NATIONAL AND SUBNATIONAL PROJECTIONS OF ELDERLY LIVING ARRANGEMENTS: AN APPLICATION OF THE NET TRANSITION PROBABILITY MACROSIMULATION MODEL

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Recently, McDonald *et al.* (2006) outlined a new method of projecting living arrangements, households and dwellings at the national and subnational level, using quinquennial census data. The purpose of this paper is to apply this new simulation method to project the composition of elderly living arrangements at the national and subnational level in Australia over the period 2001 to 2016.

This study presents projections of living arrangements for Temporal Statistical Districts within New South Wales and for Australia as a whole. Results show a strong increase in the number of the elderly living alone, particularly elderly males. The rate of growth in lone-person households is particularly strong in coastal and regional New South Wales, underlining the importance of capturing subnational differences in probabilities of births, deaths, migration and household movements when producing regional projections of living arrangements. This paper concludes by considering implications of the findings and potential uses of the net transition probability method.

Keywords: household composition, transition probabilities, macrosimulation, Australian demography, demographic ageing, individual ageing

Although there are many excellent studies on the range of possibilities for the ageing of Australia's population (McDonald and Kippen 1999; Wilson and Bell 2004), few have sought to examine regional aspects of population ageing. Spatial heterogeneity in underlying demography necessarily implies differences in the timing and speed of population ageing at the subnational level. Indeed, the policy issues arising through population ageing may occur more strongly at the subnational level (McDonald 2004). Although there is a steadily growing literature on regional ageing in Australia (e.g. Jackson and Felmingham 2002; Hugo 2003), little is known of how the composition of these populations, apart from age and sex, will shift with population ageing.

In addition to the underlying demographic processes of fertility, mortality and migration, cohort effects ripple across time, influencing the propensity to marry and family formation more generally. This combination, in turn, influences living arrangements in the later life course. Until recently, projections of spatial variations in elderly living arrangements in Australia have been limited because of modelling complexity

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and data limitations (Rowland 1997). The purpose of this paper is to adopt a newly developed methodology to project living arrangements at both the national and sub-national levels (McDonald *et al*. 2006).

Understanding the indicative futures of elderly living arrangements is important because living arrangements are key indicators of need and well-being in retirement (Rowland 1982, 1986). Where there is insufficient familial support, particularly within the household, aged persons require additional, mostly economic resources to fulfil this unmet need (Rowland 2003). The substitution of economic for familial support often occurs at the public level, placing greater strain on government funding.

Data and geographical boundaries

The data used for this study are from full-count census tables and Estimated Resident Population (ERP) data obtained from the Australian Bureau of Statistics. The spatial definitions broadly follow Blake *et al.*'s (2000) Temporal Statistical Districts (TSD). The advantage of using TSDs as opposed to Statistical Districts (SD) or Statistical Local Areas (SLA) is that first, TSDs provide adequate population size with which to fit the transition probability model; and second, evaluation of statistical boundary changes from 1991 to 2001 indicates a high degree of data comparability over time (McDonald and Temple 2003a). This study specifically examines living arrangement projections for TSDs within New South Wales and for Australia as a whole.

Method

Previous empirical studies have used propensity models (McDonald and Kippen 1998; ABS 1999), microsimulation models (Hooimeijer and Heida 1995; Hooimeijer and Oscamp 1999) or transition macrosimulation techniques (Mason and Shima 1986; Holmberg 1987; Murphy 1991; van Imhoff and Keilman 1991; Nishioka *et al.* 2000) to project households and living arrangements. For an overview of each method see Wilson and Rees (2005) and McDonald *et al.* (2006).
As noted by McDonald (2001),

> 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 to dynamic microsimulation (McDonald 2001:6).

Given the heavy spatial data demands required for this project, the method adopted here follows the macrosimulation method developed by McDonald *et al.* (2006), which uses net transition probabilities to estimate shifts in preferences for different living arrangement types over time. In the following discussion, a brief review of the net transition probabilities approach is given. A full discussion of the modelling of the demographic parameters and the transition probability formulae is available in McDonald *et al.* (2006) original paper.

For this projection the base living arrangement types are derived from McDonald and Kippen's (1998) Household Classification Types (HCT) of individuals as detailed in Table 1. Clearly, with nine different living arrangement types for individuals, a 'formal' increment–decrement approach measuring all available transitions is not possible with Australian data. To illustrate, calculating transition probabilities between nine different living arrangement types would require a 16,000-cell transition matrix

Table 1 Household Classification Type (HCT) of persons

HCT Type	Definition
1	Parent in a couple family with co-resident children
2	Parent in a one-parent family
3	Child (any age) in a couple family with children
4	Child (any age) in a one-parent family
5	Partner in a couple family without children
6	A person living alone
7	Any person living with a couple family or a one-parent family, other than persons included in categories HCT1 – HCT5
8	A group household member, including households consisting of related persons where there was no couple family or sole parent family (e.g. siblings living together)
9	A usual resident of a non-private dwelling.

for one region alone [9 * 9 * 99 (single years of age) * 2 (male / female) = 16,038]. For all regions considered in this paper, this implies a 272,646-cell matrix. Obviously, this approach places unrealistic demands on the data, as well as imposing high computational requirements.

To simplify the calculation of transition probabilities, two adjustments are made regarding (1) the age groups within which certain living arrangement transitions take place and (2) the use of 'net transitions'.

Age-specific transitions

At any given age, a limited number of transitions are more likely to occur than any others. For example, in late old age, moving into a non-private dwelling is a more important transition than moving from the parental home to live with a partner (becoming 'coupled'). Moreover, the interdependency of household transitions must also be accounted for. For example, for every male in a couple household in time t who enters a non-private dwelling by $t+1$, there is a female who becomes the sole member of a household (lone person), enters a non-private dwelling, or changes to another living arrangement.

One solution is to divide individuals into six wide age ranges: 0–14 years, 15–24 years, 25–34 years, 35–59 years, 60–79 years and 80 years and over, and to use a specific transition approach for each of these age ranges. HCT categories for each of these age groups are collapsed into broader living arrangement classifications (the most numerous for that age group) as follows (Table 2).

Using these classifications, the proportional distribution of age–sex-living arrangement types for each region was calculated using the 1991, 1996 and 2001 full count censuses. For the intervening years, 1992–1995 and 1997–2000, linear interpolation is used to estimate the proportional distribution of living arrangements. From these proportional distributions, transition probabilities are calculated, by single-years-of-age, sex and region for each year. The transition probability, $T^*(r, g, x, a \rightarrow \mathrm{b})$, meas-

Table 2 Living Arrangement Classification (LA) derived from HCT

Age	Living Arrangement Classification (LA)	
0–14	LA1	Child in couple family with children (HCT 3)
	LA2	Child in one-parent family (HCT 4)
	LA3	Not living with parent(s) (HCT 1–2, 5–9)
15–34	LA4	Living with parent(s) (HCT 3, 4)
	LA5	Coupled (HCT 1, 5)
	LA6	Not living with parent(s) and not coupled (HCT 2, 6–9)
35–59	LA5	Coupled (HCT 1, 5)
	LA7	Not coupled (HCT 2–4, 6–9)
60+	LA5	Coupled (HCT 1, 5)
	LA8	Resident of non-private dwelling (HCT 9)
	LA9	Not coupled and not living in a non-private dwelling (HCT 2–4, 6–8)

ures the proportion by which living arrangement a decreases in region r for sex g owing to a change to living arrangement b from age x in year y to age $x+1$ in year $y+1$. Between the intercensal periods, the sets of five transition probabilities were averaged and smoothed.

