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Two Worlds of Ageing: Spatial Microsimulation Estimates of Small Area Advantage and Disadvantage Among Older Australians

Corresponding author:
Justine McNamara
NATSEM
University of Canberra ACT 2601 Australia
justinem@natsem.canberra.edu.au
Phone: +61 (0)2 6201 2776
Fax: +61 (0)2 6201 2751

JUSTINE MCNAMARA, CATHY GONG, RIYANA MIRANTI, YOGI VIDYATTAMA, ROBERT TANTON, ANN HARDING AND HAL KENDIG

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NATSEM aims to be a key contributor to social and economic policy debate and analysis by developing models of the highest quality, undertaking independent and impartial research, and supplying valued consultancy services.

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It must be emphasised that NATSEM does not have views on policy. All opinions are the authors' own and are not necessarily shared by NATSEM.

Director: Ann Harding

National Centre for Social and Economic Modelling
University of Canberra ACT 2601 Australia
170 Haydon Drive Bruce ACT 2617

Phone + 61 2 6201 2780
Fax + 61 2 6201 2751
Email natsem@natsem.canberra.edu.au
Website www.natsem.canberra.edu.au

AUTHOR NOTE

Justine McNamara, Cathy Gong, Riyana Miranti, Yogi Vidyattama and Robert Tanton are all researchers at the National Centre for Social and Economic Modelling (NATSEM) at the University of Canberra. Ann Harding is Director of NATSEM and Professor of Applied Economics and Social Policy at the University of Canberra. Hal Kendig is Research Professor of Ageing and Health in the Faculty of Health Sciences at the University of Sydney and National Convenor of the ARC/NHMRC Research Network in Ageing Well.

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GENERAL CAVEAT

NATSEM research findings are generally based on estimated characteristics of the population. Such estimates are usually derived from the application of microsimulation modelling techniques to microdata based on sample surveys.

These estimates may be different from the actual characteristics of the population because of sampling and nonsampling errors in the microdata and because of the assumptions underlying the modelling techniques.

The microdata do not contain any information that enables identification of the individuals or families to which they refer.

ABSTRACT

Older Australians are a diverse population group, with many pre-retirement differences in well-being being maintained into older adulthood. Recent Australian research supports the notion of wide gulfs in economic well-being in later life, with evidence of very large differences among older Australians in the distribution of income, wealth and home ownership. In this paper, we explore these differences in advantage and disadvantage at a small area level. While there has been considerable interest in Australia in recent years in the spatial distribution of disadvantage, this work has not tended to focus on older adults. We have used spatial microsimulation techniques to estimate the small area distribution of deep economic disadvantage among Australians aged 65 and older, combining data on disposable income, main source of income and tenure in the private rental market. Using the same techniques, we have also created small area estimates of relative economic advantage among older Australians. Our synthetic estimates are created by combining data from the Australian Bureau of Statistics Surveys of Income and Housing and the Australian Census of Population and Housing, and we describe the production and validation of this synthetic data. The preliminary results presented in this paper provide some evidence of geographic concentrations of advantage and disadvantage for older people, and we discuss further work that is currently being undertaken to refine our methodology and further analyse these results.

INTRODUCTION

Disparities in economic well-being among older people develop out of those which are present across the lifespan. Complex combinations of life chances, education, labour force participation, health and a myriad of other factors determine income and wealth during the working years, which in turn influence these factors in later life (O'Rand 2006). Indeed, theories of 'cumulative advantage/disadvantage' suggest that inequalities present across the lifecourse may actually magnify in old age, resulting in an increasing gulf between the well-off and the financially disadvantaged (Crystal and Shea 1990; Dannefer 2003; Scharf *et al*. 2005; O'Rand 2006; Naughtin 2008). Recent Australian research supports the notion of wide gulfs in economic well-being in later life, with evidence of very large differences among older Australians in the distribution of income, wealth and home ownership (Kelly 2009; Kelly and Harding 2007). There have also been expectations of a growing gap between the living standards of older Australians in future decades, as the accelerating accumulation of superannuation by a sub-set of baby boomers results in growing wealth inequality within older generations (King *et al.* 2001).

In an international context, broad measures of economic well-being suggest differences in incomes between older and younger Australians may be more marked than in many other affluent nations. Among 23 OECD countries in 2000, Australia ranked the lowest in terms of ratio of equivalised disposable income of people aged 65 and over to that of people aged 18 to 64 (OECD 2005), with equivalised disposable income of people aged 65 and over being only 59.3 per cent of that for people aged 18 to 64. In contrast, countries including Switzerland, the United States, Japan, Austria, Canada, France, Poland, and Mexico had ratios of more than 80 per cent (OECD 2005). These differences may be due in part to a less generous social security system for older people in Australia than in many other OECD countries, demonstrated by relatively low spending on old age pensions in Australia, which in 2003 represented only 3.2 per cent of GDP (Saunders and Abe 2009). This compares with spending of more than 10 per cent of GDP on age pensions in countries such as Austria, Germany, France, Poland and Greece. While these international comparisons do not provide data about differences between particular groups of older adults, they do suggest the importance of developing further knowledge about the economic well-being of older Australians.

Geographic differences in economic and social well-being represent a dimension of inequality which has become an increasing focus of research and policy development in Australia in recent years. There is wide acknowledgement that small areas across Australia differ enormously on a range of socioeconomic indicators, with numerous studies focusing on aspects of these differences (see, for example, ABS 2008; Biddle *et al.* 2002; Bray 2003; Gregory and Hunter, 2001; Harding *et al.* 2004; Hunter 1995; Hunter 2003; Lloyd *et al.* 2000; Vinson 2001, 2004, 2007) .

