Associated with Long-Stay Nursing Home Admissions Among the U.S. Elderly Population: Comparison of Logistic Regression and the Cox Proportional Hazards Model with Policy Implications for Social Work. *Social Work in Health Care*, 48(2): 154-168.
- Caldwell, S.B. (1983)** Broadening policy models: alternative strategies. Microanalytic simulation models to support social and financial policy. North-Holland: Amsterdam.
- Campbell, J., Ikegami, N., Gori, C. et al (2016)** How different countries allocate long-term care resources to older users: a comparative snapshot. In: Gori, C., Fernandes, J. L. & Wittenberg, R. (Eds.) Long term care reforms in OECD countries, pp. 47-66.
- Caplan, G. (2014)** Community services for older people in Australia. In: Caplan, G. (Ed.) *Geriatric Medicine – An Introduction* (p.47-56). Melbourne: IP Communications.
- Caplan, C.A., Sulaiman, N.S., Ricauda, N.A. et al (2012)** A meta-analysis of 'hospital in home'. *Medical Journal Australia*, 197: 512-519.
- Carers Australia (2017)** Care Statistics. On-line source. Canberra: Carers Australia.
<http://www.carersaustralia.com.au/about-carers/statistics/> [Accessed: 30/07/2017]
- CEPAR (2014)** *Aged care in Australia: Part I – Policy, demand and funding*. ARC Centre of Excellence in Population Ageing Research. Sydney: UNSW.
http://www.cepar.edu.au/media/127442/aged_care_in_australia_-_part_i_-_web_version_fin.pdf
 [Accessed: 27/03/2015].
- Chambers, R. (2008)** Regression analysis of probability-linked data. *Statisphere*, 4.
<http://www.statisphere.govt.nz/official-statistics-research/series/vol-4.htm> [Accessed: 20/04/2017].
- Chan, D.C., Kasper, J.D., Black, B.S., & Rabins, P.V. (2003)** Presence of behavioural and psychological symptoms predicts nursing home placement in community-dwelling elders with cognitive impairment in univariate but not multivariate analysis. *Journals of Gerontology—Series A, Biological Sciences and Medical Sciences*, 58(6): 548-554.
- Chapin, R. & Dobbs-Kepper, D. (2001)** Aging in Place in Assisted Living: Philosophy versus Policy. *Gerontologist*, 41(1): 43-50.
- Chappell, N.L., Havens, B., Hollander, M.J. et al (2004)** Comparative Costs of Home Care and Residential Care. *Gerontologist*, 44(3): 389-400.
- Chase, G.A. & Folstein, M. (1990)** Psychiatric symptoms and nursing home placement of patients with Alzheimer's disease. *The American Journal of Psychiatry*, 147(8): 1049-1051
- Chernew, M.E., Weissert, W.G. & Hirth, R.A. (2001)** Heterogeneity of risk in a managed home health care population. *Medical Care*, 39(9): 1002-1013.
- Chou, S.C., Boldy, D.P. & Lee, A.H. (2003)** Factors Influencing Residents' Satisfaction in Residential Aged Care. *Gerontologist*, 43(4): 459-472
- Chung, R., Tin, K., Cowling, B. et al (2009)** Long-term care cost drivers and expenditure projection to 2036 in Hong Kong. *BMC Health Services Research*, 9: 172.
- CIHI (2010)** Depression Among Seniors in Residential Care. Ottawa: Canadian Institute for Health Information.
- Cohen, A. & Roebuck Bulanda, J. (2015)** Social Supports as Enabling Factors in Nursing Home Admissions: Rural, Suburban, and Urban Differences. *Journal of Applied Gerontology*, 35(7): 721-743.
- Cohen-Mansfield, J. & Wirtz, P.W. (2007)** Characteristics of adult day care participants who enter a nursing home. *Psychology and Aging*, 22(2): 354-360.

- Cohen-Mansfield, J. & Wirtz, P.W. (2009)** The reasons for nursing home entry in an adult day care population: Caregiver reports versus regression results. *Journal of Geriatric Psychiatry and Neurology*, 22(4): 274-281.
- Cole, A., Garrison, L., Mestre-Ferrandiz, J. & Tows, A. (2015)** Data governance arrangements for real-world evidence. Canberra: Office of Health Economics.
- Colombo, F., Llena-Nozal, A., Mercier, J. & Tjadens, F. (2011)** Help wanted? Providing and paying for long-term care. Paris: OECD.
- Commonwealth of Australia (2010)** *Australia to 2050: Future Challenges*. The 2010 Intergenerational Report. Canberra: Commonwealth of Australia.
- Commonwealth of Australia (2015)** Public Sector Data Management. Canberra: Department of the Prime Minister and Cabinet.
- Coughlin, T., McBride, T., Perozek, M. & Liu, K. (1992)** Home Care for the Disabled Elderly: Predictors and Expected Costs. *Health Services Research*, 27(4): 453-479.
- Costa-Font, J. & Courbage, C. (2012)** Financing Long-Term Care in Europe: Institutions, Markets, and Models. London: Palgrave
- Csesko M. & Reed, R. (2009)** Will residential aged care facilities meet long-term demand? *Property Management*, 27: 58-74).
- Cullen, D. (2007)** The financial impact of entering aged care. *Australasian Journal on Ageing*, 26(3):145–147.
- Cumpston, J.R. (2011)** An Australian disease and long-term care microsimulation model. 3rd General Conference of the International Microsimulation Association. Stockholm, June 8-10, 2011.
- Cumpston, J.R. (2012)** New techniques for household microsimulation, and their application to Australia. PhD thesis, Canberra: Australian National University.
- Cumpston, J.R. (2016)** Submission to the Productivity Commission Inquiry on Data Availability and Use. Canberra: Australian Projections Pty Ltd.
- Cumpston, J.R. & Jukic, M. (2017)** Microsimulation of aged care residents in Australia. Unpublished materials.
- Cutler, H., Cumpston, J.R. & Bailey, B. (2016)** *Implications of uncapping supply in aged care*. Proposal prepared for Department of Health. Sydney, September 2016.
- Dale, M.C., Burns, A., Panter, L. & Morris, J. (2001)** Factors affecting survival of elderly nursing home residents. *International Journal of Geriatric Psychiatry*, 16: 70-76.
- Damiani, G., Farelli, V., Anselmi, A. et al (2011)** Patterns of long term care in 29 European countries: evidence from an exploratory study. *BMC Health Services Research*, 11:316.
- Davison, T., McCabe, M., Mellor, D. et al (2007)** The prevalence and recognition of major depression among low-level aged care residents with and without cognitive impairment. *Aging & Mental Health*, 11:82–88.
- De Almeida-Mello, J., Van Durme, T., Macq, J. & Declercq, A. (2012)** Interventions to delay institutionalization of frail older persons: design of a longitudinal study in the home care setting. *BMC Public Health*, 12: 615-623.
- Dekkers, G. (2015)** The simulation properties of microsimulation models with static and dynamic ageing – a brief guide into choosing one type of model over the other. *International Journal of Microsimulation*, 8(1): 97-109.
- Dekkers, G. & Belloni, M. (2009)** Microsimulation, pension adequacy and the dynamic model MIDAS: an introduction. Project AIM - Deliverable 4.10. Brussels: CEPS.
- Dekkers, G. & Legros, F. (2006)** A first definition of simulation properties. Text prepared for the colloquium “Simulation Properties of Models of Pension Systems”, AIM (Adequacy of Old-Age Income) project. Brussels: Centre for European Policy Studies (CEPS).
- Department of Health and Ageing (2004)** The Way Forward—A New Strategy for Community Care. Canberra: DoHA.