Table 3 displays the net transition probabilities considered for females. These transitions were found to be the key household composition movements in Australia (McDonald 2001). The transitions for males were identical, with the exception that coupling and uncoupling were based upon a proportional distribution of the age of female partner to age of male partner, yielding a female-dominant projection. The oldest age group for males was also extended from age 80+ to 85+.

The net transition approach

Tables 3 and 4 illustrate the use of the net transition probability approach. Using the age group 60–79 as an example, a traditional increment–decrement approach would estimate transition probabilities for:

Coupled → Resident of Non-Private Dwelling
Resident of Non-Private Dwelling → Coupled
Coupled → Not Coupled and Not Resident of Non-Private Dwelling
Not Coupled and Not Resident of Non-Private Dwelling → Coupled
Resident of Non-Private Dwelling → Not Coupled and Not Resident of Non-Private Dwelling
Not Coupled and Not Resident of Non-Private Dwelling → Resident of Non-Private Dwelling

However, a pure increment–decrement approach requires retrospective or longitudinal data on past living arrangements: information that is not available from the Australian census. Table 4 displays an example of the living arrangement propensi-

Table 3 Net transitions considered for each age group

Age ranges	Living arrangement at time t	Living Arrangement at time t+1
<15	Applied using propensities	
15–24	Living with parent(s)	Coupled
	Living with parent(s)	Not living with parent(s) and not coupled.
25–34	Living with parent(s)	Coupled
	Not living with parent(s) and not coupled.	Coupled
35–59	Coupled	Not coupled
60–79	Coupled	Non-private Dwelling
	Coupled	Not coupled and not living in a non-private dwelling
80+	Coupled	Non-private Dwelling
	Not coupled and not living in a non-private dwelling	Non-private Dwelling

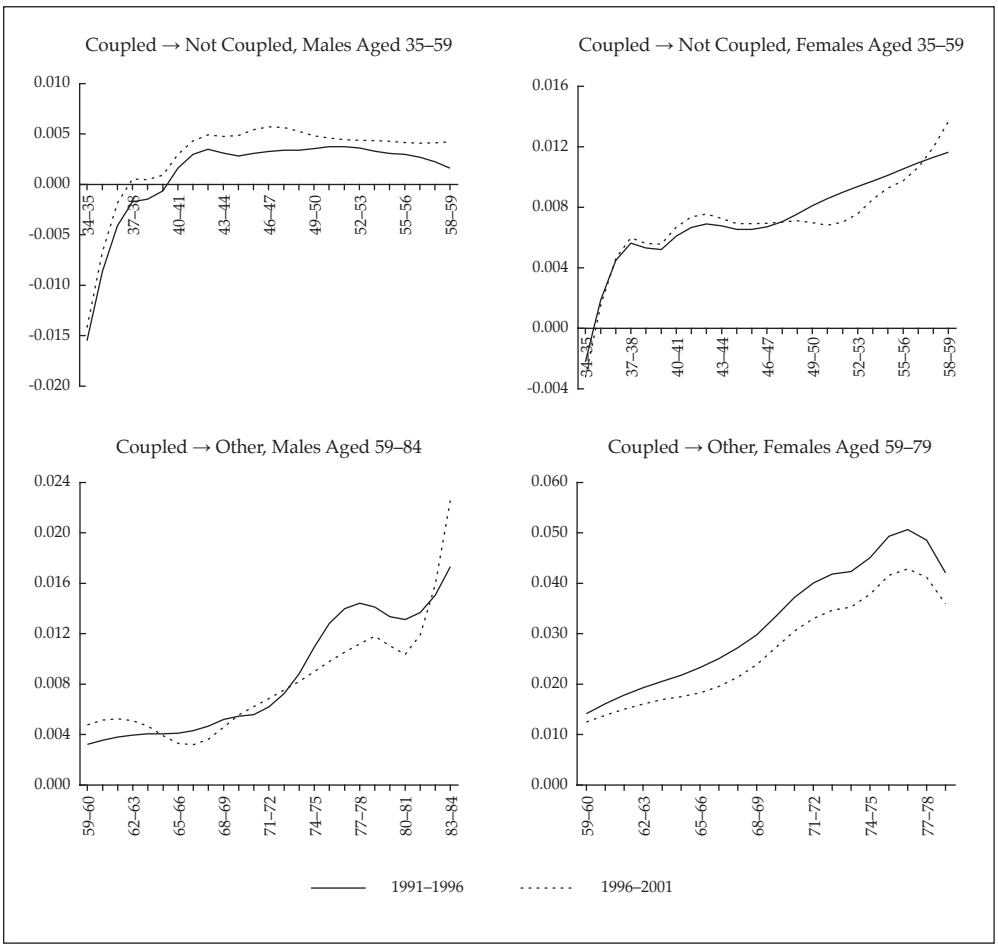
ties available from the census data for females aged 60–79. The proportion of elderly women who are coupled has decreased from year y to $y+1$, and the proportions who are residents of NPDs or not coupled and not residents of NPDs have increased. It is not possible to estimate if the 0.06 increase in 'Resident of NPD' is due to a 0.06 decrease in 'Coupled' or some other combination.

The solution is to consider only two net transitions, with the assumption that these will capture the movements of the excluded transition. In the example above, if we consider the transitions (1) Coupled → Non Private Dwelling, and (2) Coupled → Not coupled and not living in a non-private dwelling, the 0.06 increase in 'NPD' and the 0.02 increase in 'Not coupled and not living in a non-private dwelling' can both be tracked to the 0.08 decrease in 'Coupled'. The ability to match household transitions in this way is a key advantage of the net transition probabilities approach.

Table 4 Fictitious transitions for females aged 60–79

	Age x, year y	Age x+1, year y+1
Living arrangement	Proportion	
Coupled	0.50	0.42
Resident of NPD	0.02	0.08
Not coupled and not resident of NPD	0.48	0.50
Total	1.00	1.00