However, very little Australian analysis of geographic differences in economic well-being has focused on older people, despite the importance of a geographical or regional viewpoint in relation to ageing. Small area characteristics can influence how older persons are perceived and treated in their communities - and a region's economic and social

development also has impacts on the economic well-being of older persons and can determine the quality and level of care and services that they have access to. There has been some analysis of differential access to health services for older people at a small area level (see, for example, Adams *et al*. 2004; Ringland *et al*. 2004; Vecchio 2008, in relation to dental services), and some attention to the position of older adults in rural and remote communities (see AIHW 2007; Gibson and Liu 2002) but, overall, very little work exists which analyses the spatial dimensions of differences in the ageing experience.

In this paper, we examine geographic dimensions of inequality between older adults by examining the extent of spatial concentrations of deeply economically disadvantaged older people and their comparatively advantaged counterparts. In developing a working definition of economic disadvantage (and advantage) for this paper we draw on the concept of social exclusion, and its emphasis on the effects of multiple sources of disadvantage, rather than the study of simpler univariate proxies for disadvantage (such as income poverty alone). The notion of deep disadvantage is mirrored in the social exclusion literature in which 'deep social exclusion' refers to the experience of 'multiple and overlapping' dimensions of disadvantage (Hayes *et al.* 2008, p. 2).

While the extensive debate on the concept of social exclusion tends to focus more on children or working aged people, it is clear that many older people are also particularly at risk of exclusion, which is not only limited to material/financial disadvantage such as income poverty, but also includes exclusion from services, community activities, social isolation and discrimination (Davies 2005). Naughtin (2008), however, argues that little work has been undertaken focusing on social exclusion amongst older Australians. The Social Exclusion Unit in the UK (2008) constructed seven dimensions of social exclusion relevant to older people from the English Longitudinal Study of Ageing (ELSA), a large-scale survey of people aged 50 or over living in UK. These seven dimensions were modified by Naughtin (2008) to adapt to an Australian context and cover social relationships, cultural activities, civic activities, access to basic services, financial products and material consumption. Naughtin (2008) discusses the fact that older people can be at risk on one or more dimensions. Using analysis from the UK Office of the Deputy Prime Minister (2006), Naughtin (2008) notes that the risk of social exclusion increases with various factors - including age (with those 80 years and above being more prone to exclusion), living alone or having no children, poor mental or physical health, no access to a private car or lack of access to public transport, living in rental accommodation, having low income and/or being reliant on welfare and having no access to a telephone.

In this paper, we focus on the economic aspects of social exclusion (captured in the 'material consumption' dimension noted above), and combine variables measuring low income, welfare dependence and housing costs. Combining these three variables allows us to create two groups of older adults, with members of one group being disadvantaged in relation to three different measures which proxy the availability (or lack of availability) of income and thus purchasing power, and the other group experiencing relative advantage. In future work, we aim to extend our analysis to additional aspects of social exclusion, including social relationships and activities.

An additional reason for focusing in this paper on multiple sources of disadvantage relates to the numerous debates which exist around the extent to which cash income measures alone can capture disadvantage. These arguments may be particularly relevant to some groups of older people. Previous research suggests that for many older adults in Australia, relatively low incomes may be balanced out somewhat by relatively large asset holdings and often very low housing costs (due to very high rates of outright home ownership) (Kelly 2009; Kendig and Bridge 2007; Olsberg and Winters 2005; Yates *et al.* 2008). Indeed, when housing costs are taken into account, rates of income poverty among older adults, and their representation at the bottom end of the income distribution, tend to fall substantially (Chotikapanich *et al.* 2003; Harding *et al.* 2001; Marks 2005; Yates and Gabriel 2006). By combining several variables, our intention is to overcome this issue, and isolate those older people whose low income, when combined with their other characteristics, is likely to translate into a very substantial degree of disadvantage.

In order to be able to combine several variables related to advantage and disadvantage at a small area level, including variables not available in Australia at a high level of spatial disaggregation, we use NATSEM's spatial microsimulation methodology to generate estimates of the proportion of older people in small areas across Australia living in circumstances of multiple economic disadvantage and those experiencing more economically favourable circumstances. The methodology used in this paper is similar to that used by Tanton *et al.* (2008b), who used spatial microsimulation techniques to analyse the regional effects of two hypothetical policy changes on poverty rates for older persons living in lone person households. However, this paper represents our first attempt to combine household characteristics for people aged 65 and older, and much of our work here is devoted to exploring the possible limits of the methodology we use to generate our estimates, and a description of our data validation techniques. The results we present here are preliminary only, and we are continuing to refine our techniques and test the robustness of our results.

While Census data could also be used to capture groups of economically vulnerable/advantaged elders, we have chosen to use the microsimulation methodology here for several reasons:

- Census income data are available only as gross (not disposable) income, and only in income ranges. This means that disposable income – that is, the income which remains to households after paying income tax – cannot be measured using Census data. In addition, the use of ranges of income in the Census limits the accuracy of equivalisation procedures used to take into account household size and composition when comparing household incomes. Our simulation methodology allows us to take advantage of the greatly superior income data available in the Australian Bureau of Statistics' Surveys of Income and Housing, while retaining the ability to examine income distribution at a small area level.
- Income composition is not available through the Census and, while some small area data are available which provide estimates of recipients of a range of government benefits, such data provide information only about the numbers of

persons receiving benefits, not about the extent of their dependency on such transfers.[1] In addition, such data could not be readily combined with Census data about income and housing costs in order to develop a profile of older people who are experiencing multiple sources of financial disadvantage, as was our intention in this study.