- Department of Health and Ageing (2008)** Ageing and Aged Care in Australia. Canberra: DoHA.
- Department of Health and Ageing (2009)** The residential care manual. Canberra: DoHA.
- Department of Health and Ageing (2010)** 2009-10 Report on the operation of Aged Care Act 1997. Canberra: DoHA.
- Department of Health and Ageing (2010)** Submission to the Productivity Commission Inquiry Caring for Older Australians from the Department of Health and Ageing. Canberra: DoHA.
http://www.pc.gov.au/__data/assets/pdf_file/0016/104092/sub482.pdf [Accessed: 01/11/2014]
- Department of Health and Ageing (2011)** 2010-11 Report on the operation of the Aged Care Act 1997. Canberra: DoHA.
- Department of Health (2013)** Aged Care Funding Instrument (ACFI) User Guide. Canberra: DoH.
<https://agedcare.health.gov.au/aged-care-funding/residential-care-subsidy/basic-subsidy-amount-aged-care-funding-instrument/aged-care-funding-instrument-acfi-user-guide> [Accessed 18/11/16]
- Department of Health (2015)** 2014-15 Report on the operation of Aged Care Act 1997. Canberra: DoH.
https://agedcare.health.gov.au/sites/g/files/net1426/f/documents/11_2015/201415_report_on_the_operation_of_the_aged_care_act_1997.pdf [Accessed: 12/10/2016]
- Department of Health (2016)** Aged Care Funding Instrument. Appraisal Pack. Canberra: DoH.
https://agedcare.health.gov.au/sites/g/files/net1426/f/documents/02_2017/final_acfi_answer_appraisal_pack.pdf [Accessed: 27/02/2017].
- Department of Health (2017)** Ageing and Aged Care. Aged Care Reforms. On-line statements. Canberra: DoH.
<https://agedcare.health.gov.au/aged-care-reform> [Accessed: 02/07/2017]
- Department of Health (2017b)** Legislated Review of Aged Care 2017. Canberra: Department of Health.
- Department of Parliamentary Library (1993)** Residential Care for the Aged: An overview of Government policy from 1962 to 1993. Canberra: Parliament of the Commonwealth of Australia.
- Dew, A. & Griffin, T. (2002)** Ageing in Place: Good Practice Sourcebook. New South Wales: University of Sydney, Centre for Developmental Disability Studies.
- Dow, B., Sparrow, P., Moore, K., Gaffy, E. & Yates, I. (2013)** What do older Australians want? *Australasian Journal on Ageing*, 32: 236-240.
- Doyle, M. & Timonen, V. (2007)** Home care for ageing populations: A comparative analysis of domiciliary care in Denmark, the United States and Germany. Cheltenham: Edward Elgar.
- Department of Community Services and Health (1990)** Nursing homes for the aged - a statistical overview (1988-89). Canberra: DCSH.
- Department of Human Services (2017)** Aged Care Assessments. On-line statements. Canberra: DHS.
<https://www.humanservices.gov.au/health-professionals/services/assessment-aged-care> [Accessed: 23/02/2017]
- Department of Social Services (2014a)** Aged Care Assessment Program Guidelines. Canberra: DSS.
https://www.dss.gov.au/sites/default/files/documents/09_2015/final__acap_guidelines_2014_-_website_accessibility_check_-_20_jan_14.pdf (Accessed: 02/02/2016)
- Drame, M., Lang, P., Jolly, D. et al (2012)** Nursing home admission in elderly subjects with dementia: predictive factors and future challenges. *JAMDA*, 13(1): 17-20.
- DSS (2014)** The Residential Care Manual. Canberra: Department of Social Services.
<http://www.resicaremanual.health.gov.au/wp-content/uploads/Residential-Care-Manual-PDF.pdf> [Accessed: 20/03/2015].
- DSS (2014b) 2013-14 Report on the Operation of the Aged Care Act 1997.
- Department of Social Services (2014c)** 2013-14 Concise facts and figures on aged care. Canberra: DSS.

Department of Social Services (2014d) Removal of low care – high care distinction in permanent residential aged care from 1 July 2014. Canberra: DSS.

DSS (2014e) Aged Care Funding Instrument. User guide. Canberra: DSS.

DSS (2015) Aged Care Subsidies and supplements - new rates of payment from 1 July 2015.
<https://www.dss.gov.au/our-responsibilities/ageing-and-aged-care/aged-care-funding/aged-care-subsidies-and-supplements/aged-care-subsidies-and-supplements-new-rates-of-payment-from-1-july-2015>
[Accessed: 11/11/2015]

DSS (2015a) Aged Care Assessment Program Guidelines. Canberra: Department of Social Services.

Department of Social Services (2016) ACAT Central Intake Form – All Sites. Aged Care Assessment Referral Form. February 2016.

Dunkin, J.J. & Anderson-Hanley, C. (1998) Dementia caregiver burden: A review of the literature and guidelines for assessment and intervention. *Neurology*, 51(1): 53-60.

Dying Matters Coalition (2012) Identifying end of life patients.
www.dyingmatters.org/gp_page/identifying-end-life-patients (Accessed: 31/05/2017).

Elbert, K.B., & Neufeld, P.S. (2010) Indicators of a successful naturally occurring retirement community: A case study. *Journal of Housing for the Elderly*, 24(3): 322-334.

Epstein, J.M. (2008) Why model? *Journal of Artificial Soc. Simulation* 11(4), 12.

Epstein, J.M. (2007) Generative Social Science: Studies in Agent-Based Computational Modelling. Princeton Studies in Complexity. Princeton: Princeton University Press.

Epstein, J.M. (1999) Agent-based computational models and generative social science. *Complexity*, 4(5): 41-60.

Epstein, J.M. & Axtell, R.L. (1996) Growing Artificial Societies: Social Science from the Bottom Up. Washington, DC: Brookings Institution Press; Cambridge: MIT Press.

Eriksson, M. & Lindstrom B. (2006) Antonovsky's sense of coherence scale and the relation with health: a systematic review. *Journal of Epidemiology and Community Health*, 60: 376-381.

European Commission (2008) *Long-Term Care in the European Union*. Brussels: European Union.

Evandrou M., Falkingham J., Johnson P. et al (2003) The SAGE model: a dynamic microsimulation population model for Britain. In: Gupta, A. and A. Harding (Eds.) *Modelling our future - population ageing health and aged care*, Amsterdam: Elsevier.

Fellegi, I.P. & Sunter, A.B. (1969) A theory for record linkage. *Journal of the American Statistical Association*, 64(328): 1183-1210.

Ferris, R.E., Glicksman, A. & Kleban, M.H. (2016) Environmental Predictors of Unmet Home and Community-Based Service Needs of Older Adults. *Journal of Applied Gerontology*, 35(2): 179-208.

Fiatarone-Singh, M. & Mayer, J. (2002) Exercise comes of age rationale and recommendations for a geriatric exercise prescription. *J Gerontol Med Sci*, 57a: 262-82.

Fishbein, M. & Ajzen, I. (1975) *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fischer, S., Bosshard, G., Zellweger, U. et al (2004) Place of death: "Where do people die in Switzerland nowadays?". *Z Gerontol Geriatrics*, 37: 467-474.

Fisher, L. & Lieberman, M.A. (1999) A Longitudinal Study of Predictors of Nursing Home Placement for Patients with Dementia: The Contribution of Family Characteristics. *Gerontologist*, 39(6): 677-686.

Fisher, F., Andrews, S., Churchyard, A. & Mathers, S. (2012) Home or Residential care? The Role of Behavioural and Psychosocial Factors in Determining Discharge Outcomes for Inpatients with HD. *Journal of Huntington's Disease*, 1: 187-193.

- Flacker, J. M & Kiely, D.K. (1998)** A practical approach to identifying mortality-related factors in established long-term care residents. *Journal of American Geriatrics Society*, 46: 1012–5.
- Flaskerud, J.H. & Winslow, B.J. (1998)** Conceptualizing vulnerable populations health-related research. *Nursing Research*, 47(2): 69-78.
- Fredriksen, D. & Stolen, N. (2007)** MOSART: Dynamic Cross-Sectional Microsimulation Model. In: Anil Gupta, Ann Harding (Eds.) *Modelling Our Future: Population Ageing, Health and Aged Care*. Volume 16. EGPL, pp. 433 - 437.
- Fries, J. F. (1980)** Aging, Natural Death, and the Compression of Morbidity. *The New England Journal of Medicine*, 303: 130-135.
- Foley, D. J., Ostfield, A. M., Branch, L. G. et al (1992)** The risk of nursing home admission in three communities. *J Aging Health*, 4: 155-173.
- Fong, J., Mitchell, O. & Koh, B. (2012)** Nursing home admittance and functional disabilities. *Working Paper 2012/19*. Sydney: CEPAR.
- Fong, J., Shao, A. W. & Sherris, M. (2013)** Multi-state actuarial models of functional disability. *Working Paper 2013/16*. Sydney: CEPAR.
- Fossey, J., Ballard, C., Juszczak, E. et al (2006)** Effect of enhanced psychosocial care on antipsychotic use in nursing home residents with severe dementia: cluster randomised trial. *British Medical Journal*, 332-756.
- Freedman, V.A., Berkman, L.F., Rapp, S.R. & Ostfeld, A.M. (1994)** Family networks: predictors of nursing home entry. *American Journal of Public Health*, 84(5): 843-845
- Fried, L.P., Tangen, C.M. & Walston, J. (2001)** Frailty in older adults: evidence for a phenotype. *Journal of Gerontology A Biol Sci Med Sci*, 56(3): 156-156.
- Friedberg, L., Sun, W., Webb, A. et al (2014)** *New Evidence on the Risk of Requiring Long-Term Care*. Boston: Boston College.
- Friedman, S.M., Steinwachs, D.M., Rathouz, P.J., Burton, L.C. & Mukamel, D.B. (2005)** Characteristics predicting nursing home admission in the program of all-inclusive care for elderly people. *Gerontologist*, 45(2): 157-166.
- Friedman, S.M., Steinwachs, D.M., Temkin-Greener, H., & Mukamel, D.B. (2006)** Informal caregivers and the risk of nursing home admission among individuals enrolled in the program of all-inclusive care for the elderly. *Gerontologist*, 46(4): 456-463.
- Furstenberg F.F., Hoffman S.D. & Shrestha L. (1995)** The effect of divorce on intergenerational transfers: New evidence, *Demography*, 32: 319-333.
- Gaugler J.E. (2005)** Family involvement in residential long-term care: A synthesis and critical review. *Aging & Mental Health*, 9: 105-118.
- Gaugler, J.E., Duval, S., Anderson, K. & Kane, R. (2007)** Predicting nursing home admission in the US: a meta-analysis. *BMC Geriatrics*, 7: 13.
- Gaugler, J.E., Edwards, A.B., Femia, E.E. et al (2000)** Predictors of institutionalization of cognitively impaired elders: family help and the timing of placement. *Journal of Gerontology: Psychological Sciences*, 55B (4): 247-255.
- Gaugler J.E. & Kane R.L. (2007)** Families and assisted living. *Gerontologist*, 47: 730-740.
- Gaugler, J.E., Kane, R.L., Kane, R.A., Clay, T. & Newcomer, R. (2003)** Predicting institutionalization of cognitively impaired older people: utilizing dynamic of predictors of change. *Gerontologist*, 43: 219-229.
- Gaugler, J.E., Kane, R.L., Kane, R.A., & Newcomer, R. (2005)** Unmet care needs and key outcomes in dementia. *Journal of the American Geriatrics Society*, 53(12): 2098-2105.
- Gaugler, J.E., Leach, C.R., Clay, T. & Newcomer, R.C. (2004)** Predictors of nursing home placement in African Americans with dementia. *Journal of the American Geriatrics Society*, 52(3): 445-452.
- Gaugler, J.E., Yu, F., Krichbaum, K. & Wyman, J.F. (2009)** Predictors of Nursing Home Admission for Persons with Dementia. *Medical Care*, 47(2): 191-198.