Figure 1 Living arrangement net transition probabilities, intercensal results

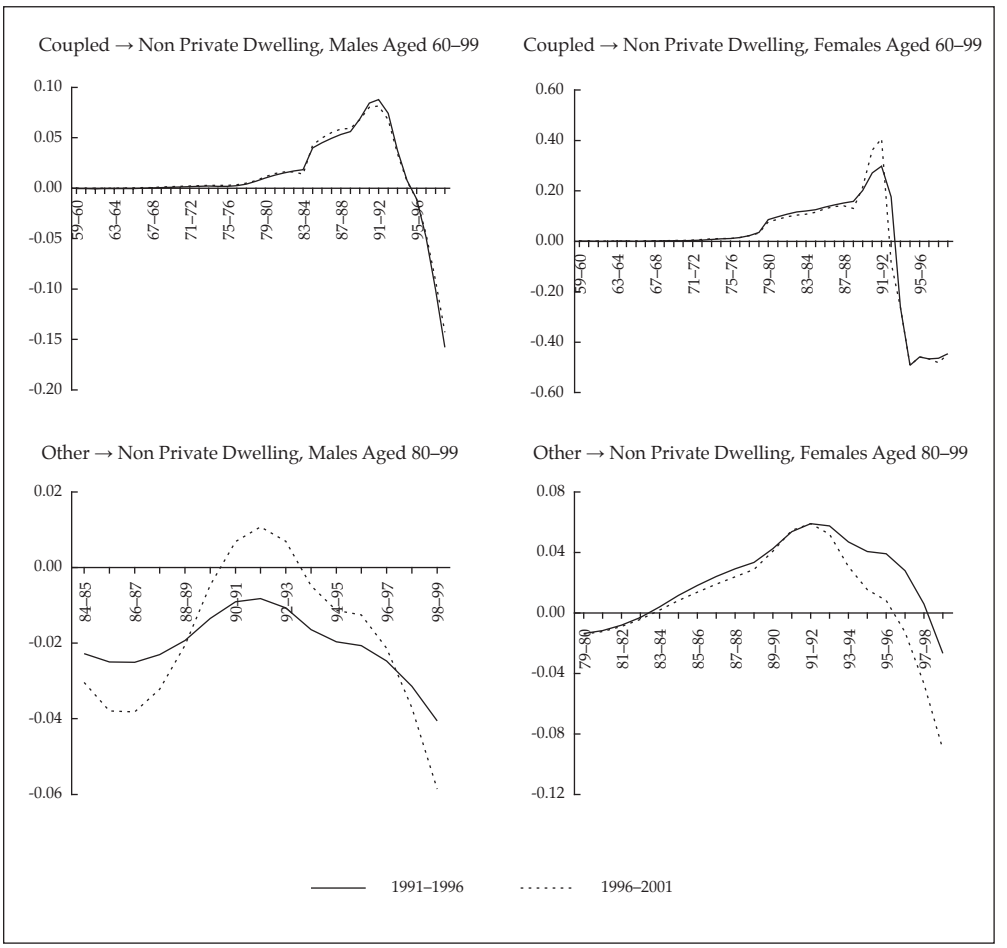


Results

Figure 1 displays the net transition probabilities calculated for the living arrangement transitions for age groups 55 and over. These transition probabilities were calculated from 10 years of data, from the 1991, 1996 and 2001 full-count census of population and housing. The two lines in each figure compare the transitions for each transition set calculated from (1) 1991 and 1996 census data (crossed line), and (2) the 1996 and 2001 censuses (dotted line). In examining these figures, it is important to recognize that the net transition probabilities incorporate the effects of differential mortality. Moreover, negative transition probabilities represent a net transition away from the *i*th living arrangement type.

As is evident from Figure 1, the age-specific patterns are highly consistent from one period to the next. The first transition set applicable for elderly living arrangements is from 'coupled' to 'not coupled', which applies to the age range 35–59. In the initial years, especially for males, the net balance is towards coupled (negative on the graphs), but then the balance moves to uncoupling. The net rate of uncoupling

Figure 1 ***(continued)***



at each age remains relatively unchanged across the age range, although there is a rise at the higher end of the age range for women, perhaps reflecting the onset of the mortality of their husbands. The constancy of the transitions implies little change in rates of coupling and uncoupling at these ages.

The next transition, 'coupled' to 'other', applies to ages 59–84 for men and 59–79 for women. 'Other' here means other than coupled or living in a non-private dwelling. The age patterns (tempo) are very similar across the two periods and, for males, the levels (quantum) are also similar. The levels for males are also much lower than those for females, reflecting the higher mortality of husbands than of wives in this age range. The fall across time for women is not insignificant, presumably reflecting the improvement in life expectation for their husbands across the 1990s. This result would also be produced if the age difference between husbands and wives fell across time.

Both the tempo and quantum remained constant across the two periods for the 'coupled' to 'non-private dwellings' probability also. This transition is considered

for ages 60–99 for both males and females. The transitions remain close to zero until people reach their late seventies. They then rise slowly during the eighties to a peak around age 91. Following this age, the net transitions fall away rapidly and become negative. This means that at these ages, people are leaving nursing homes (through mortality) more rapidly than others enter at the same age from couple relationships. This is the clearest manifestation of the differential effect of mortality on the net transition probabilities.

The final transition considered here is from 'other' to 'non-private dwellings' between ages 80 and 99. 'Other' here refers to other than a couple or a non-private dwelling. It is mainly the movement of people living alone into nursing homes, but it can also be affected by changes from age x to age x+1 in the numbers who live with relatives other than their partner. The age patterns for both sexes are once more similar across the two periods. For men in the 1991–96 period, the transitions were negative at all ages presumably because of the higher mortality of men in nursing homes compared to those who were living alone. For women, the transitions are positive across most of the age range and much higher than the transitions for men.

National-level results

With estimates and projections of the net transition probabilities, the cohort component method provides the base population projections to estimate the number of persons in each living arrangement by age, sex and region[1]. This section details the results of the living arrangement projections. In interpreting the following tables, it is important to recall that the figures and growth rates refer to individuals living in different living arrangement types, and not households. Before turning to the TSD-level pattern in living arrangements, I discuss the national-level variations and projections, calculated using the net transition probabilities detailed above.

As shown in Table 5, there is significant variation in the base living arrangement profiles across the three age groups for Australia. In the youngest age group (55–64), 'coupled without children' (52 per cent versus 49 per cent), 'coupled with children' (19 per cent versus 29 per cent) and living alone (16 per cent versus 12 per cent) are the most prevalent living arrangement types for females and males respectively. For the two older age groups, the proportion of persons living in a family with a child is significantly lower. In the oldest age group (75+), the most prevalent living arrangement type for females is living alone (42 per cent) and living in a couple-only household (23 per cent). Reflecting their poorer survival chances, males are more likely to be living in a couple-only relationship (53 per cent) or living alone (23 per cent). Indicative of women surviving longer into advanced old age, about 15 per cent of all females aged 75 and over are residents of non-private dwellings, whereas the comparative figure for males is just eight per cent.

By 2016, the model projects a very different proportional distribution of the elderly in Australia. Comparing 2016 and 2001 living arrangement profiles, women in the youngest age group are less likely to live in a couple household with children or be coupled without children. The strongest proportional shift is for females to be living alone: indeed an additional six per cent of the female population aged 55–64 is projected to be living alone in 2016. For the oldest age group, there is a projected decrease in the proportion of women living alone (by about five per cent), partly reflecting the increasing survival prospects of males. That is, as men survive beyond age 75, there is a greater capacity for the family unit to remain intact. For the young-

Table 5 National-level living arrangement results, Australia, 2001–2016

	Couple with children	Single parent	Couple without children	Lone	Other	Group household	Non-private dwelling
			Aged 55–64				
Females							
% Distribution 2001[a]	19.04	6.39	52.16	16.09	3.73	1.96	0.62
Change % 2016–2001[b]	–1.93	–2.25	–4.13	5.97	1.39	0.73	0.22
Ratio 2016/2001[c]	1.45	1.05	1.48	2.21	2.21	2.21	2.19
Change N 2016–2001[d]	77,338	2,615	228,601	176,143	40,869	21,500	6,680
Males							
% Distribution 2001	29.67	2.19	49.19	12.58	3.00	2.25	1.12
Change % 2016–2001	–4.57	1.10	–6.21	6.51	1.53	1.16	0.48
Ratio 2016/2001	1.28	2.27	1.32	2.29	2.28	2.29	2.16
Change N 2016–2001	76,466	25,785	145,756	150,731	35,552	26,906	11,958
			Aged 65–74				
Females							
% Distribution 2001	7.38	5.83	50.08	28.19	5.25	1.59	1.68
Change % 2016–2001	0.09	–0.50	–0.20	0.56	0.22	0.12	–0.30
Ratio 2016/2001	1.64	1.48	1.61	1.65	1.69	1.74	1.33
Change N 2016–2001	32,067	19,102	208,769	125,006	24,538	8,040	3,797
Males							
% Distribution 2001	14.28	1.41	65.76	12.86	2.19	1.60	1.90
Change % 2016–2001	–0.93	0.45	–4.29	3.71	0.73	0.57	–0.24
Ratio 2016/2001	1.56	2.21	1.56	2.16	2.23	2.27	1.47
Change N 2016–2001	51,487	10,858	237,088	95,004	17,213	12,992	5,645
			Aged 75+				
Females							
% Distribution 2001	2.33	6.87	23.78	42.91	7.68	1.13	15.31
Change % 2016–2001	0.27	2.25	1.45	–5.23	–0.47	–0.12	1.84
Ratio 2016/2001	1.51	1.79	1.43	1.18	1.27	1.21	1.51
Change N 2016–2001	7,978	36,791	69,482	53,720	13,916	1,572	53,057
Males							
% Distribution 2001	6.20	2.65	53.49	23.64	4.18	1.77	8.07
Change % 2016–2001	–0.22	0.52	–2.51	2.83	0.84	0.11	–1.56
Ratio 2016/2001	1.48	1.84	1.47	1.72	1.85	1.64	1.24
Change N 2016–2001	13,125	9,775	109,155	74,747	15,484	4,934	8,504

a Percentage distribution of living arrangements in 2001.