- Our intention in moving forward with our work is to use our microsimulated estimates to test the regional effects of policy scenarios related to older adults' economic well-being. This is one of the great strengths of spatial microsimulation, and is not possible without first being able to generate reliable synthetic estimates.

The definitions we use to create our groups of deeply economically disadvantaged and relatively advantaged older people, and our spatial microsimulation methodology, are both described in the following section. We then go on to discuss the validation of our small area estimates, and then present some preliminary results and discuss the ways in which we intend to extend this work.

DATA AND METHODOLOGY

Definitions of deeply disadvantaged and relatively advantaged older people

In this paper we define older people as those aged 65 and above, which is a commonly used age cut-off, and corresponds with the usual age for eligibility for the age pension in Australia (although some women receive the pension before this age). While some studies focusing on older people deal with an age group that extends below 65 (as substantial numbers of people retire, partially retire, or actively plan for retirement before this age), there is no consensus on where older adulthood begins and, in many cases, the choice of age groups to represent later life is a contextual one. As our analysis in this paper is person-based, some of the older people included in our analysis, however, will be living in households with people younger than 65.

In order to capture the notion of multiple sources of economic disadvantage, as described above, we define our two groups as follows:

- Relative economic advantage – in the top two quintiles of the equivalised national household disposable income distribution, paying no rent or mortgage, and relying mainly on private household income
- Deep economic disadvantage - in the bottom quintile of the equivalised national household disposable income distribution, paying private rent, and relying mainly on government income benefits

[1] Some income transfer data is available, for example, at www.abs.gov.au, Cat. No. 6524.0.55.001 Experimental Estimates of Personal Income for Small Areas, Taxation and Income Support Data. Table S01: Persons Aged 15 and over, Source of Personal income (a) by SLA, 2000/01.

Older people living in public housing are excluded from our analysis, as although public housing tenants generally have low income, the lower rents in public housing help provide tenants with somewhat higher discretionary incomes[2] than equally low income seniors paying private rent. Older Australians renting in the private market are widely acknowledged as a group likely to experience substantial housing affordability problems, and their housing tenure may also be associated with other disadvantage issues such as housing quality, lack of tenure stability and lower levels of well-being (Babacan *et al.* 2006; Faulkner *et al.* 2002; Kendig and Bridge 2007; Jones *et al.* 2007). We had considered including in our disadvantaged group those older people still paying mortgages (as well as having the other disadvantage characteristics), but the decision as to whether or not to include older mortgage-payers in our economically vulnerable group was a difficult one. Mortgage-payers, while having less discretionary income than outright home-owners, are less economically vulnerable than private rent payers, due to the asset base and housing stability offered by home purchasing. In fact, we found we were not able to develop sufficiently accurate synthetic estimates of this group at a small area level, and thus were not in any case able to include mortgage-payers. This had the effect of reducing our overall sample size, and issues related to this are discussed in the validation section below.

In creating our two groups of 'deep economic disadvantage' and 'relative economic advantage' we have set up our research as a contrast analysis, comparing those older adults experiencing the most economic disadvantage with those experiencing the least economic disadvantage. In fact, many older adults in Australia fall into neither of these groups, and are not part of our analysis. Data demonstrating the percentage of older adults who fall into our two groups, and those who meet one but not all of our criteria for group inclusion, are provided in our results section (see Tables 4 and 5).

It should be noted that the definition of 'disadvantage' which we adopt for this paper is a very narrow one, and is designed to represent deep economic disadvantage, and capture only the *most* economically vulnerable older people. Many older adults who fall outside the scope of our 'deep disadvantage' variable will nevertheless be living in circumstances of substantial hardship. For example, most older public housing tenants will typically have very low, fixed incomes, and older home owners who no longer have a mortgage may nevertheless have housing costs (such as rates, repairs and insurance), which, on a low income, may be very burdensome.

Data source

In order to identify those older adults with the multiple sources of advantage and disadvantage outlined above we have used spatial microsimulation methods to overcome limitations that exist in relation to data available at a small area level. Our spatially microsimulated estimates of population characteristics are produced using a combination of data from the Australian Census of Population and Housing 2006 and the Survey of Income and Housing Costs (SIH) for 2003/04 and 2005/06. Household and dwelling

[2] Discretionary income is that income that is left over after essential needs (like housing) have been met. It differs from disposable income, which is after-tax income.

characteristics in the Census data relate to respondents' usual residence, not their place of enumeration. All this data is collected by the Australian Bureau of Statistics (ABS). In addition, we provide some national-level descriptive data about older adults who fit into our two groups, and this data was generated using the Survey of Income and Housing Costs 2005/06.

Spatial unit

In this study we use the Statistical Local Area (SLA) as our base spatial unit of analysis. The SLA is one type of standard spatial unit described in the Australian Standard Geographic Classification (ASGC) 2006, and SLAs are based on the boundaries of incorporated local government bodies where these exist (ABS 2007). The 2006 Census data covered 1426 SLAs in Australia. There are 200 SLAs in New South Wales, 210 in Victoria, 479 in Queensland, 128 in South Australia, 156 in Western Australia, 44 in Tasmania, 96 in the Northern Territory, and 109 in the Australian Capital Territory respectively.

There are two main reasons why the SLA was used as the unit of analysis in this study. First, the SLA is the smallest unit in the ASGC where there are not substantial issues with confidentiality, as occur with Census Collection Districts. The ABS randomises any cells in tables where the number of people is less than 3 and, as an area gets less populous, the chance of getting many randomised cells increases. Second, SLAs cover the whole of Australia (as opposed to Local Government Areas which do not cover areas with no local government) and cover contiguous areas (unlike some postcodes) (McNamara *et al.* 2008).