- Geerlings, S.W., Pot, A.M., Twisk, J.W.R. & Deeg, D.J.H. (2001)** Predicting transitions in the use of informal and professional care by older adults. *Ageing and Society*, 25: 111-130.
- Genet, N., Boerma, W.G., Kroneman, M. et al (2013)** Home care across Europe: case studies. EURHOMAP. Utrecht: NIVEL. World Health Organization.
- Gibson, D., Brown, P. & Liu, Z. (2002)** Spatial equity in the distribution of aged care services in Australia. *Australasian Journal on Ageing*, 21(2): 80-86.
- Gibson, D. (1996)** Reforming Aged Care in Australia: Change and Consequence. *Journal of Social Policy*, 25(2): 157-179.
- Gibson, D. (1998)** *Aged care: Old policies, new problems*. Cambridge: Cambridge University Press.
- Gilbert, N. & Troitzsch, K. (2005)** Simulation for the social scientists: Second edition. Open University Press.
- Gillen, P., Spore, D., Mor, V. et al (1996)** Functional and residential status transitions among nursing home residents. *J Gerontol A Biol Sci Med Sci*, 51:M29-36.
- Gilley, D.W., Bienias, J.L., Wilson, R.S. et al (2004)** Influence of behavioural symptoms on rates of institutionalization for persons with Alzheimer's disease. *Psychological Medicine*, 34(6): 1129-1135.
- Giles, L.C., Glonek G.F., Luszcz, M.A. & Adreus, G.R. (2005)** Effect of social networks on 10-year survival in very old Australians: Australian longitudinal study of aging. *Journal of Epidemiological Community Health*, 59(7): 574-579.
- Giles, L.C., Glonek, G.F., Luszcz, M.A. & Adreus, G.R. (2007)** Do social networks affect the use of residential aged care among older Australians? *BMC Geriatrics*, 7:24.
- Giuliani, C.A., Gruber-Baldini, A.L., Park, N.S. et al (2008)** Physical performance characteristics of assisted living residents and risk for adverse health outcomes. *Gerontologist*, 48(2): 203-212.
- Goldstein, J.R. & Cassidy, T. (2010)** How Slowing Senescence Changes Life Expectancy? MPIDR Working Paper WP 2010-006. MPIDR: Rostock.
URL: <http://www.demogr.mpg.de/papers/working/wp-2010-006.pdf> (Accessed: 18/01/2015).
- Gong, C. & Kendig, H. (2016)** Ageing and Social Change in Australia. In: Kendig, H, McDonald P & Piggott, J. (Eds.) *Population Ageing and Australia's Future* (pp.19-45), Canberra: ANU Press.
- Gott, M., Ingleton, C., Bennett, M. I. & Gardiner, C. (2011)** Transitions to palliative care in acute hospitals in England: qualitative study. *British Medical Journal*. 342: d1773.
- Greenberg, J. N. & Ginn, A. (1979)**: A multivariate analysis of the predictors of long-term care placement. *Home Health Care Services Quarterly*, 1: 75-99.
- Gruenberg, E. (1977)** The Failures of Success. *The Milbank Memorial Fund Quarterly*, 1 (55): 3-24.
- Grundy, E., Mayer, D., Young, H. et al (2004)** Living arrangements and place of death of older people with cancer in England and Wales: a record linkage study. *British Journal of Cancer*, 91: 907-912
- Grundy, E. & Jitlal, M. (2007)** Socio-demographic variations in moves to institutional care 1991-2001. A record linkage study from England and Wales. *Age and Ageing*, 36: 424-430.
- Gupta, A. & Harding, A. (2007)** Introduction and Overview - Chapter 1. In: Gupta, A. & Harding, A. (Eds.) *Modelling our Future: Population Ageing, Health & Aged Care*, North-Holland: Amsterdam. [E-book]
- Guralnik, J.M., Branch, L.G., Cummings, S.R. & Curb, J.D. (1989)** Physical Performance Measures in Aging Research. *Journal of Gerontology*, 44: M141.
- Gutiérrez, L.F., Jiménez-Martín, S., Vegas-Sánchez, R. & Vilaplana, C. (2010)** The long-term care system for the elderly in Spain. ENEPRI Research Report no. 88.
- Hajek, A., Brettschneider, C., Lange, C. et al (2015)** Longitudinal Predictors of Institutionalization in Old Age. *PlosONE*. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0144203> [Accessed: 27/02/2017]

- Hale, B., Barrett, P. & Gauld, R. (2010)** The Age of Supported Independence: Voices of In-home Care. New York: Springer [E-book]
- Harding, A. (2007)** Challenges and Opportunities of Dynamic Microsimulation Modelling. *Plenary paper presented to the 1st General Conference of the International Microsimulation Association*, Vienna, 21 August 2007. Canberra: NATSEM. 2007, p4.
- Harris, Y. & Cooper J.K. (2006)** Depressive symptoms in older people predict nursing home admission. *Journal of the American Geriatrics Society*, 54: 593-597.
- Haupt, M. & Kurz, A. (1993)** Predictors of nursing home placement in patients with Alzheimer's disease. *International Journal of Geriatrics Psychiatry*, 8:741-746
- Healy, J. (1990)** Community Services: long-term care at home? In: Kendig, H. & McCallum, J. (Eds., *Grey Policy: Australian policies for an ageing society*. Sydney: Allen & Unwin.
- Heathcote, C.R., Davis, B.A., Borek, D.P. & O'Neill, T.J. (2003)** The health expectancies of older Australians. *Journal of Population Research*, 20(2): 169-185.
- Hebert, R., Dubois, M. F., Wolfson, C. et al (2001)** Factors associated with long-term institutionalization of older people with dementia: data from the Canadian Study of Health and Aging. *Journal of Gerontology A Biol Sci Med Sci*, 56(11): 693-699.
- Hiedemann, B., Sovinsky, M. & Stern, S. (2013)** "Will You Still Want Me Tomorrow? The Dynamics of Families' Long-Term Care Arrangements. Manuscript. University of Virginia.
- Hellström, Y. & Hallberg, I.R. (2001)** Perspectives of elderly people receiving home help on health, care and quality of life. *Health Soc Care Community*, 9: 61-71.
- Henderson, E.J. & Caplan, G.A. (2008)** Home sweet home? Community care for older people in Australia. *Journal of American Medical Directors Association*. 9(2): 88-94.
- Heppenstall, C.P., Broad, J., Boyd, M. et al (2015)** Progress towards predicting 1-year mortality in older people living in residential long-term care. *Age and ageing*. 44: 497-501.
- Herlofson, K. & Hagestad G.O. (2011)** Challenges in moving from macro to micro: Population and family structures in ageing societies. *Demographic Research*, 25(10): 337-370.
URL: <http://www.demographic-research.org/volumes/vol25/10/25-10.pdf> (Accessed: 18/11/2014)
- Heyman A., Peterson B., Fillenbaum G. & Pieper C. (1997)** Predictors of time to institutionalization of patients with Alzheimer's disease: The CERAD experience, part XVII. *Neurology*, 48:1304-1309.
- Himes, C.L., Wagner, G.G., Wolf, D.A. et al (2000)** Nursing home entry in Germany and the United States. *Journal of Cross-Cultural Gerontology*, 15: 99-118.
- Hirdes, J.P. & Kehyayan, V. (2014)** Long-term care for the elderly in Canada: progress towards an integrated system. In: Mor, V., Leone, T. & Maresso, A. (Eds.) *Regulating long-term care quality - an international comparison*. Cambridge: Cambridge University Press, pp. 324-356.
- Hjaltadóttir, I., Ingalill, R. A., Hallberg, A. et al (2011)** Predicting mortality of residents at admission to nursing home: A longitudinal cohort study. *BMC Health Services Research*, 11:86.
- Hollander, M.J. & Chappell, N.L. (2007)** A comparative analysis of costs to government for home care and long-term residential care services, standardized for client care needs. *Canadian Journal on Aging*. 26(1): 149-161.
- Holm, E., Lingren, U., Makila, K., & Malmberg, G. (1996)** Simulating an entire nation. In: G. Clarke (Ed.), *Microsimulation for urban and regional policy analysis*. London: Pion.
- Holmberg, I. (1987)** Household and housing forecasting models. In: Bongaarts, J., Burch, T. & Wachter, K. (Eds.) *Household Demography and Household Modelling*, pp. 327-341.
- Holroyd-Leduc, J.M., Mehta, K.M., & Covinsky, K.E. (2004)** Urinary incontinence and its association with death, nursing home admission, and functional decline. *Journal of the American Geriatrics Society*, 52(5): 712-718.
- Hooimeijer, P. & Heida, H. (1995)** Household projections and housing market behaviour. In: Van Imhoff et al (Eds.)