b Change in the percentage distribution of living arrangements between 2001 and 2016.

c Ratio of the number of people in 2016 to the number of people in 2001.

d Numerical increase in the number of people between 2001 and 2016.

Source: 2001 ABS Full Count Census.

est age group, a similar pattern is apparent for men, with a six per cent shift towards living alone in 2016, when compared with the 2001 underlying propensity. For the oldest age group, however there is less variation in the movement away from or toward certain living arrangement types. Inconsistently with the female results, males are actually less likely (by about two per cent) to be living in a couple-only relationship, and more likely to be living alone in 2016 when compared with 2001 (2.8 per cent). This may seem contradictory; however, as male survival increases, the number of divorced or never-married men increases in the older age group. That is, the combination of increased survival and the cohort effect of increased divorce rates leads to a greater proportional distribution of lone men[2].

A further insight is given into future living arrangement types by viewing the numerical growth ratios. Consistently with the increase in numerical ageing, all living arrangement types experience strong growth between 2001 and 2016. For females, the numbers aged 55–64 living alone, in group households or in non-private dwellings increase by over two times. For the oldest age group, there is also strong growth in the number of females partnered with or without children. It is interesting that the number of females living alone grows by only about 18 per cent over a 15-year period. In contrast, the number of males living alone in the oldest age group grows by about 72 per cent. The number of males in all living arrangement types outnumbers the growth for females in this age group. For the younger age groups, there is strong growth projected for living alone, in group or other households: more than doubling between 2001 and 2016.

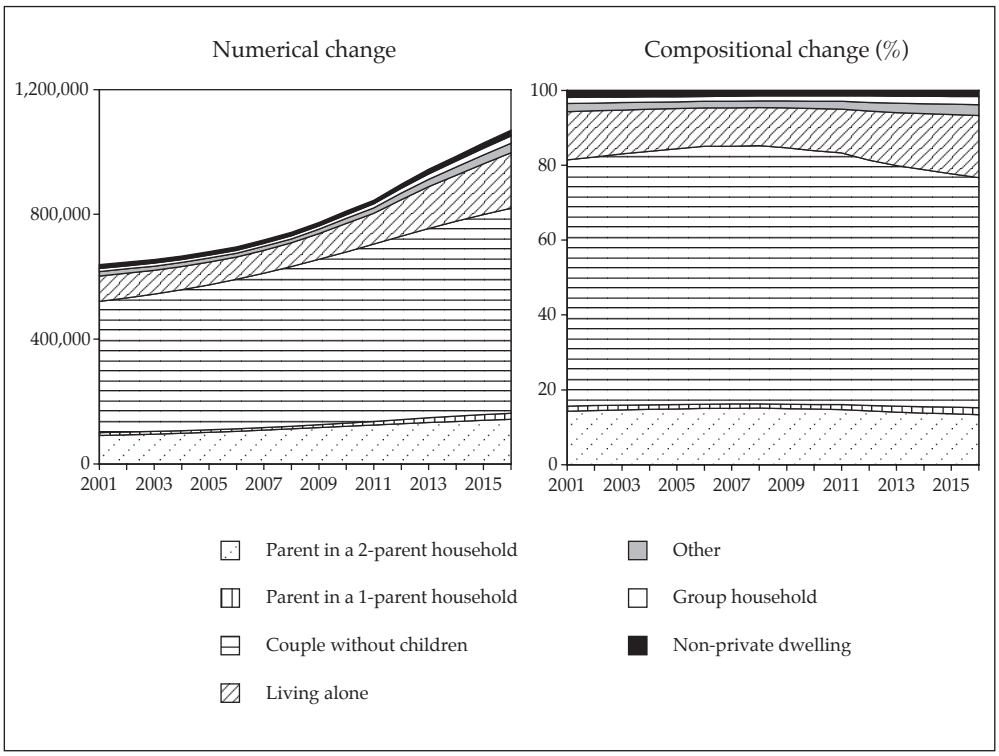
Across all three age groups, there is a larger number of females living in couple-only relationships being added to the population than of lone persons. For example, in the youngest age group, an additional 228,600 females living in couple-only relationships are projected, compared with an additional 176,143 females living alone. For males, the opposite is observed: the number of people living in couple-only relationships is greater than the number living alone across all living arrangement types.

In examining the above tables, it is important to recognize that the growth in each living arrangement type and for each age does not occur linearly. Figure 2 displays the projected number and distribution of the elderly in different living arrangement types for males aged 65–74. The population in this group grows somewhat linearly to 2009; from then on the speed of growth increases dramatically. From about 2010 onwards, the proportion of males living in couple-only households is shown to decrease, and the proportion living alone falls. These figures highlight the importance of the cohort differences of family formation earlier in the life course. Indeed, the projection period used in the model is relatively short: just 15 years. Beyond 2016, increasing proportions of divorcees will be surviving into older age.

Regional-level results

A key advantage of the net transition probability approach is the ability to produce projections at the subnational as well as at the national level. Tables 6 – 10 show the current and projected living arrangements at the state and TSD level. For brevity, two age ranges are shown for the regional projections, 65–74 and 75 years and over. Several measures are given to analyse the shifting living arrangements over time: (1) the 2001 proportional distribution (Table 6), (2) the change in the proportional distribution of living arrangements over the period 2001–2016 (Table 7), (3) the numerical growth in each living arrangement type between 2001 and 2016 (Table 8), and

Figure 2 Numerical and compositional change in male living arrangements, 2001–2016



(4) the numerical increase in each living arrangement type over this period (table not included, but available from author upon request).

The method used here accounts for heterogeneity in the underlying demography, regional differences in transition probabilities and the underlying HCT propensities. That is, the method accounts for differences in regional 'preferences' for different living arrangement types.

Table 6 reveals important differences in living arrangement preferences. For both males and females in the 65–74 age group, persons in Sydney are more likely to be partnered with children than those living in Coastal or Regional NSW. For example, in 2001 the proportion of the elderly who are partnered with children ranges from 15.2 per cent in Outer North Sydney to 22.8 per cent in Middle Sydney. For Coastal NSW, the proportion ranges from just over seven per cent in the Mid North Coast TSD to 11 per cent in Illawarra. In contrast, persons living in Coastal or Regional NSW are more likely than Sydney residents to be living in a couple-only household. This pattern occurs across both age groups for men, and the youngest age groups for women. Interestingly, there is less variation between the regions in the proportion of the population living alone. Summarizing at the state level shows that within Sydney a greater proportion of males are living in a couple relationship with children, and the NSW Balance population has a greater proportion of people living partnered with children or living alone. This pattern occurs across both male age groups, but the difference decreases with age. For females, a similar pattern is apparent also.