However, using SLAs does pose a problem because of different population sizes within SLAs. The population of SLAs is distributed unevenly across Australia, with some small states and territories having a relatively large number of SLAs and other larger states consisting of relatively few. For example, according to the 2006 Census, the Australian Capital Territory contained only 1.63 per cent of Australia's total population, but had 7.64 per cent (109) of the total SLAs. In contrast New South Wales, which contained 33 per cent of Australia's total population, had only 200 SLAs (or 14.03 per cent of all SLAs). Queensland also had 479 SLAs (33.59 per cent of total Australian SLAs), but contained only 19.67 per cent of the total population. Almost half of Queensland SLAs are Brisbane SLAs, with quite low populations.

These differences in population sizes give rise to an issue known as the Modifiable Areal Unit Problem (MAUP). More populous SLAs are more likely to cover more heterogeneous populations, whereas less populous SLAs usually have more homogenous populations. Thus smaller, less populous SLAs (which are particularly concentrated in Canberra and Brisbane) will have more homogenous populations, and thus more extreme values for the variables we are considering simply because they are more homogenous. In more populous SLAs, small pockets of extreme values will tend to be averaged out.

The methodology we used to overcome these issues follows that developed by Baum *et al.* (2005) and used in Daly *et al.* (2008) and McNamara *et al.* (2008). SLAs in Brisbane and Canberra (the areas most affected by relatively small population sizes within SLAs) were

aggregated to Local Council Electoral Wards for Brisbane[3] and Statistical Subdivisions (SSD) for Canberra, so that they were more similar in population size to SLAs in other areas to allow comparison of regional characteristics across Australia. We also excluded off-shore and migratory SLAs from the analysis.

Spatial microsimulation methodology

This section describes the methodology used to derive the small area estimates of older adults' multiple economic advantage and disadvantage. As discussed above, we have adopted this methodology in order to be able to combine the rich income and income source information available in the income surveys in ways which allow us to identify older adults with *multiple* sources of economic advantage and disadvantage, and then to combine this with Census data so as to produce small area estimates of our combination variables. The method is called spatial microsimulation, and the version of this method used in this paper is called SpatialMSM/09C.[4] SpatialMSM creates a synthetic household microdata file for each Statistical Local Area (SLA) in Australia, containing a set of synthetic household weights which replicate, as closely as possible, the characteristics of the real households living within each small area in Australia (Chin and Harding 2007; Chin *et al.* 2005). A range of approaches to reconstructing spatially detailed microdata have been trialled, including data fusion and synthetic reconstruction (Voas and Williamson 2000; Williamson *et al.* 1998), and methods which involve some type of reweighting approach to connect survey and Census data, such as we undertake here, have shown substantial success (Ballas *et al.* 2006).

As noted above, we combine information from two sources – the Australian Census of Population and Housing 2006, and the 2003-04 and 2005-06 ABS Survey of Income and Housing Confidentialised Unit Record Files (CURFs). These two survey files are combined for two reasons: first, to maximise the sample size available for the modelling and, second, to make our weights compatible with NATSEM's static microsimulation model of Australia's tax and transfer system, STINMOD, which then provides the potential for policy analysis (Lloyd 2007).

To produce a set of household weights, we benchmark the combined SIH files to the Census, using variables that are available in both data sources. We continuously improve and refine the production of our small area weights and, in this case, in order to improve our estimates of older adults' income, we added an additional benchmark variable to our existing model: equivalised gross household income by age. This variable substantially improved our initial validation results for older adults (earlier results not shown), and also improved the accuracy of our estimates of poverty for all persons and for children.

[3] A 2001 concordance between SLAs and Brisbane Local Council Electoral Wards was kindly supplied by the Centre for Research into Sustainable Urban and Regional Futures (CR-SURF) at the University of Queensland. This was modified by the authors for use with 2006 SLAs.

[4] The general method is outlined in more detail in Lymer *et al.* (2008) and Chin *et al.* (2006).

The Census benchmark tables are developed based on BCP (Basic Community Profiles), XCP (Expanded Community Profiles) Census data and special data requests from the ABS. Our full list of 12 benchmark variables is shown in Table 1.

In order to make the income values in both SIH years comparable with income values from the Census prior to reweighting, the incomes from the surveys were uprated to 2006 dollar values, using changes in average weekly earnings. For all other benchmark variables, extensive work was undertaken to ensure that they had the same definition and coverage on both the Census and the SIH. For example, the SIH includes no non-classifiable households (for example, households which contain no persons over 15 or which contain visitors only), while some of the person-level Census tables included non-classifiable households. Thus for Benchmark 2 (age by sex by labour force status) we requested a special table from the ABS that excluded non-classifiable households. (An excellent introduction to the issues that emerge when attempting to ensure a microdata survey can reliably be matched to a Census benchmark is contained in Chin *et al.* 2006)

Table 1 Benchmark tables used for SpatialMSM/09C

No	Benchmark Table
1	All household type
2	Age by sex by labour force status
3	Tenure by weekly household rent
4	Tenure by household type
5	Tenure by weekly household income
6	Persons in non-private dwellings
7	Monthly household mortgage by weekly household income
8	Dwelling structure by household family composition
9	Number of children aged under 15
10	Number of adults
11	Weekly household rent by weekly household income
12	Gross equivalised weekly household income by age

Source: ABS Census Population and Housing 2006

The reweighting process we use in this paper is described in Chin and Harding (2007). The procedure used is a SAS macro called GREGWT which uses an iterative constrained optimisation technique to calculate weights that best represent all the Census benchmarks. The procedure is a generalised regression procedure outlined in Bell (2000).