Household Demography and Household Modelling, pp. 293-318. New York: Plenum Press.

Hooimeijer, P. & Oskamp, A. (1999) Advances in the Microsimulation of Demographic Behaviour. In: L.J.G. van Wissen & P.A. Dykstra (Eds.) *Population Issues: An Interdisciplinary Focus*, pp. 229-263. New York: Plenum Press.

Hosmer, D.W. & Lemeshow, S. (2000) *Applied Logistic Regression*. New York: John Wiley & Sons.

Howe, A. (1999) Future Directions for Residential Care. *Australasian Journal on Ageing*, 18: 12–18.

Howe, A. & Sarjaent, H. (1999) Strengthening the financing of aged care in Australia. Paper presented at Productivity Commission Conference - The Policy Implications of the Ageing of Australia's Population Melbourne, March 18-19.

Howe, A. & Kung, F. (2003) Does assessment make a difference for people with dementia? The effectiveness of the Aged Care Assessment Teams in Australia. *International Journal of Geriatric Psychiatry*, 18: 205–210.

Hugo, G. (2003) Australia's Ageing Population: Some Challenges for Planers. PIA Congress Keynote Paper.

Hugo, G. (2007) Contextualising the 'crisis in aged care' in Australia: A demographic perspective. *Australian Journal of Social Issues*, 42(2): 169–182.

Hugo, G. (2009) Care worker migration, Australia and development. *Population, Space and Place*, 15(2): 189-203.

Hugo, G. (2013) Global and Regional Perspectives: The changing demographics of Australia over the last 30 years. *Australasian Journal on Ageing*, 32(2): 18-27.

Huisman, M., Kunst, A., Bopp M. et al (2005) Educational inequalities in cause-specific mortality in middle-aged and older men and women in eight western European populations. *Lancet*, 365: 493-500.

IWH - Institute for Work and Health (2015) Cross sectional vs. longitudinal studies. Toronto: IWH.
URL: <https://www.iwh.on.ca/wrmb/cross-sectional-vs-longitudinal-studies> (Accessed: 05/11/2016).

Jackman, S. (2015) pscl: Classes and Methods for R Developed in the Political Science Computational Laboratory, Stanford University. Department of Political Science, Stanford University. Stanford, California. R package version 1.4.9.

Jagger, C., Matthews, R., Matthews, F. et al (2007) The burden of diseases on disability-free life expectancy in later life. *Journal of Gerontology*, 62A (4): 408–414.

Jee, J., Wang, J.J., Rose, K.A. et al (2005) Vision and hearing impairment in aged care clients. *Ophthalmic Epidemiology*, 12: 199-205.

Jeon, Y.H, Govett, J., Low, L.F. et al (2013) Care planning practices for behavioural and psychological symptoms of dementia in residential aged care: A pilot of an education toolkit informed by the Aged Care Funding Instrument. *Contemporary Nurse*, 44: 156–169.

Johri, M., Beland, F. & Bergman, H. (2003) International experiments in integrated care for the elderly: a synthesis of the evidence. *Geriatric Psychiatry*. 18(3): 222-235.

Jorm, L., Walter, S., Lujic, S., Byles, J. & Kendig, H. (2010) Home and community care services: a major opportunity for preventive health care. *BMC Geriatrics*, 10(26): 1-9.

Joseph, A. & Hallman, B. (1998) Over the hill and far away: distance as a barrier to the provision of assistance to elderly relatives. *Social Science and Medicine*, 46(6): 631-639.

Joenperä, J. et al (2015) Long and winding road: Aged care use before death. *Australasian Journal on Ageing*, 35(1): 9-11.

Joenperä, J. (2017) Tales from the ACFI: Dementia in residential aged care. Invited article. *Australasian Journal on Ageing*, 36(1): 10-13.

Kaiser, M.S. (2005) *Advanced Statistical Methods. Statistics 601*. Department of Statistics. Iowa State University.

Karlsson, M., Iversen, T., Øien, H. (2012) Scandinavian long-term care financing. In: Costa-Font, J. & Courbage, C. (Eds.) *Financing Long-Term Care in Europe: Institutions, Markets, and Models*, pp. 254-278. London: Palgrave.

- Karmel, R., Gibson, D., Anderson, P., Wells, Y. & Duckett, S. (2012)** Care trajectories through community and residential aged care services: disease effects. *Ageing & Society* 32(8): 1428-1445.
- Karmel, R., Powierski, A. & Anderson, P. (2014)** Patterns in use of aged care 2002–03 to 2010–11. Data linkage series no.18. CSI 20. Canberra: AIHW 2014, p.31.
<http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129548006> (Accessed: 18/10/2015)
- Kasper, J.D., Pezzin, L.E. & Rice, J.B. (2010)** Stability and changes in living arrangements: Relationship to nursing home admission and timing of placement. *Journals of Gerontology—Series B, Psychological Sciences and Social Sciences*, 65(6): 783-791.
- Kelman, H. R. & Thomas C. (1990)** Transitions between community and nursing home residence in an urban elderly population. *Journal of Community Health*, 15 (2): 105-122.
- Kendig, H. (2014)** Ageing and social change in Australia. Paper presented to Academy of the Social Sciences in Australia. Annual symposium, *Population ageing and Australia's future*. Canberra: Australian National University.
- Kendig, H. & Duckett, S. (2001)** Australian directions in aged care: the generation of policies for generations of older people. *Commissioned Paper Series 2001/05*. Australian Health Policy Institute.
- Kendig, H., Browning, C., Pedlow, R., Wells, Y. & Thomas, S. (2010)** Health, social and lifestyle factors in entry to residential aged care: An Australian longitudinal analysis. *Age and Ageing*, 39: 342–349.
- Kendig, H., Mealing, N., Carr, R. et al (2012)** Assessing patterns of home and community care service use and client profiles in Australia: a cluster analysis approach using linked data. *Health and Social Care in the Community*. 20(4): 375-387.
- Kendig, H., Browning, C., Thomas, S. & Wells, Y. (2014)** Health, lifestyle, and gender influences on aging well: an Australian longitudinal analysis to guide health promotion. *Front. Public Health*, 2:70.
<http://journal.frontiersin.org/article/10.3389/fpubh.2014.00070/full> (Accessed: 28/02/2017).
- Kendig, H., McDonald, P. & Piggott, J. (2016)** Introduction: A multidisciplinary approach to ageing. In: Kendig, H, McDonald P & Piggott, J. (Eds.) *Population Ageing and Australia's Future* (pp.3-18), Canberra: ANU Press.
- Kersting, R.C. (2001a)** Impact of social support, diversity, and poverty on nursing home utilization in a nationally representative sample of older Americans. *Social Work in Health Care*, 33(2), 67-87.
- Kersting, R.C. (2001b)** Predictors of nursing home admission for older Black Americans. *Journal of Gerontological Social Work*, 35(3): 33-50.
- Keysor J.J., Desai T. & Mutran E.J. (1999)** Elders' preferences for care setting in short- and long-term disability scenarios. *Gerontologist*, 39: 334-344.
- Kiel, D.P., O'Sullivan, P., Teno, J.M. & Mor, V. (1991)** Health care utilization and functional status in the aged following a fall. *Medical Care*, 29: 221-228.
- Kim, G. & Chambers, R. (2009)** Regression analysis under incomplete linkage. Working Paper Series, Wollongong: University of Wollongong.
- Knickman, J.R. & Snell, E.K. (2002)** The 2030 Problem: Caring for Aging Baby Boomers. *Health Services Review*, 37(4): 849-884.
- Knight, S. & Tjassing, H. (1994)** Health care moves to the home. *World Health*, 4:413-444.
- Kok, L., Berden, C. & Sadiraj, K. (2015)** Costs and benefits of home care for the elderly versus residential care: a comparison using propensity scores. *The European Journal of Health Economics*, 16(2): 119-131.
- Larsson, K. & Thorslund, M. (2002)** Does gender matter? Differences in patterns of informal support and formal services in a Swedish urban elderly population. *Research on Ageing*, 24: 308-336.
- Latham, K. (2011)** Nursing home stays and the pace of severe disability onset. *Research on Aging*, 33(6): 637-660.
- Lee, R.D. (1994)** The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle. In: Martin, L.G. & Preston, S.H. (Eds.) *Demography of Ageing*, pp. 8-49. Committee on Population, National Research Council.