Table 6 Living arrangements, 2001 distribution (%)

	Couple with children		Single parent		Couple without children		Lone		Other		Group household		Non-private dwelling	
						Aged 65–74								
State Level	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Capital City – NSW	9.6	19.9	7.3	1.8	44.8	59.1	26.6	11.9	8.2	3.1	1.7	1.9	1.9	2.3
Balance – NSW	5.8	9.8	4.8	1.2	54.3	68.7	28.2	14.8	3.8	2.3	1.7	1.7	1.5	1.6
TSD Level														
Sydney														
Inner Sydney	8.9	18.1	7.5	1.9	37.8	47.3	33.6	20.6	6.8	3.2	2.4	3.4	2.9	5.4
Middle Sydney	11.2	22.8	7.3	2.2	44.6	55.9	24.9	11.6	8.4	3.7	1.6	1.8	1.8	2.1
Outer Nth Sydney	7.4	15.2	5.5	1.1	51.7	70.2	26.6	8.9	6.1	1.8	1.7	1.3	1.3	1.5
Outer Sth Sydney	9.9	21.4	8.8	1.9	43.4	61.2	24.4	9.3	10.4	3.3	1.5	1.5	1.6	1.4
Coastal														
Hunter	6.3	10.7	4.9	1.1	53.8	70.5	28.1	12.7	3.9	1.9	1.5	1.5	1.4	1.6
Richmond Tweed	5.1	8.5	3.7	1.1	56.6	70.2	27.9	14.9	3.3	1.9	2.2	2.2	1.2	1.1
Illawarra	6.3	11.1	5.2	1.2	54.9	68.8	26.5	13.7	4.4	2.3	1.5	1.6	1.2	1.3
Mid North Coast	4.7	7.1	3.7	0.9	58.3	70.9	26.7	15.8	3.2	2.2	1.9	2.0	1.4	1.1
Regional														
Northern	6.1	10.7	5.9	1.6	50.2	66.8	30.8	14.9	3.7	2.8	1.4	1.4	1.8	1.7
South Eastern	4.9	8.9	4.9	1.0	55.2	66.8	27.6	16.8	3.7	2.2	1.9	1.9	1.8	2.4
North Western	5.6	9.3	5.7	1.4	50.5	62.9	29.5	19.4	4.9	3.0	1.9	1.9	1.7	2.1
Murrumbidgee	6.4	12.3	5.4	1.4	51.1	66.1	30.2	14.8	3.8	2.4	1.2	0.9	1.8	1.9
Central West	6.8	11.2	5.2	1.4	50.8	65.5	29.9	15.7	3.7	2.9	1.5	1.3	2.2	2.1
Murray	5.4	8.7	4.1	1.1	55.3	69.3	29.3	15.1	2.8	2.1	1.9	1.9	1.2	1.8

Table 6 ***(continued)***

	Couple with children		Single parent		Couple without children		Lone		Other		Group household		Non-private dwelling	
						Aged 75+								
State Level	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Capital City – NSW	2.8	7.9	7.8	3.2	21.9	50.7	40.8	22.6	10.4	5.5	1.3	2.1	15.0	8.1
Balance – NSW	2.1	5.0	6.7	2.5	26.1	56.3	43.8	23.7	6.4	3.6	1.1	1.6	13.8	7.2
TSD Level														
Sydney														
Inner Sydney	2.3	6.9	7.9	3.4	17.6	41.4	46.6	30.2	8.2	4.6	1.9	3.6	15.4	9.9
Middle Sydney	3.1	8.6	8.2	3.5	22.3	50.6	40.0	21.9	9.9	5.6	1.3	1.8	15.2	7.9
Outer Nth Sydney	2.2	5.9	5.9	2.3	25.2	56.2	41.8	21.8	8.9	4.2	1.2	1.8	14.8	7.9
Outer Sth Sydney	3.3	9.6	9.3	3.5	21.1	52.2	36.2	18.9	14.4	7.1	1.1	1.6	14.6	7.1
Coastal														
Hunter	2.1	5.4	7.2	2.5	25.9	56.6	43.2	23.3	6.6	3.5	1.2	1.5	13.9	7.2
Richmond Tweed	1.9	4.3	5.9	2.1	29.0	56.0	42.5	25.1	5.5	3.5	1.6	2.3	13.4	6.7
Illawarra	2.4	5.5	6.6	2.5	27.7	58.6	41.9	22.2	7.8	3.5	1.1	1.5	12.5	6.3
Mid North Coast	1.7	3.8	5.7	2.1	29.6	58.1	42.6	23.9	5.7	3.6	1.2	1.9	13.4	6.5
Regional														
Northern	1.9	5.5	7.8	2.9	21.6	52.9	46.4	25.2	6.4	3.5	0.8	1.3	15.2	8.6
South Eastern	2.1	4.5	6.7	2.6	25.5	55.4	43.2	24.2	6.5	3.5	0.9	1.6	15.1	8.2
North Western	2.2	6.1	8.6	3.1	21.2	50.9	43.7	25.2	7.0	5.1	1.2	1.6	16.2	8.1
Murrumbidgee	2.3	5.7	7.0	2.6	21.2	53.7	46.8	24.2	5.7	3.8	1.2	1.3	15.9	8.8
Central West	1.6	5.3	7.4	3.0	21.7	52.9	44.8	24.4	6.0	3.7	0.9	1.2	17.4	9.4
Murray	1.8	5.5	5.6	2.4	24.9	54.1	46.6	25.3	5.5	3.7	1.3	1.4	14.3	7.7

Table 7 Living arrangements, change in percentage distribution, 2001–2016

	Couple with children		Single parent		Couple without children		Lone		Other		Group household		Non-private dwelling	
						Aged 65–74								
State Level	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Capital City – NSW	0.3	–1.3	–0.3	0.6	0.6	–4.2	–0.4	3.5	0.1	1.0	0.1	0.7	–0.3	–0.3
Balance – NSW	–0.1	–1.0	–0.9	0.5	–1.0	–6.7	1.7	5.6	0.3	1.0	0.2	0.7	–0.2	–0.3
TSD Level														
Sydney														
Inner Sydney	0.2	–0.0	–1.1	0.1	0.2	–0.2	0.7	0.7	0.2	0.2	0.1	0.2	–0.4	–1.0
Middle Sydney	0.3	–1.5	0.8	0.7	0.4	–4.2	–1.3	3.3	0.0	1.3	0.1	0.7	–0.3	–0.3
Outer Nth Sydney	0.2	–1.4	–0.2	0.8	0.2	–6.4	0.1	5.1	0.1	1.1	0.1	0.8	–0.4	0.1
Outer Sth Sydney	0.3	–2.3	–0.4	1.1	0.5	–6.5	–0.4	5.1	0.0	1.8	0.1	0.9	–0.2	–0.1
Coastal														
Hunter	–0.1	–1.2	–0.6	0.7	–1.2	–8.3	1.6	6.9	0.4	1.2	0.2	0.9	–0.3	–0.3
Richmond Tweed	–0.3	–1.7	–0.9	0.83	–4.1	–13.7	4.5	10.9	0.6	1.8	0.5	1.8	–0.3	0.1
Illawarra	–0.1	–1.2	–0.7	0.5	–1.6	–7.5	2.1	6.0	0.4	1.2	0.2	0.9	–0.2	0.0
Mid North Coast	–0.3	–0.8	–1.1	0.4	–3.8	–8.4	4.2	6.9	0.6	1.2	0.4	1.2	0.09	–0.3
Regional														
Northern	0.3	–0.7	–1.2	0.4	2.7	–3.6	–1.2	3.4	–0.1	0.9	–0.0	0.3	–0.5	–0.6
South Eastern	0.0	–0.9	–1.4	0.4	–0.7	–6.6	2.1	6.3	0.4	0.9	0.2	0.7	–0.5	–0.9
North Western	0.0	0.0	–0.7	–0.0	0.0	0.5	0.5	–1.0	0.1	0.1	0.1	0.1	–0.1	0.3
Murrumbidgee	0.3	–0.6	–0.6	0.5	1.9	–3.4	–1.7	2.6	–0.2	0.8	–0.1	0.5	0.5	–0.3
Central West	–0.3	–1.4	–0.7	0.6	–2.1	–7.6	2.6	6.7	0.4	1.3	0.2	0.6	–0.0	–0.2
Murray	0.5	0.3	–1.3	–0.2	5.8	2.8	–4.8	–1.3	–0.5	–0.3	–0.3	–0.4	0.5	–1.1