Because the reweighting process is iterative, there will be areas where the procedure will not find a solution. If there is no solution found after 30 iterations, then the process has not converged. Those SLAs where the process does not converge are usually very small SLAs where the population is quite different to the sample population – for instance, industrial estates or inner city areas, (Tanton *et al.* 2008b). For some areas, however, we found that the GREGWT criteria for non-convergence was too strict: even after iterating 30 times and not converging, the estimate we got from the weights was still reasonable when compared with the benchmarks. In order to maximise the number of SLAs for which we could produce valid data, we developed a new criteria for reweighting accuracy, which uses the

total absolute error (TAE) from all the benchmarks. If the absolute total error from all the benchmarks is greater than the population in that SLA, then the accuracy criteria has failed, and the SLA is dropped from any further analysis. Generally, the convergence criteria and the accuracy criteria provide the same results when an area has obviously not converged; but for marginal areas, the area may reach the maximum number of iterations but still provide a reasonable total absolute error. For this paper, we have applied the TAE criteria rather than the GREGWT convergence criteria, and found 149 SLAs where we were unable to produce weights.

While the acceptance rate of SLAs was overall very high (especially when considered in population terms), we lost almost half of the Northern Territory population in this reweighting process, and thus estimates of older adults' multiple advantage and disadvantage for the Northern Territory should be treated cautiously. Further SLAs were removed from our analysis due to low elderly populations, low sample sizes for our variables, and insufficiently accurate estimates. These further exclusions, and the rationale for them, are described in the next section.

Once our weights are produced, and SLAs which did not meet our reweighting accuracy criteria were removed from our analysis, we then apply these weights to combined data from the same SIH surveys which were used to create the weights (having once again first uprated income values in these surveys). We create two sets of variables – one which we use to produce our final results (presented in our results section below), and another which we use in order to check the accuracy of our estimates (discussed in the validation section below). For our final results, households with zero and negative incomes are removed from the sample.

VALIDATION

While the convergence and accuracy process described above ensures that only those small areas for which accurate estimates of benchmark variables have been obtained are included in the modelling, this is only the first step in ensuring the quality of our synthetic estimates. Before analysing our data, we perform additional checks on our estimates.

The validation of synthetic small area estimates is inherently a difficult task, as the whole purpose of producing such estimates is to create data where none exist. Several methods exist for overcoming this problem, and we have applied two of these here. First, we have checked our data against existing small area data that is similar to, although not precisely the same as, the estimates we want to produce. Secondly, we have aggregated our estimates up to a larger spatial unit (in this case to the state level) so that aggregated results can be compared with survey data available at this level.

Small area data validation

While it was not possible to directly validate our small area estimates of multiple economic vulnerability and advantage, due to an absence of available data which combine all three of these variables together, we were able to conduct substantial validation at a small area level

of two of our three input variables – those based on income quintile and rent/mortgage costs, as data related to these two variables can be sourced from the Census. Our final variable (income source) was validated at an aggregate level, as described below.

Using the same Census data which we had incorporated into our model as an additional benchmark table, we were able to examine the differences between our synthetic estimates and Census data measuring the proportion of people in each small area who:

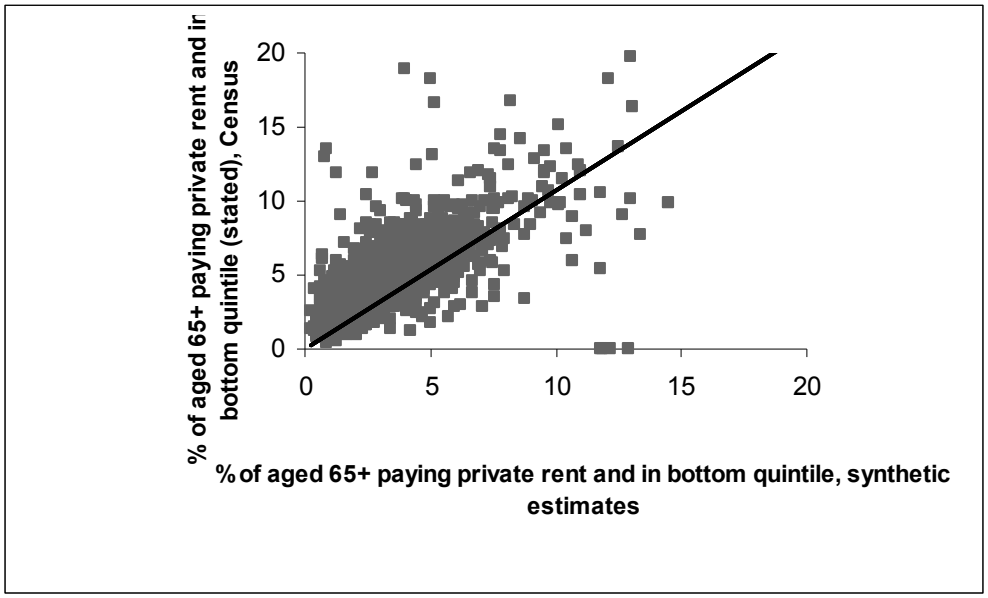
1. Were aged 65 and over and fell into the bottom income quintile of gross national equivalised household income and who were paying rent in the private market
2. Were aged 65 and over and fell into the top two quintiles of the gross national equivalised household income distribution and who were paying neither private rent nor mortgage, and who were not public housing tenants.[5]

Summary results of our validation of these two variables are provided in Figures 1 and 2. These results include all SLAs except those which were excluded from our sample at an early point because they did not meet our convergence criteria or had zero population (165 SLAs). As can be seen from the charts, the accuracy of the synthetic estimates is moderately high for our estimate of the combined advantage variable, but less so for our combined disadvantage variable. Figure 1 contains more outliers than Figure 2, and shows evidence of a modest bias (not evident in Figure 2), with a tendency for our synthetic estimates to be slightly lower than those produced directly from the Census (which could be due in part to the more accurate income data available in the income surveys). Some of the inaccuracies in Figure 1 may also due to very low sample sizes for the 'disadvantaged' group in some SLAs.