- Lefroy, R. (2001)** Origins and development of geriatric medicine in Australia. *International Medical Journal*, 31(7): 422–425.
- Leibson, C.L., Tosteson, A.N.A., Gabriel, S.E. et al (2002)** Mortality, disability, and nursing home use for persons with and without hip fracture: A population based study. *Journal of the American Geriatrics Society*, 50(10): 1644-1650.
- Leung, E. (2004)** Projecting the Needs and Costs of Long Term Care in Australia. *Australian Actuarial Journal*, 10(2): 343-385.
- Li, J. & O'Donoghue, C. (2013)** A survey of dynamic microsimulation models: uses, model structure and methodology. *International Journal of Microsimulation*, 6(2), 3-55
- Liang, J., Brown, J. & Bennet, J. (2005)** Health and Living Arrangements of older Americans: Does Marriage Matter? *Journal of Aging and Health*, 17(1): 305-335.
- Liu, K., Coughlin, T. & McBride, T. (1991)** Predicting nursing-home admission and length of stay. *Medical Care*, 29(2): 125-141.
- Liu Z. (1996)** Length of stay in Australian nursing homes. Aged Care Series no.1. Canberra: AIHW.
- Lieberman, M.A. & Kramer, J. (1991)** Factors affecting decisions to institutionalize demented elderly. *The Gerontologist*, 31: 371–374.
- Lo Sasso, A.T. & Johnson, R.W. (2002)** Does informal care from adult children reduce nursing home admissions for the elderly? *Inquiry*, 39: 279-297.
- Long, S. & Freese, J. (2014)** Regression Models for Categorical Dependent Variables Using STATA (3rd ed.). Lakeway Drive: STATA PRESS.
- Luck, T., Lupp, M., Weber, S. et al (2008)** Time until institutionalization in incident dementia cases—results of the Leipzig Longitudinal Study of the Aged (LEILA 75+). *Neuroepidemiology*, 31: 100–108.
- Lupp, M., Luck, T., Weyerer, S., et al (2010)** Prediction of Institutionalisation in the Elderly: A Systematic Review. *Age and Ageing*, 39: 31-38.
- Lutz, W., Sanderson, W. & Scherbov, S. (2008)** The Coming Acceleration of Global Population Ageing. *Nature*, 451 (7179): 716-19.
- Majer, I., Stevens, R., Nusselder, W. et al (2013)** Modelling and forecasting health expectancy: Theoretical framework and application. *Demography*, 50:673–697.
- Manton, K.G. (1982)** Changing concepts of morbidity and mortality in the elderly population. *Health and Society*, 60: 183-244.
- Manton K.G., Corder, L. & Stallard, E. (1997)** Chronic Disability Trends in Elderly United States Populations: 1982-1994. *Proceedings of the National Academy of Science USA*, pp. 2593-8.
- Martikainen, P., Moustgaard, H., Murphy, M. et al (2009)** Gender, Living Arrangements, and Social Circumstances as Determinants of Entry into and Exit from Long-Term Institutional Care at Older Ages: A 6-Year Follow-Up Study of Older Finns. *The Gerontologist*, 49(1): 34-45.
- Martikainen, P., Moustgaard, H., Einio, E. & Murphy, M. (2014)** Life expectancy in long-term institutional care by marital status: Multistate life table estimates for older Finnish men and women. *Journals of Gerontology B*. 69: 303-310.
- Mason, A. & Shima, W. (1986)** Home Microcomputer User's Guide. Honolulu: East West Centre.
- McCallum, J. (2015)** Policy Implications of Australian Ageing: The Greying of a Young Society. *The Journal of Sociology & Social Welfare*: 26(1): 87-106.
- McCallum, J., Simons, L., Simons, J. & Friedlander, Y. (2005)** Patterns and predictors of nursing home placement over 14 years: Dubbo study of elderly Australians. *Australasian Journal on Ageing*, 24(3): 169-173.
- McCann, J.J., Hebert, L.E., Li, Y., Wolinsky, F.D. et al (2005)** The effect of adult day care services on time to nursing home placement in older adults with Alzheimer's disease. *Gerontologist*, 45(6): 754-763.

- McCann, M., Donnelly, M. & O'Reilly, D. (2011)** Living arrangements, relationship to people in the household and admission to care homes for older people. *Age and Ageing*, 40: 358–363.
- McDonald, P. (2000a)** Gender equity, social institutions and the future of fertility. *Journal of Population Research*, 17(1): 1-16
- McDonald, P. (2000b)** Low Fertility in Australia: Evidence, Causes and Policy Responses. *People and Place*, 8(2): 6-21.
- McDonald, P. (2001)** Medium and Long-Term Projections of Housing Needs in Australia: Positioning Paper. Melbourne: Australian Housing and Urban Research Institute.
- McDonald, P. (2004)** Getting a little older each year: the demography of ageing in Australia. In: *CEDA - Australia's Ageing Population: Fiscal, Labour Market and Social Implications*, pp. 31-37. Melbourne: Committee for the Economic Development of Australia.
- McDonald, P. (2014)** Australian population change and responses. Paper presented to Academy of the Social Sciences in Australia. Annual symposium, *Population ageing and Australia's future*. Canberra: ANU.
- McDonald, P. (2016)** Ageing in Australia: Population changes and responses. In: Kendig, H, McDonald P & Piggott, J. (Eds.) *Population Ageing and Australia's Future* (pp.65-83), Canberra: ANU Press.
- McDonald, P. & Kippen, R. (1998)** Household Trends and Projections: Victoria 1986–2011. Canberra: Demography Program, The Australian National University.
- McDonald, P., Kippen, R. & Temple, J. (2006)** Net transition probabilities: an approach to subnational level projections of households and housing demand based on Census data. *Population, Space and Place*, 12(6): 479–495.
- McDonald, P., Temple, J. & Jukic, M. (2017)** Development of an aged care simulation model. The University of Melbourne (Unpublished).
- McFadden, D. (1974)** Conditional logit analysis of qualitative choice behaviour. In: Zarembka, P. (Ed.) *Frontiers in Econometrics* (p. 105-142). Academic Press.
- McFall, S. & Miller, B. (1992)** Caregiver Burden and Nursing Home Admission of Frail Elderly Persons. *Journal of Gerontology*, 47(2): S73-S79.
- McGrath, P., Patton, M., McGrath, Z. et al (2006)** 'It's very difficult to get respite out here at the moment': Australian findings on end-of-life care for Indigenous people. *Health and Social Care in the community*, 14(2): 147-155.
- Meldon, S.W. et al (2003)** A brief risk-stratification tool to predict repeat emergency department visits and hospitalizations in older patients discharged from the emergency department. *Academic Emergency Medicine*, 10(3): 224-232.
- Merz, J. (1993)** Micro simulation as an Instrument to Evaluate Economic and Social Programmes, Invited paper presented during the 49th session of the International Statistical Institute, August 25th-September 3rd, 1993, Florence, Italy, also published as Working Paper no 5, Forschungsinstitut Freie Berufe FFB, University of Lueneburg.
- Merz, J. (1994)** Micro simulation – A Survey of Methods and Applications for Analysing Economic and Social Policy, Working Paper no 9, Forschungsinstitut Freie Berufe FFB: University of Lueneburg.
- Microsoft Corporation (2013)** C# Language Specification Version 5.0: chapter 2.4.4.1 Boolean literals.
- Miller, D.K., Wolinsky, F.D., Andresen, E.M. et al (2008)** Adverse outcomes and correlates of change in the Short Physical Performance Battery over 36 months in the African American health project. *J Gerontol A Biol Sci Med Sci.*, 63: 487–494.
- Miller, E.A., Schneider, L.S., & Rosenheck, R.A. (2011)** Predictors of nursing home admission among Alzheimer's disease patients with psychosis and/or agitation. *International Psychogeriatrics*, 23(1): 44-53.
- Miller, E.A. & Weissert, W.G. (2000)** Predicting elderly people's risk for nursing home placement, hospitalization, functional impairment and mortality: a synthesis. *Medical Care Research and Review*, 57(3): 259-297.
- Miller, J.H. & Page, S. (2007)** *Complex adaptive systems: An introduction to computational models of social life*. Princeton University Press.