Table 7 ***(continued)***

	Couple with children		Single parent		Couple without children		Lone		Other		Group household		Non-private dwelling	
						Aged 75+								
State Level	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Capital City – NSW	0.8	–0.6	1.9	1.0	1.7	–6.1	–4.2	6.2	–0.6	1.8	–0.1	0.4	0.6	–2.6
Balance – NSW	0.1	–0.6	1.6	0.9	1.0	–6.0	–5.4	5.3	–0.4	1.2	–0.2	0.2	3.0	–0.9
TSD Level														
Sydney														
Inner Sydney	0.7	–0.3	0.7	0.7	3.4	–2.6	–4.1	4.2	–0.5	0.8	–0.1	0.5	–0.2	–3.2
Middle Sydney	0.9	–1.1	3.5	1.4	1.2	–8.1	–6.8	7.4	–1.2	2.1	–0.2	0.3	2.7	–2.0
Outer Nth Sydney	0.4	–0.5	1.3	0.8	1.0	–7.4	–2.9	7.5	–0.1	1.7	–0.1	0.4	0.3	–2.5
Outer Sth Sydney	0.7	–1.0	1.5	1.2	0.5	–6.8	–3.1	5.3	–0.5	2.9	–0.1	0.4	0.8	–2.1
Coastal														
Hunter	0.6	0.2	2.9	0.4	1.9	–0.7	–5.8	0.6	–0.6	0.5	–0.2	–0.1	1.1	–0.8
Richmond Tweed	0.3	–0.7	5.5	1.5	1.2	–10.4	–6.3	8.7	–0.7	2.0	–0.2	0.5	0.2	–1.6
Illawarra	0.7	–0.8	2.2	1.4	1.7	–9.9	–4.7	9.1	–0.4	1.6	–0.2	0.4	0.7	–1.6
Mid North Coast	0.4	–0.2	2.2	0.8	0.5	–3.9	–4.9	3.1	–0.3	0.7	–0.2	0.0	2.2	–0.5
Regional														
Northern	0.4	0.1	1.1	0.0	3.5	0.9	–4.5	0.1	–0.6	–0.1	–0.1	0.0	0.3	–1.1
South Eastern	0.5	–0.2	1.6	0.7	3.1	–5.1	–4.8	3.3	–0.4	1.1	–0.1	0.1	0.1	0.1
North Western	0.1	–0.6	1.2	0.3	2.9	–4.2	–4.2	4.0	–0.5	1.5	–0.1	0.4	0.5	–1.4
Murrumbidgee	0.3	–0.6	2.0	0.9	3.5	–5.8	–7.2	6.6	–0.6	0.8	–0.2	0.1	2.0	–2.0
Central West	0.4	–0.6	0.7	1.1	4.8	–6.0	–6.1	7.6	–0.6	1.4	–0.1	0.2	1.0	–3.6
Murray	0.4	–0.1	–0.6	1.2	4.1	–1.6	–2.8	1.0	0.2	0.8	–0.2	0.0	–1.1	–1.3

By 2016, the underlying proportional distribution of living arrangements is projected to change significantly. On average, there is a stronger movement away from living in a couple-without-children household in Coastal and Regional NSW than in Sydney. The effect is particularly strong in Coastal NSW. For example, for males aged 65–74 living in Sydney (Table 7) the proportional move away from living in a couple-only household ranges from less than one per cent (Inner Sydney) to about 6.5 per cent in Outer South Sydney. In Coastal NSW, the proportional shift in this living arrangement type ranges from –7.5 per cent in Illawarra to –13.7 per cent in Richmond Tweed TSD.

For the other major living arrangement type, living alone, there is a strong transition toward living in this HCT (males in all three age groups, and females in the first two age groups) in Coastal NSW. For example, the proportion living alone is projected to grow by between 6.9 and 10.9 per cent for 65–74-year-old males in Coastal NSW. For Regional NSW, this figure ranges between –1.0 and 6.7 per cent, and for Sydney only, between 0.7 and 5.1 per cent. At the state level, by 2016 there is a shift of 4.2 per cent of males aged 65–74 away from being partnered without children in Sydney (i.e. –4.2 per cent), whereas for NSW Balance it is about seven per cent.

Table 8 provides further evidence for the regional differences in future living arrangement types. The regional differences in the growth rate can be seen as a function of (1) regional differences in numerical ageing, (2) regional differences in the 2001 distribution of living arrangement types and (3) regional differences in the transition probabilities for different living arrangement types. Relying upon the changing distribution of the living arrangements alone does not give an accurate description of the growth of different living-arrangement types.

Coastal NSW is projected to experience strong growth in the number of males and females living alone over the period 2001–2016. The strongest growth occurs for males in Richmond Tweed where the number of males aged 55–64 living alone is projected to increase by three and a half times. Although on average the growth in the numbers living alone is slightly higher in Regional NSW than in Sydney, both Outer South and Outer North Sydney experience strong growth: indeed the number of lone males aged 65–74 is projected to grow by between 2.8 and 3.1 times over the period 2001–2016. From the state-level results it is apparent that the growth in the number of lone persons is higher in NSW Balance than in Sydney.

Mirroring the national-level results discussed earlier, strong growth is also projected for the elderly living in couple-only households, but less so than for living alone. For males, the growth in this living arrangement type is slightly higher in Sydney than NSW Balance for the younger age group. However, for the oldest age group (75+) the number of males in a couple-only relationship is projected to grow by 54 per cent over the period 2001–2016, compared with a 41 per cent projected growth in Sydney. For females, the same pattern is apparent. For the oldest age group (75+), the numbers living in a couple-only relationship are projected to increase by 58 per cent in NSW Balance, compared with 38 per cent in Sydney between 2001 and 2016.

Across both age groups for females and the youngest age groups for males, the growth in the number of the elderly living in a couple relationship with children is greater in Sydney than in NSW Balance. This result seems counter-intuitive as first, fertility in NSW Balance is higher than in Sydney, and secondly, the numerical growth in age groups alone is stronger in the NSW Balance population. The explanation lies in the ASFR profiles for these regions. Women in Sydney, particularly in Inner

and Middle Sydney, were shown to be delaying childbirth until later in life (Temple 2006). Thus they are more likely to have a child living with them, particularly in the younger age groups. A second explanation refers to a migration effect. As many younger people leave Regional and Coastal NSW to obtain education and further their careers, they are forced to relocate away from the family home to Sydney and other major metropolitan centres. For those children born in Sydney, the necessity to leave the family home to obtain education or to further one's career is less important. This is apparent in the underlying propensities discussed earlier, which showed a greater proportion of the Sydney elderly living in family relationships with a child when compared to either Coastal or Regional NSW populations.