Part of the difference between our synthetic data and the Census estimates may be due to the fact that we are studying a sub-population (people aged over 65) and incorporating into our study relatively uncommon variables (the rent portion of our disadvantage variable and the high income portion of our advantage variable) which, as noted above, led to problematic low sample sizes in some small areas. Refining our methodology so as to improve the accuracy of these estimates is part of our ongoing work on this project (discussed in our conclusion), but the degree of difference at this stage between our synthetic estimates and Census data should be kept in mind when interpreting the spatial distribution of deep disadvantage among older Australians presented in this paper. However, in order to increase our confidence in the accuracy of our estimates, we did go on to exclude a significant number of low sample and outlying small areas before conducting any further data analysis.

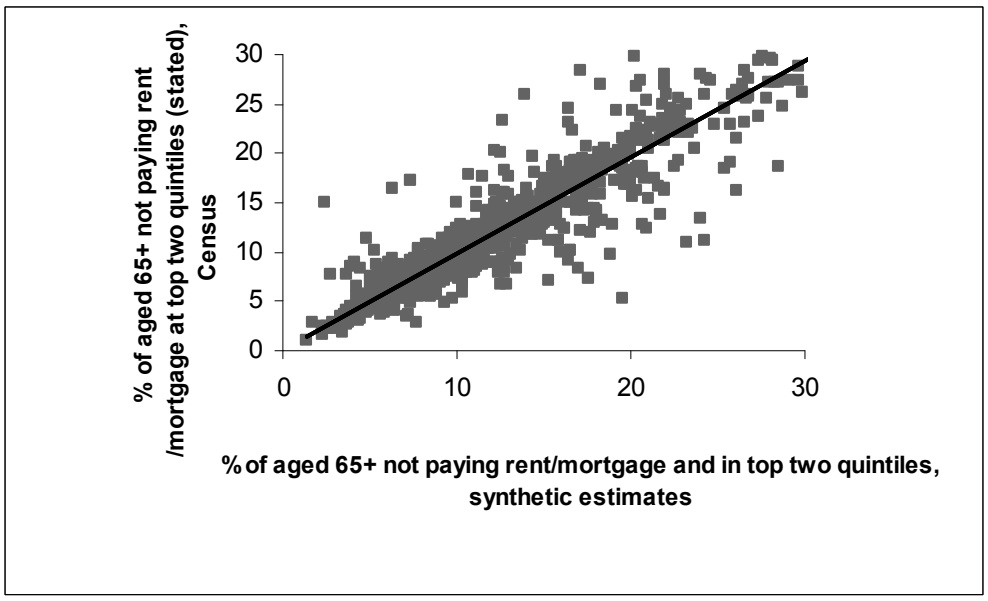
[5] We also conducted validation of these variables individually, but presentation of all this material here is beyond the scope of this paper.

Figure 1 Synthetic estimates and Census data: bottom gross income quintile and paying rent, 2006



Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06; ABS Census of Population and Housing 2006

Figure 2 Synthetic estimates and Census data: top two gross income quintiles and not paying rent/mortgage, 2006



Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06; ABS Census of Population and Housing 2006

We established several criteria for excluding small areas with questionable results. We first aggregated our data up to larger spatial units for Canberra and Brisbane (as described above) and then additionally excluded from our analysis those SLAs which had a total population over 65 of less than 30 (an additional 7 SLAs). We then further excluded those which had sample sizes of less than 30 on *both* any variable within our 'disadvantage' set of

variables *or* any variable within our set of 'advantage' variables (152 small areas). Finally, we excluded from our analysis those small areas which had a greater than 5 percentage point difference between our synthetic estimates and Census data on the two variables shown here (an additional 19 small areas). This left us with a final sample of 816 small areas, containing 89.8 per cent of the population aged 65+. With this reduced sample of SLAs, we then conducted some additional validation of our synthetic estimates by aggregating our data up to state level (see below). It should be noted that many of the small areas we excluded are in Australia's remote inland areas, which have small populations but often high levels of disadvantage. Thus our final results should be considered as indicative only, as the distribution of geographic concentrations of deep disadvantage and relative advantage among older people might appear different if all small areas were able to be included in modelling.

As noted earlier, we had originally considered including *both* rent-payers and mortgage-payers in our 'disadvantaged' group. However, our original small area validation of this combined variable showed extensive differences between our synthetic estimates and Census validation data. On exploring this further, we found that the majority of the difficulty in achieving accurate estimates was due to the mortgage variable. Sample sizes for this variable were often very small, but our difficulty in accurately estimating this variable may also be due to possible heterogeneity in the types of older households who are paying mortgages. As spatial microsimulation works by matching up household characteristics in order to estimate other characteristics that are closely correlated with the matched variables, characteristics for which correlations are weak (as may possibly be the case for this particular sub-group of mortgage payers) may be difficult to estimate. Further discussion about possible additional ways of overcoming the difficulties we found in estimating mortgage-payers (and to a lesser extent rent-payers) are discussed in our conclusion.