- Mitchell, S.L., Teno, J.M. & Roy, J. (2003)** Clinical and Organizational Factors Associated with Feeding Tube Use Among Nursing Home Residents with Advanced Cognitive Impairment. *JAMA*, 290(1):73-80.
- Mittelman, M., Ferris, S., Shulman, E. et al (1996)** A Family Intervention to Delay Nursing Home Placement of Patients with Alzheimer's Disease. *Journal of the American Medical Association*, 276: 1725-1731.
- Mor, V., Leone, T. & Maresso, A. (2014)** *Regulating long-term care quality – an international comparison*. Cambridge: Cambridge University Press.
- Morand, E., Toulemon, L., Pennec, S. et al (2010)** Demographic Modelling: State of the Art. Sustain City Working Paper, 2.1a, INED, Paris.
- Morrison, A., & Levy, R. (2006)** Fraction of nursing home admissions attributable to urinary incontinence. *Value in Health*, 9(4): 272-274.
- Mot, E., Faber, R., Geerts, J. & Willeme, P. (2012)** Performance of long-term care systems in Europe. ENEPRI Research Report No. 117. European Network of Economic Policy Research Institute and Assessing Needs of Care in European Nations.
- Muir, T. (2017)** Measuring social protection for long-term care. *OECD Health Working Papers*, No. 93, Paris: OECD Publishing.
- Muramatsu, N., Yin, H., Campbell, R.T., Hoyem, R.H. et al (2007)** Risk of nursing home admission among older Americans: does state's spending on home- and community-based services matter? *Journal of Gerontology*, 62B: 169-178.
- Murphy, M.J. (1991)** Modelling households: a synthesis. *Population Research in Britain*, supplement 45, NRC.
- Murray, C.J. & Lopez, A.D. (1997)** Alternative projections of mortality and disability by cause, 1990-2020: Global burden of disease study. *Lancet*, 349: 1498 – 1504.
- National Aged Care Alliance (2015)** Enhancing the quality of life of older people through better support and care. National Aged Care Alliance. NACA. Blueprint Series, June 2015.
- NATSEM (2004)** Who's going to care? Informal care and an ageing population. Report prepared for Carers Australia. Canberra: National Centre for Social and Economic Modelling, University of Canberra.
http://www.bsl.org.au/pdfs/informal_care_NATSEM.pdf [Accessed: 17/12/2014]
- Navaie-Waliser, M., Feldman, P.H., Gould, D.A. et al (2002)** When the caregiver needs care: The plight of vulnerable caregivers. *American Journal of Public Health*, 92: 409-413
- Nepal, B., Brown, L., Kelly, S. et al (2011)** Projecting the Need for Formal and Informal Aged Care in Australia: A Dynamic Microsimulation Approach. Canberra: NATSEM.
- NHMRC (2015)** National Statement on Ethical Conduct in Human Research. Ethical Consideration Specific to Research Methods or Fields, Chapter 3.2: Databank. Updated version. Canberra: NHMRC.
URL:http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e72_national_statement_may_2015_150514_a.pdf (Accessed: 07/06/2015)
- Nihtila, E. & Martikainen, P. (2008)** Why older people living with a spouse are less likely to be institutionalised: The role of socioeconomic factors and health characteristics. *Scandinavian Journal of Public Health*, 36: 35-43.
- Nishioka, H., Suzuki, H., Koyama, T. et al (2000)** Household projections for Japan, 1995–2020: methods and results. *Review of Population and Social Policy*, 9(1): 65–85.
- Noel-Miller, C. (2010)** Spousal Loss, Children, and the Risk of Nursing Home Admission. *Journal of Gerontol, Series B Psychology Sci Social Sci*, 65B (3): 370-380.
- Nolan, M., Bauer, M. & Nay, R. (2009)** Supporting family carers: implementing a relational and dynamic approach. In: Nay, R. & Garrat, S. (Eds.) *Issues and innovations in care* (p.136-152). Sydney: Elsevier.
- O'Donoghue, C. (2001)** Dynamic Microsimulation: A Survey, *Brazilian Electronic Journal of Economics*.

- OECD (2006)** Projecting OECD health and long-term care expenditures: What are the main drivers? (OECD Economics Department Working Papers No. 477). Paris: OECD.
- OECD (2010)** Health at a Glance 2011: OECD indicators. Paris: OECD.
- OECD (2013)** A good life in old age? Monitoring and improving quality in long-term care. Paris: OECD.
- OECD (2015)** OECD Health Statistics 2015, Definitions, Sources and Methods, Long-term care recipients in institutions (other than hospitals). Paris: OECD.
<http://www.oecd.org/health-data.html> [Accessed: 22/01/2016]
- Oeppen, J. & Vaupel, J.W. (2002)** Broken Limits to Life Expectancy. *Science*, 296(5570): 1029-1031.
- Ostby, T., Steenhuis, R., Wolfson, C. et al (1999)** Predictors of five-year mortality in older Canadians: The Canadian Study of Health and Aging. *Journal of American Geriatrics Society*, 47: 1249–1254.
- Orcutt, G., Merz, J. & Quinke, H. (1986)** *Microanalytic Simulation Models to Support Social and Financial Policy*. Information Research and Resource Reports (7). Amsterdam: North-Holland.
- Orcutt, G. (1957)** A new type of socio-economic system. *Review of Economics and Statistics*, 39(2), 116-123. Reprint in *International Journal of Microsimulation* (2007) 1(1), 3-9.
http://www.microsimulation.org/IJM/V1_1/IJM_1_1_2.pdf [Accessed: 22/06/2013]
- Ostir, G.V., Volpato, S., Kasper, J.D., Ferrucci, L. & Guralnik, J. M. (2001)** Summarizing amount of difficulty in ADLs: A refined characterization of disability. Results from the women's health and aging study. *Aging Clinical and Experimental Research*, 13(6): 465-472.
- Ovseiko, P. (2007)** Long-Term Care for Older People: Ageing Horizons, Oxford: Oxford Institute of Ageing.
- Palmore, E. (1976)** Total chance of institutionalization. *The Gerontologist*, 16: 504-507.
- Palmer, J.L. et al (2014)** A Model of Risk Reduction for Older Adults Vulnerable to Nursing Home Placement. *Research and Theory for Nursing Practice: An International Journal*, 28(2): 162-192.
- Peace, S. & Holland, C. (2001)** Housing in an ageing society. In: S. Peace & C. Holland (Eds.) *Inclusive housing in an ageing society* (pp. 1–26). Bristol: The Policy Press.
- Percival, R (2007)** APPSIM - software selection and data structures. Working paper, no 3. Canberra: NATSEM.
- Percival, R. & Kelly, S. (2004)** Who's Going to Care? Informal Care and an Ageing Population, Canberra, a report prepared for Carers Australia by NATSEM, University of Canberra
- Petriwskyj A., Gibson A., Parker D. et al (2014)** Family involvement in decision making for people with dementia in residential aged care: a systematic review of quantitative literature. *International Journal of Evidence Based Healthcare*, 12(2): 64-86.
- Pezzin L.E. & Schone B.S. (1999)** Parental marital disruption and intergenerational transfers: An analysis of lone elderly parents and their children, *Demography*, 36: 287-297.
- Phillips, V.L., & Diwan, S. (2003)** The incremental effect of dementia-related problem behaviours on the time to nursing home placement in poor, frail, demented older people. *Journal of the American Geriatrics Society*, 51(2): 188-193.
- Phillipson, C. (2004)** Social Networks and Social Support. In: C. Phillipson, G. Allan and D. Morgan (Eds.) *Social Networks and Social Exclusion: Sociological and Policy Perspectives* (pp. 204-218), Aldershot: Ashgate.
- Pickard L., Wittenberg R., Comas-Herrera A. et al (2000)** Relying on Informal Care in the New Century? Informal Care for Elderly People in England to 2031. *Ageing and Society*, 20: 745–772.
- Piggott, J. (2016)** Population ageing in Australia - National policy challenges and future directions. In: Kendig, H, McDonald P & Piggott, J. (Eds.) *Population Ageing and Australia's Future* (pp.47-62), Canberra: ANU Press.
- Porock, D., Oliver D.P., Zweig, S. et al (2005)** Predicting death in the nursing home: development and validation of the 6-month Minimum Data Set Mortality Risk Index. *J Gerontol Med Sci*, 60A: 491-498.