Finally, the numerical change in the number of elderly persons in each living-arrangement type between 2001 and 2016 is an important component of change. For several living-arrangement types including couples with children, single parents and couples and other households, the numerical increase in Sydney is far greater than in NSW Balance for males. For couples without children, group households and non-private dwellings, the difference between Sydney and NSW Balance is quite small. For example, an additional 606 females aged 65–74 are projected to be living in non-private dwellings in Sydney compared with 552 females in NSW Balance.

Although the numerical growth in the aged was higher in coastal and Regional NSW than in Sydney, the absolute numerical increase was greatest in Sydney. The advantage of projections of the composition of the elderly is that they decompose numerical increase by living arrangement type. Of striking importance is the fact that both the numerical growth ratios and the absolute numerical increase in the numbers living alone are projected to be higher in NSW Balance than in Sydney. For example, for males aged 65–74 and all elderly female age groups, the absolute numerical increase in the number living alone is greatest in NSW Balance. For females 75+, the number living alone in NSW Balance is projected to increase by over 13,000 compared with about 8,500 in Sydney. Similarly, for the oldest age group (75+) the additional number of males and females living in non-private dwellings is greater in NSW Balance than in Sydney. The number of males aged 75+ living in a non-private dwelling in NSW Balance is projected to grow by 2424, compared with an increase of 567 in Sydney. The comparative figures for females are 7,083 and 11,120 for Sydney and NSW Balance respectively.

Discussion

This paper has applied a new method of household projections to examine the future living arrangements of older persons at the national and subnational level in Australia. Several important insights have been offered, both methodological and substantive. From a methodological perspective, this newly developed method of projecting living arrangements has a number of advantages. First, this model has captured regional-level heterogeneity in the compositional aspects of populations through using region-specific estimates and projections of fertility, mortality, migration and living arrangement transitions. Second, providing strong support for this model, the net transition probabilities estimated from the 1991, 1996 and 2001 Australian Censuses of Population and Housing are highly comparable. Moreover, re-estimating the model using historical data shows the projections produced from the model to be highly reliable (McDonald and Temple 2003b). Additional comparisons

Table 8 Living arrangements, growth ratio, 2001–2016

	Couple with children		Single parent		Couple without children		Lone		Other		Group household		Non-private dwelling	
						Aged 65–74								
State Level	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Capital City – NSW	1.57	1.52	1.46	2.16	1.54	1.52	1.49	2.12	1.53	2.17	1.58	2.20	1.24	1.43
Balance – NSW	1.55	1.50	1.28	2.34	1.53	1.50	1.66	2.30	1.68	2.41	1.73	2.40	1.36	1.39
TSD Level														
Sydney														
Inner Sydney	1.46	1.42	1.21	1.46	1.43	1.41	1.45	1.47	1.47	1.52	1.51	1.50	1.24	1.15
Middle Sydney	1.25	1.26	1.34	1.79	1.22	1.25	1.15	1.73	1.22	1.81	1.26	1.83	1.00	1.18
Outer Nth Sydney	1.77	1.66	1.66	3.12	1.74	1.66	1.74	2.88	1.75	2.92	1.80	3.03	1.18	1.89
Outer Sth Sydney	1.85	1.75	1.72	3.04	1.81	1.75	1.76	3.05	1.79	3.03	1.88	3.12	1.56	1.86
Coastal														
Hunter	1.58	1.54	1.41	2.81	1.56	1.54	1.68	2.70	1.74	2.83	1.79	2.80	1.23	1.46
Richmond Tweed	1.61	1.62	1.31	3.51	1.58	1.62	1.98	3.48	2.02	3.81	2.13	3.60	1.27	2.10
Illawarra	1.51	1.50	1.31	2.45	1.49	1.50	1.66	2.42	1.66	2.52	1.74	2.64	1.28	1.70
Mid North Coast	1.58	1.55	1.17	2.51	1.56	1.55	1.93	2.52	1.96	2.71	1.99	2.77	1.78	1.25
Regional														
Northern	1.55	1.35	1.19	1.76	1.56	1.37	1.42	1.77	1.46	1.89	1.45	1.72	1.07	0.92
South Eastern	1.78	1.70	1.26	2.72	1.76	1.70	1.91	2.60	1.95	2.69	1.94	2.56	1.27	1.22
North Western	1.37	1.32	1.21	1.30	1.36	1.32	1.38	1.25	1.40	1.37	1.46	1.35	1.31	1.49
Murrumbidgee	1.39	1.34	1.18	1.90	1.38	1.34	1.26	1.67	1.28	1.87	1.23	2.13	1.68	1.23
Central West	1.43	1.37	1.29	2.30	1.43	1.38	1.62	2.23	1.65	2.24	1.67	2.24	1.49	1.38
Murray	1.56	1.55	0.96	1.27	1.57	1.55	1.19	1.36	1.18	1.30	1.22	1.22	2.05	0.62

Table 8 ***(continued)***

	Couple with children		Single parent		Couple without children		Lone		Other		Group household		Non-private dwelling	
						Aged 75+								
State Level	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Capital City – NSW	1.66	1.48	1.59	2.12	1.38	1.41	1.15	2.04	1.20	2.13	1.15	1.89	1.33	1.08
Balance – NSW	1.58	1.53	1.86	2.34	1.58	1.54	1.32	2.10	1.41	2.28	1.28	1.88	1.83	1.51
TSD Level														
Sydney														
Inner Sydney	1.43	1.35	1.19	1.70	1.30	1.32	1.00	1.61	1.03	1.66	1.02	1.60	1.08	0.95
Middle Sydney	1.42	1.22	1.58	1.98	1.16	1.18	0.91	1.87	0.97	1.93	0.89	1.66	1.30	1.05
Outer Nth Sydney	1.66	1.59	1.68	2.33	1.44	1.51	1.29	2.34	1.37	2.46	1.27	2.11	1.41	1.19
Outer Sth Sydney	2.01	1.75	1.92	2.62	1.68	1.69	1.50	2.49	1.59	2.75	1.52	2.38	1.74	1.38
Coastal														
Hunter	1.76	1.53	1.90	1.72	1.45	1.47	1.17	1.53	1.24	1.67	1.13	1.35	1.45	1.31
Richmond Tweed	1.38	1.40	2.35	2.81	1.27	1.36	1.04	2.24	1.08	2.60	1.06	2.02	1.24	1.27
Illawarra	1.96	1.60	2.04	2.91	1.61	1.56	1.35	2.65	1.45	2.71	1.28	2.33	1.60	1.40
Mid North Coast	1.90	1.58	2.13	2.27	1.56	1.55	1.36	1.87	1.46	1.97	1.34	1.67	1.79	1.52
Regional														
Northern	1.71	1.58	1.61	1.57	1.64	1.58	1.28	1.56	1.28	1.52	1.24	1.56	1.44	1.36
South Eastern	1.99	1.83	1.96	2.38	1.78	1.73	1.41	2.16	1.48	2.50	1.35	2.05	1.59	1.94
North Western	1.43	1.40	1.53	1.70	1.52	1.44	1.21	1.81	1.25	2.03	1.25	1.99	1.38	1.29
Murrumbidgee	1.54	1.47	1.73	2.19	1.56	1.46	1.13	2.09	1.20	2.00	1.16	1.79	1.51	1.27
Central West	1.73	1.58	1.53	2.41	1.71	1.58	1.21	2.33	1.26	2.44	1.23	2.00	1.48	1.10
Murray	1.70	1.60	1.26	2.46	1.65	1.58	1.33	1.69	1.47	1.99	1.18	1.67	1.31	1.35

show that in the majority of cases, the tempo of the age-specific transition probabilities is highly consistent, although the quantum, as one would expect, differs considerably across the regions. Finally, by building upon the usual headship or propensity-type models, the net transition approach specifically tracks cohort differences in living arrangement transitions.