Aggregated data validation

In order to further check the extent to which our synthetic estimates of economic vulnerability and advantage match existing data, we aggregated our spatial estimates to state level in order to see how the relative positions of states in terms of our variables compare for Census, survey and synthetic data. These results are shown in Table 2 (using the variables described above) and Table 3 (showing main source of household income), and overall show fairly strong connections between our estimates and the underlying data. In these tables, our aggregated synthetic data include only those 816 small areas which remained in our modelling after the small area validation exercise described above. Differences between the synthetic, survey and Census data may be due to inaccuracies in the synthetic data, or merely to differences in data quality and variable definitions between the original data and the final synthetic estimates, or to the different geographical coverage provided by the three sets of estimates. Data for the Northern Territory and the ACT are combined in these tables because these geographical areas are not available separately on the survey CURF.

The left hand side of Table 2 compares a variable combining low income and private rent across the three data sources, and shows the synthetic estimates to have reasonably similar broad geographic distribution patterns to those in the underlying data. Values of this variable are fairly similar across the three datasets, although the synthetic estimates of disadvantage tend to be lower in the less populous states of Queensland, Western Australia and South Australia, possibly due to the exclusion from our synthetic estimates of numerous low-sample SLAs in these states. Rankings of states by the proportion of older people falling into the disadvantaged group defined for this validation procedure are closely aligned across the datasets, with Queensland, Western Australia and Tasmania representing the three states with the highest level of disadvantage across all the datasets.

The right hand side of Table 2 compares a variable combining relatively high income and an absence of rent/mortgage costs across the three data sources. Here it is clear that both the synthetic estimates and the Census data generally provide slightly higher absolute values for this variable than those from the SIH, but with similar rankings of states between all three datasets. The main exception to this is the position of New South Wales, which is ranked number 2 in both the synthetic estimates and the Census, but number 5 in the SIH data.

Table 2 Comparison of aggregated synthetic estimates of income/housing costs with Census data and SIH2005/06 data, all for persons aged 65+

	Bottom gross income quintile and paying rent						Top two income quintiles and not paying rent/mortgage					
	SpatialMSM/09C		Census 2006		SIH0506		SpatialMSM/09C		Census 2006		SIH0506	
	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank
NSW	3.3	5	4.2	5	3.1	5	13.3	2	13.5	2	8.7	5
VIC	3.2	6	4.1	6	3.6	4	11.8	3	12.3	3	13.3	2
QLD	4.3	1	5.8	1	5.6	2	10.9	5	10.8	5	10.3	3
SA	3.6	4	4.4	4	2.0	6	9.5	6	9.5	6	8.7	6
WA	4.1	2	5.0	3	7.8	1	11.7	4	11.7	4	10.1	4
TAS	3.7	3	5.7	2	4.8	3	8.4	7	8.5	7	7.0	7
NT&ACT	1.2	7	3.5	7	0.0	7	25.9	1	24.8	1	27.1	1

Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06; ABS Census Population and Housing 2006; Survey of Income and Housing Costs 2005/06

Table 3 compares our aggregated synthetic estimates with SIH data on the source of income variable (this data is not available in the Census). As the table shows, the synthetic estimates tend to slightly understate the proportion of older people dependent on government benefits compared with the SIH data (and slightly overstate those whose main source of income is private), although the ranks of states are fairly closely aligned, with NSW, Victoria and the ACT/NT in both cases representing the states with the lowest proportion of older people whose main source of income is government benefits. The state which differs most in the rankings is Tasmania, which is ranked as having the most government benefit-dependent elders in the synthetic estimates, but falls around the middle in the SIH estimates.

Table 3 Comparison of aggregated synthetic estimates of income source for persons with SIH2005/05 data, all for persons aged 65+

	Main source of income government benefits				Main source of income not government benefits			
	SpatialMSM/09C		SIH0506		SpatialMSM/09C		SIH0506	
	%	Rank	%	Rank	%	Rank	%	Rank
NSW	57.7	6	63.6	5	41.6	2	36.4	3
VIC	58.8	5	62.7	6	40.6	3	37.3	2
QLD	59.7	3	68.2	2	39.7	5	31.8	6
SA	63	2	69.3	1	36.6	6	30.7	7
WA	59.4	4	68.1	3	40	4	31.9	5
TAS	64.9	1	67.8	4	34.7	7	32.2	4
NT&ACT	42.2	7	38.5	7	57.5	1	61.5	1

Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06; ABS Census Population and Housing 2006; Survey of Income and Housing 2005/06

In summary, our validation results suggest that additional refinement of our spatial microsimulation methodology which we are undertaking (described further in our conclusion) may be beneficial in producing accurate results for more small areas. However, the production of a set of useable spatial weights for measuring multidimensional variables related to economic disadvantage for a sub-group of the Australian population represents substantial and innovative progress in developing data to understand and analyse locational disadvantage among older adults.

RESULTS

Before presenting our spatially disaggregated data, it is useful to provide a picture at a national level of the characteristics of older Australians. Tables 4 and 5 show the distribution in the Australian population of older people of the variables being mapped for this paper, broken down by various characteristics. While it is not possible (due to sample size issues in the underlying survey data) to provide these breakdowns in the spatially disaggregated results, the data in these tables provide important background information which should be kept in mind when interpreting the spatial results.

Table 4 shows data related to the 'disadvantage' variable, with the first results column showing the deep economic disadvantage variable we used for our spatial analysis (bottom income quintile + paying private rent + dependent on government benefits), the second column showing the version of this variable which also includes mortgage payers, and the remaining columns showing the individual variables which make up the deep disadvantage variable. As can be seen, the overall proportion of older adults falling into our definition of deep economic disadvantage is relatively low (largely due to the small proportion still paying private rent). However, it is notably larger for older adults living alone, of whom 8.5 per cent are living on low pension incomes and paying rent. Protective factors include living in a household which includes persons aged under 65 or having at least one person employed. Some modest differences are evident on this set of variables between capital city and balance of state areas, with proportions of older adults in deep disadvantage, reliant on government benefits, and in the bottom income quintile slightly

higher in non capital-city areas. Had we included mortgage payers in our disadvantage variable, the results in the second column show an increase in sample size, but fairly similar overall patterns of distribution. When we compare mortgage payers and private rent payers separately, however, we do see some differences between these groups, with the presence of a younger person or a working person in the household being much more strongly associated with mortgage paying than rent paying. Older capital city residents are slightly more likely than their rural and regional counterparts to be still paying a mortgage, which may reflect different age distributions in these broad regions, or higher home purchase costs in capital cities.