- Porock, D., Parker-Oliver, D, Petroski, G. & Rantz, M. (2010)** The MDS Mortality Risk Index: The evolution of a method for predicting 6-month mortality in nursing home residents. *BMC Research Notes*, 3(200).
- Productivity Commission (2011)** Caring for Older Australians: An Overview. Report no. 53, Final Inquiry Report. Canberra: Productivity Commission, 2011, p.480.
<http://www.pc.gov.au/inquiries/completed/aged-care/report/aged-care-overview-booklet.pdf>
 [Accessed: 08/11/2015]
- Productivity Commission (2013)** Annual Report 2012-13. Canberra: Productivity Commission.
www.pc.gov.au (Accessed: 08/01/ 2016)
- Rajeski, W. & Mihalko, S. (2001)** Physical activity and quality of life in older adults. *J Gerontol Med Sci*, 56a: 23-36.
- Rechel, B., Doyle, Y., Grundy, E. & McKee, M. (2009)** How can health systems respond to population ageing? WHO Regional Office for Europe on behalf of the European Observatory on Health Systems and Policies: Copenhagen; 2009 (Health Systems and Policy Analysis Brief No. 10).
- Redfoot, D., Feinberg, L. & Houser, A. (2013)** The Aging of the Baby Boom and the Growing Care Gap: A Look at Future Declines in the Availability of Family Caregivers. Insight on the Issues 85. Washington: AARP Public Policy Institute.
- Ribbe, M.W., Ljunggren, G., Steel, K. et al (1997)** Nursing homes in 10 nations: a comparison between countries and settings. *Age and Ageing*. 26(S2): 3-12.
- Ritchey, K. & Studenski, S. (2012)** Epidemiology of Falls and Mobility Disorders. In: Newman, A. & Cauley, J. (Eds.) *The Epidemiology of Ageing*, pp. 293-316, New York: Springer.
- Robine, J.M. & Saito, Y. (2009)** The relationship between longevity and healthy life expectancy in Europe. *Quality in Ageing*, 10(2): 5-14.
- Robinson, T.N., Wallace, J.I., Wu, D.S. et al (2011)** Accumulated frailty characteristics predict postoperative discharge institutionalization in the geriatric patient. *Journal of the American College of Surgeons*, 213(1): 37-42.
- Rolland, Y., Pillard, F., Klapouszczak, A. et al (2007)** Exercise Program for Nursing Home Residents with Alzheimer's Disease: A 1-Year Randomized, Controlled Trial. *Journal of the American Geriatrics Society*, 55(2): 158-165.
- Ronald, L.A., McGregor, M.J., McGrail, K.M. et al (2008)** Hospitalization rates of nursing home residents and community-dwelling seniors in British Columbia. *Canadian Journal on Aging*. 27: 109-115.
- Rouwendal, J. & Thomese, F. (2010)** Home ownership, institutionalization and mortality of elderly in Netherlands. In: Doling, J., Elsinga, M. & Ronald, R. (Eds.) *Home ownership, getting in, getting from, getting out*, pp. 137-152. Amsterdam: IOS.
- Rowland, D.T. (2012)** Population Aging: The Transformation of Societies. In: Powell, J.L. and Sheying C. (Eds.) *International Perspectives on Aging 3*, New York: Springer.
- Rowland, D.T. (1984)** Old Age and the Demographic Transition. *Population Studies*, 38: 73-87.
- Rowland, D.T. (2003)** An ageing population: emergence of a new stage of life? In: S. Khoo and P. McDonald (Eds.) *The Transformation of Australia's Population: 1970 –2030*, pp. 238-265. Sydney: UNSW Press.
- Runge, C., Gilham, J. & Peut, A. (2009)** Transitions in Care of People with Dementia: A Systematic Review of the Literature. Canberra: AIHW.
- Ryan, A.A. & Scullion, H.F. (2000)** Nursing home placement: an exploration of the experiences of family carers. *Journal of Advanced Nursing*, 32(5): 1187-1195.
- Ryan, L., Smith, J., Antonucci, T. & Jackson, J. (2012)** Cohort Differences in the Availability of Informal Caregivers: Are the Boomers at Risk? *Gerontologist*, 52(2): 177-188.
- Sanderson, W. & Scherbov, S. (2007)** A Near Electoral Majority of Pensioners: Prospects and Policies. *Population and Development Review*, 33(3): 543-554.
- Sanderson, W. & Scherbov, S. (2008)** Rethinking age and aging. *Population Bulletin*, 63(4).

- Sands, L., Wang, Y., McCabe, G. et al (2006)** Rates of Acute Care Admissions for Frail Older People Living with Met Versus Unmet Activity of Daily Living Needs. *Journal of the American Geriatrics Society*, 54(2): 339-344.
- Scarmeas, N., Albert, M., Brandt, J. et al (2005)** Motor signs predict poor outcomes in Alzheimer disease. *Neurology*, 64(10): 1696-1703.
- Schaie, K.W. & Uhlenberg, P. (2007)** *Social Structures: Demographic Changes and the Well-Being of Older Persons*. Societal Impact on Aging Series. New York: Springer.
- Schaller, F, Sidelnikov, E., Theiler, R. (2012)** Mild to moderate cognitive impairment is a major risk factor for mortality and nursing home admission in the first year after hip fracture. *Bone*, 51(3): 347-352.
- SCRGSP (2014)** Steering Committee for the Review of Government Service Provision. Report on Government Services. Canberra: Productivity Commission.
<http://www.aihw.gov.au/aged-care/residential-and-community-2012-13/accessing-services/>
 (Accessed: 22/05/2015)
- Segall, A. & Chappell, N.L. (2000)** Health and health care in Canada. Toronto: Prentice-Hall.
- Shah, S.M., Carey, I.M., Harris, T. et al (2013)** Mortality in older care home residents in England and Wales. *Age and Ageing*. 42: 209-215.
- Shapiro E. & Tate, R.B. (1985)** Predictors of long-term care facility use among the elderly. *Canadian Journal on Ageing*, 4(1): 11-19.
- Schulz, R., Zdaniuk, B., Belle, S.H. et al (2010)** Baseline differences and trajectories of change for deceased, placed, and community residing Alzheimer disease patients. *Alzheimer Disease and Associated Disorders*, 24(2): 143-150.
- Silverman, E., Hilton, J., Noble, J. & Bijak, J. (2013)** Simulating the cost of social care in an ageing population. 27th European Conference on Modelling and Simulation (ECMS), Norway, 27-30 May 2013.
<https://drericssilverman.files.wordpress.com/2013/03/ecms-silverman.pdf> (Accessed: 01/09/2014)
- Smith, E. & Stevens, A.B. (2009)** Predictors of discharges to a nursing home in a hospital base cohort. *Journal of the American Medical Directors Association*, 10(9): 623-629.
- Smith, G.E., Kokmen, E., & O'Brien, P.C. (2000)** Risk factors for nursing home placement in a population-based dementia cohort. *Journal of the American Geriatrics Society*, 48(5): 519-525.
- Smith, G.E., O'Brien, P.C., Ivnik, R.J. et al (2001)** Prospective analysis of risk factors for nursing home placement of dementia patients. *Neurology*, 57(8): 1467-1473.
- Soldo, B.J. & Freedman, V.A. (1994)** Care of the Elderly: Division of Labour Among the Family, Market and the State. In: Martin, L.G. & Preston, S.H. (Eds.) *Demography of Ageing*, pp. 195-216. Committee on Population, National Research Council.
- Spielauer, M. (2012)** What is Dynamic Social Science Microsimulation? Statistics Canada – Modelling Division. Report. R.H. Coats Building, 24-O Ottawa, K1A 0T6
 URL: <http://www.statcan.gc.ca/microsimulation/pdf/chap1-eng.pdf> (Accessed: 11/07/2014)
- Spielauer, M. (2007)** Dynamic microsimulation of health care demand, health care finance and the economic impact of health behaviours: survey and review. *International Journal of Microsimulation*, 1(1): 35-53.
- Spoelstra, S.L., Given, B., You, M., & Given, C.W. (2012)** The contribution falls have on increasing risk of nursing home placement in community-dwelling older adults. *Clinical Nursing Research*, 21(1): 24-42.
- Sribney, B. (1996)** What are some of the problems with stepwise regression? StataPress.
- Stapleton, J. H. (2007)** *Models for Probability and Statistical Inference: Theory and Applications*. New Jersey: John Wiley & Sons.
- StataCorp (2013)** Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.
- Statistics Canada (2011)** The Life Paths Microsimulation Model: An Overview.
<http://www.statcan.gc.ca/microsimulation/pdf/lifepaths-overviewvuedensemble-eng.pdf> (Accessed: 21/09/2014)

Steering Committee for the Review of Commonwealth/State Service Provision (1998) Report on Government Services Vol 2. Community Services, Housing. Melbourne: Commonwealth of Australia.

Stephen, E.H., Freedman, V.A., Wolf, D.A. & Soldo, B.J. (1992) Intergenerational Flows of Support: Transfers Between the Elderly and their Adult Children. Department of Demography Working Paper. Washington: Georgetown University.

Stevens, A., Owen, J., Roth, D. et al (2004) Predictors of time to nursing home placement in white and African American individuals with dementia. *Journal of Aging and Health*, 16(3): 375–397.

Stillwell, P. & Kerslake, A. (2004) What makes older people choose residential care, and are there alternatives? *Housing, Care and Support*, 7: 4–8.

Summerfield, M., Freidin, S., Hahn, M., Li, N., et al (2014) HILDA User Manual – Release 13, Melbourne: Melbourne Institute of Applied Economic and Social Research, University of Melbourne.

URL:<http://www.melbourneinstitute.com/downloads/hilda/User%20Manual/HILDA%20User%20Manual%20Release%202013.1.pdf> (Accessed: 15/11/2015)

Swartz, K. (2013) Searching for a Balance of Responsibilities: OECD Countries' Changing Elderly Assistance Policies. *Annual Rev. Public Health*, 34:397-412.

Swerissen, H. & Duckett, S. (2014) *Dying Well*. Melbourne: Grattan Institute.

Tamiya, N., Noguchi, H., Nishi, A., Reich, M. R., Ikegami, N. et al (2011) Population ageing and wellbeing: lessons from Japan's long-term care insurance policy. *Lancet*, 378: 1183-92.

Taylor, A. (2016) Not Just Ageing: Policy and Service Delivery Implications from Changing Population Compositions in the Northern Territory of Australia. In: Wilson, T., Charles-Edwards, E., Bell, M. (Eds.) *Demography for Planning and Policy: Australian Case Studies*, pp. 91-107. Applied Demography Series, Cham: Springer.

Taylor, C. & Donoghue, J. (2015) New ways to provide community aged care services. *Australasian Journal on Ageing*, 34(3): 199-200.

Taylor, D.H. & Hoenig, H. (2004) The effect of equipment usage and residual task difficulty on use of personal assistance, days in bed, and nursing home placement. *Journal of the American Geriatrics Society*, 52(1): 72-79.