These methodological advances having been noted, the usual caveat with demographic projections applies: results present a possible future based upon a restricted set of assumptions. There are exogenous policy shocks that may affect the utility of belonging to different living arrangements in the later life course. For example, American studies have shown that increases in income and social security payments as well as reforms to nursing-home subsidies have given rise to a higher demand for independent living (Hoerger *et al.* 1996; Costa 1997; McGarry and Schoeni 2000). Engelhardt *et al.* (2002) estimate that a 10 per cent cut in social security in America would create a movement of 600,000 lone persons into shared living arrangements.

Changes in Australian social and economic policy could also hasten the transition probabilities toward living independently. But as shown in the above analysis, the proportion living in non-private dwellings is relatively small in Australia, until advanced old age. This is consistent with the Australian government's policy of ageing in place, promoting independent living through community care services (Bishop 1999). Although community care partly offsets government-funded residential services, many carers and their employers bear a heavy financial and social cost in forgone time spent in the labour market, leisure and other activities (Rubin 2002). Transition probabilities for independent living may be affected by the availability of carers and public support for them. Another factor that may affect the transition probabilities, particularly in the earlier life cycle, is housing prices (McDonald and Temple 2004). However, in old age there is little evidence to suggest that living arrangement decisions are made on the basis of house prices, with the major determinants being demographic (Börsch-Supan 1989).

Through applying this new method of projecting living arrangements, this paper has offered a number of important substantive findings. Most significant among them is the relatively high speed of growth in the number of elderly males and females living alone. At the national level, for the 55–64 and 65–74 group there is a transition toward living alone, relative to living in a couple-only relationship. For the oldest age group (75+), the propensity to live alone increases for males, but decreases for females, indicative of the improving survival prospects of males. The strong growth in the number of the elderly living alone is important given that previous studies find a strong association of the presence of a spouse or partner in the household with health and financial well-being. For example, studies have suggested that belonging to a married couple reduces risky behaviour and encourages a healthy lifestyle, resulting in a lower risk of mortality (Umberson 1987; Lillard and Waite 1995; Rogers 1996). For women, the role of higher financial resources in marriage is particularly important in enhancing survival prospects (Lillard and Waite 1995). For men, having a spouse increases the probability of health care utilization and has important implications for well-being in retirement (Umberson 1987). Indeed, previous studies consistently show that women are more likely to use health care services than men when their health deteriorates (Aday and Eichhorn 1972; Sindelar 1982; Haas *et al.* 1994).

In addition to implications for health, living without a partner may result in reduced social and economic resources (Waite 1995). When asked about their finan-

cial well-being, older lone persons, whether male or female, are likely to have more negative perceptions of this than couples of the same age (Qu and Weston 2003). Older persons living alone in Australia have also been found to be at a greater risk of food insecurity, to have greater difficulty in access to private health insurance, and to be at a greater risk of experiencing housing problems (Temple 2003, 2005, 2006b). The economies of scale generated from living together are undoubtedly a strong reason for the better financial well-being of those living with a partner in later life (Casey and Yamada 2002).

A further issue in the growth of the number of elderly persons living alone is the proportion of those who have been previously divorced. This is important, as research shows that even within specific living-arrangement types, the financial and health outcomes of living alone differ by whether one is divorced, never married or widowed, and different effects predominate for males and females (Choi 1995; Arber 2004). In particular, divorce has been shown to significantly reduce intergenerational exchanges and the role of the family in providing social support (Pezzin and Schone 1999).

An additional finding from this paper is the heterogeneity in regional living arrangements. An understanding of spatial differences in the populations of the elderly is becoming more important as the speed and tempo of ageing in Australia has strong regional dimensions (Jackson and Felmingham 2002; Temple 2006a). This necessarily implies that the need for resources to meet the demands of ageing populations will differ in its timing and its geographical location. In Australia, local governments are now providing a number of human services that had previously been provided by state and federal governments. For example, in 2002–03, local governments in Australia allocated 11 per cent of their annual budget to education, health, welfare and public safety, and 24 per cent was spent on housing and community amenities (Productivity Commission 2005). A further 27 per cent of local government expenditure was allocated to transport and communication. Importantly, many of these services have an age, sex and living arrangement-specific component; specifically health and aged care, home support services and housing amenities. In this context, the relatively strong growth of lone-person households, particularly in coastal and regional NSW, has implications for funding of these government services.

These projections also have implications for the costing of public pensions and other government transfer payments. Currently, the maximum age pension available to a lone person is $499.70 per fortnight. Each member in a couple household is eligible for a maximum payment of $417.20. Taken together a couple household is paid 83.5 per cent of the total amount of two persons living alone. Of course, many other public transfers are contingent upon household composition such as rent assistance, the seniors' concession allowance, utilities allowance and access to government concession cards. Taking into account the faster growth in the number of lone persons relative to couple households, government expenditure on pensions and other transfers may be different from what it would have been if propensities for differing living arrangements had remained static. This once more highlights the advantage of the net transition probability model over the static propensity type projection models.

The goal of this paper has been to apply a newly developed method of projecting living arrangements and households to examine the medium-term profile of living arrangements among the elderly in Australia, at both the national and subnational level. The strength of this model has been the ability to track the regional-level heter-

ogeneity in the compositional aspects of populations by capturing subnational levels of fertility, mortality, migration and household movements. Providing strong support for this model, the net transition probabilities estimated from the 1991, 1996 and 2001 Australian Censuses of Population and Housing are highly comparable. Where available, this methodology can be applied in other countries where quinquennial census data are available, to understand shifts in the composition of living arrangements as the rate of population ageing increases.

Results from this study show a significantly faster growth in the number of older persons living alone, particularly males. This is important as the family provides the most significant form of support; in old age and during periods of disability or long-term health conditions, the care provided by spouses is very important (Wolcott 1997). Studies generally confirm that the availability of support and caregiving in old age is more heavily dependent upon having someone in the household, than on marital status (Chappell 1991). Moreover, results from this study reinforce the importance of capturing the geographic heterogeneity in the composition of ageing populations at the subnational level. Understanding the composition of ageing populations at the regional level is particularly important in Australia where local governments are now funding a number of human services whose use is closely associated with demographic factors such as age, sex and living arrangements.

The net transition model may be applied to answer many questions related to household and living arrangement transitions, dwelling demand, family formation and other matters. Applications of an earlier model include projections of Australia's unmet demand for future dwellings (McDonald 2001), projections of spatial heterogeneity in demand for housing (McDonald and Temple 2003a) and simulations of the influence of international migration on urban housing markets (McDonald and Temple 2003b). An important additional question for continuing research is how population ageing, in combination with cohort preferences for different living arrangements in retirement, shape the future of residential construction demand at the regional level. Moreover, future research may examine the implications of continued population ageing, beyond 2016, on the regional growth of living arrangements. As shown by McDonald and Kippen (1998), the speed of population ageing is projected to increase substantially after 2020.

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Notes

1 Once more, the reader is directed to McDonald *et al.*'s (2006) paper for a detailed discussion of the projection method.
2 The projection does take account of the likely lower survival prospects of lone males versus coupled males as the net transition probabilities incorporate the effects of differential mortality.

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