Teale, M. (2016) Making decisions about the family home on entering aged care. *Professional Planner*. February 2016. <https://www.professionalplanner.com.au/featured-posts/2016/02/22/making-decisions-about-the-family-home-on-entering-aged-care-43766/> [Accessed: 27/10/2016]

Temkin-Greener, H., Bajorska, A., & Mukamel, D.B. (2008) Variations in service use in the program of all-inclusive care for the elderly (PACE) - Is more better? *Journals of Gerontology - Series A, Biological Sciences and Medical Sciences*, 63(7): 731-738.

Temple, J. (2007) National and Sub-National Projections of Elderly Living Arrangements: An Application of the Net Transition Probability Macrosimulation Model. *Journal of Population Research*, 24(2): 227-251.

Thom, D.H., Haan, M.N. & Van Den Eeden, S.K. (1997) Medically recognized urinary incontinence and risks of hospitalization, nursing home admission and mortality. *Age and Ageing*, 26:367-374.

Thomese, F. & Broese van Groenou, M.I. (2006) Adaptive strategies after health decline in later life: increasing the person-environment fit by adjusting the social and physical environment. *European Journal of Aging*, 3: 169-177.

Thygesen, E., Saevareid, H.I., Lindstrom, T.C. et al (2009) Predicting needs for nursing home admission – does sense of coherence delay nursing home admission in care dependent older people? A longitudinal study. *International Journal of Older People Nursing*. 4(1): 12-21.

Tinetti M.E., Speechley, M. & Ginter, S.F. (1988) Risk factors for falls among elderly persons living in the community. *New England Journal of Medicine*, 319: 1701-1707.

Tinetti, M.E. & Williams, C.S. (1997) Falls, injuries due to falls, and the risk of admission to a nursing home. *New England Journal of Medicine*. 337(18):1279-84.

- Tomiak, M., Berthelot, J.M., Guimond, E. & Mustard, C.A. (2000)** Factors associated with nursing home entry for elders in Manitoba, Canada. *J Gerontol A Biol Sci Med Sci*, 55(5): 279-287.
- United Nations (2012)** Ageing in the 21st century: A celebration and a challenge. New York/London: United Nations Population Fund (UNFPA)/HelpAge International.
- Van Bilsen, P.M.A., Hamers, J.P.H., Groot, W. & Spreeuwenberg, C. (2006)** Demand of elderly people for residential care: an exploratory study, *BMC Health Services Research*, 6: 39-48.
- Van den Berg, B. & Ferreri-Carbonell, A. (2007)** Monetary valuation of informal care: the wellbeing valuation method. *Health Economics*. 16(11): 1227-1244.
- Van Houtven, C.H. & Norton, E.C. (2004)** Informal care and health care use of older adults. *Journal of Health Economics*, 23(6): 1159-1180.
- Van Imhoff, E. & Keilman, N. (1991)** LIPRO 2.0: An application of a dynamic demographic projection model to household structure in the Netherlands. Netherlands: Swets and Zeitinger.
- Van Rensbergen, G., Nawrot, T., Van Hecke, E. et al (2006)** Where do the elderly die? The impact of nursing home utilisation on the place of death. Observations from a mortality cohort study in Flanders. *BMC Public Health*, 6: 178.
- Vantaggi, B. (2008)** Statistical matching of multiple sources: a look through coherence. *International Journal of Approximate Reasoning*, 49(3): 701-711.
- Vaupel, J.W. (2002)** Demographic Analysis of Aging and Longevity. *The American Economic Review*, 88 (2): 242-247.
- Vicente L., Wiley J.A. & Carrington, R.A. (1979)** The risk of institutionalization before death. *The Gerontologist*, 19: 361-367.
- Waite, L.J. (1995)** Does marriage matter? *Demography*, 32: 483-507.
- Walk, D., Fleishman, R. & Mandelson, J. (1999)** Functional improvement of elderly residents of institutions. *Gerontologist*, 39:720-728.
- Walker, A. (1997)** Australia's Ageing Population: How Important Are Family Structures? *Discussion Paper no. 19*, NATSEM, University of Canberra.
- Walters, P. & Bartlett, H. (2009)** Growing old in a new estate: Establishing new social networks in retirement. *Ageing and Society*, 29(2): 217-236.
- Wang, J.J., Mitchell, P., Smith, W. et al (2001)** Incidence of nursing home placement in a defined community. *Medical Journal of Australia*, 174 (6): 271-275.
- Wang, J.J., Mitchell, P., Cumming, R.G. & Smith, W. (2003)** Visual impairment and nursing home placement in older Australians: The Blue Mountains Eye Study. *Ophthalmic Epidemiology*, 10: 3-13.
- Weinberger, M., Darnell, J. C., Tierney, W.M. et al (1986)** Self-rated health as a predictor of hospital admission and nursing home placement in elderly public housing tenants. *American Journal of Public Health* April, 76(4): 457-459.
- Weissert, W.G. (1985)** Seven reasons why it is so difficult to make community-based long-term care cost-effective. *Health Services Research*, 20: 423-433.
- Weissert, W.G. & Frederick, L.F. (2013)** Pay for performance: Can it help improve nursing home quality? *Public Administration Review*, 73(1): 140-151.
- Weissman, J.D. & Russell, D. (2016)** Relationships between living arrangements and health status among older adults in the United States, 2009-2014: Findings from the National Health Interview Survey. *Journal of Applied Gerontology*. doi:10.1177/0733464816655439.
- Wells, Y. & Regan, B. (2013)** Community Support for Older Australians: Issues and Future Directions. Chapter 6. In: Rhonda Nay, Sally Garratt and Deirdre Featherstonehaugh (Eds.): *Older People: Issues and Innovations in Care*. 4th Edition. Sydney: Elsevier.
- Wheelock, V.L., Tempkin, T., Marder, K. et al (2003)** Predictors of nursing home placement in Huntington disease. *Neurology*, 60(6): 998-1001.

- Whitehead, C., Wundke, E., Williamson, B. N. & Finucane, P. (2001)** Accessing residential care from an acute hospital: Can we be more efficient? *Journal of Quality in Clinical Practice*, 21(2): 9-12.
- Whitlatch, C.J., Feinberg, L.F. & Stevens, E.J. (1999)** Predictors of institutionalization for persons with Alzheimer's disease and the impact on family caregivers. *Journal of Mental Health and Aging*, 5: 275-288.
- Whitson, H.E., Cousins, S.W., Burchett, B.M. et al (2007)** The combined effect of visual impairment and cognitive impairment on disability in older people. *Journal of the American Geriatrics Society*, 55(6): 885-891.
- Willekens, F. (2012)** Migration: A perspective from complexity science. Paper for the Migration workshop of the Complexity Science for the Real World (CSRW) network, Chilworth, UK.
- Winterton, R. & Warburton, J. (2012)** Ageing in the bush: The role of rural places in maintaining identity for long term rural residents and retirement migrants in north-east Victoria, Australia. *Journal of Rural Studies*, 28(4): 329-337.
- World Health Organization and US National Institute of Ageing (2011)** Global Health and Ageing: 32. http://www.who.int/ageing/publications/global_health.pdf [Accessed: 05/11/2014]
- World Health Organization (2015)** International Classification of Diseases (ICD-10). <http://apps.who.int/classifications/icd10/browse/2015/en> [Accessed: 27/01/2015]
- Wilmoth, J.R. (1997)** In Search of Limits: What do Demographic Trends Suggest about the Future of Human Longevity. National Academy Press (pp. 38-64). Washington DC.
- Wilmoth J.M. (2000)** Unbalanced social exchanges and living arrangement transitions among older adults. *Gerontologist*, 40 (1): 64-74.
- Wingard, D.L., Jones, D. W. & Kaplan, R. M. (1987)** Institutional care utilization by the elderly: a critical review. *The Gerontologist*, 27: 156-163.
- Wise, D.A. (1997)** Retirement against the Demographic Trend: Older People Living Longer, Working Less, Saving Less. *Demography*, 34(1): 83-95.
- Wolf, D.A., Soldo, B.J. & Freeman, V. (1996)** The Demography of Family Care for the Elderly. In: T. K. Hareven (Ed.) *Aging and Generational Life Course*. New York: Walter deGruyter.
- Wolinsky, F.D., Callahan, C.M., Fitzgerald, J.F., Johnson, R.J. (1992)** The risk of nursing home placement and subsequent death among older adults. *Journal of Gerontology: Social Sciences*, 47: 173-182.
- Yaffe, K., Fox, P., Newcomer, R., Sands, L., Lindquist, K., Dane, K. & Covinsky, K.E. (2002)** Patient and caregiver characteristics and nursing home placement in patients with dementia. *Journal of the American Medical Association*, 287(16): 2090-2097.
- Young, Y., Kalamaras, J., Kelly, L. et al (2015)** Is Aging in Place Delaying Nursing Home Admission? *Journal of American Medical Directors Association*. 16: 900-906.
- Zuckerman, I.H., Langenberg, P., Baumgarten, M. et al (2006)** Inappropriate drug use and risk of transition to nursing homes among community-dwelling older adults. *Medical Care*, 44(8): 722-730.
- Zuliani, G., Romagnoni, F., Soattin, L et al (2001)** Predictors of two-year mortality in older nursing home residents. The IRA study. *Aging*, 13: 3-7.