Table 4 Economic disadvantage variables for persons aged 65+, distribution by population characteristics, Australia, 2006

	'Deeply disadvantaged' excluding mortgage payers	'Deeply disadvantaged' including mortgage payers	Bottom equivalised income quintile	Paying mortgage	Paying private rent	Main source of household income government benefits
Characteristic	%	%	%	%	%	%
All persons 65+	3.8	5.0	47.1	5.3	6.6	64.8
Females 65+	4.1	5.3	50.4	5.2	6.8	68.5
Males 65+	3.3	4.5	43.3	5.3	6.4	60.6
Persons 75+	2.7	3.7	50.4	4.1	5.6	70.5
65+ living in hh with at least one person <65	2.0	2.9	26.6	13.9	6.3	37.8
65+ living in hh with at least one person >=75	5.0	3.6	49.8	4.0	5.4	70.4
65+ living alone	8.5	10.0	67.3	2.3	11.2	77.8
65+ living in hh where anyone working	0.4	1.1	12.1	16.2	6.1	18.4
65+ living in a capital city	3.4	4.4	45.5	5.6	6.3	60.1
65+ not living in a capital city	4.5	5.9	50.0	4.5	7.4	72.7

Note: The 'deeply disadvantaged' variable in the first column refers to those persons aged 65 and over who are in the bottom quintile of the equivalised disposable household income distribution, and whose main source of income is government benefits, and who are paying private rent (the variable we used for our spatial analysis). The variable in the second column refers to those persons who meet the first two of these criteria and are also paying either private rent or a mortgage.

Data source: ABS Survey of Income and Housing Costs 2005/06; authors' calculations

Table 5 shows data related to our 'advantage' variable, with the first results column showing the 'relative economic advantage' variable we used in our spatial analysis, and the remaining columns showing the variables that make up this summary indicator. The proportion of older adults falling into this group is somewhat larger than that falling into our multiple economic disadvantage variable. Differences between capital cities and the balance of Australia are more evident here than for the deep disadvantage variable, with 12.1 per cent of older people living in capital cities falling into this group, compared with only 7.3 per cent of those living outside capital cities. Men are also more likely to fall into our relative advantage group than women, and the presence of at least one working person in the household is also strongly associated with relative economic advantage.

Table 5 Economic advantage variables for persons aged 65+, distribution by population characteristics, Australia, 2006

Characteristic	'Relatively advantaged' %	Top two income quintiles %	Not paying rent or mortgage %	Main source of household income private %
All persons 65+	10.4	12.7	79.8	35.2
Females 65+	8.7	11.0	79.3	31.5
Males 65+	12.3	14.6	80.3	39.4
Persons 75+	10.6	12.3	83.4	29.5
65+ living in hh with at least one person <65	16.1	23.6	68.5	62.2
65+ living in hh with at least one person >=75	10.5	12.1	83.6	29.6
65+ living alone	6.5	7.3	75.9	22.2
65+ living in hh where anyone working	24.6	34.5	67.7	81.7
65+ living in a capital city	12.1	14.9	80.0	39.9
65+ not living in a capital city	7.3	8.7	79.9	27.3

Data source: ABS Survey of Income and Housing Costs 2005/06; authors' calculations

Spatial results

It should be noted when interpreting our spatial results that any examination of advantage and disadvantage at a geographic level necessarily misses out on identifying some instances of these characteristics. Areas which show up on our maps as having low concentrations of either of our variables are not areas in which no deeply disadvantaged (or relatively advantaged) older people live – they are simply areas in which the proportion of these people relative to the total population of people aged 65+ in that area is relatively low. Also, despite the geographical modifications we have made in order to overcome the issue of greater heterogeneity being associated with larger spatial units, this issue cannot be completely resolved, and differences in population sizes within small areas are still likely to be affecting our findings. These points, along with the preliminary nature of the estimates discussed here, should be kept in mind when interpreting the data presented below.

Figure 3 shows the spatial distribution of our deep economic disadvantage variable. Using natural breaks (a common method for displaying geographic data) we have divided the small areas in our sample into groups, with the darkest two colours on the maps showing those areas with the highest concentrations of older people experiencing multiple economic disadvantage. The remaining areas fall into the bottom three groups (those with the lowest concentrations of this variable), or are areas (hatched on the map) which were excluded from our analysis as described earlier. We have combined the three bottom groups into one because the focus of our attention in this analysis is those SLAs with the highest concentrations of deep disadvantage, and because areas in the bottom three groupings had generally very low concentrations of this variable (as can be seen from the values of the variable shown in the legend).

As can be seen, concentrations of deeply disadvantaged older adults are present in both capital city and non-capital city areas, with groups of small areas in south-western Sydney and Melbourne, and some outer suburbs of Perth and Brisbane showing relatively high

concentrations of this variable. Hobart and Canberra are exceptions to this pattern, and while relatively high incomes in Canberra are consistent with this finding, the absence of high concentrations in Hobart are more surprising, as other research suggests that this is the capital city with the overall lowest gross household income (Vu *et al.* 2008). Further comparison of these microsimulated results with patterns of disadvantage produced by Census data would be worthwhile, along with analysis of the extent to which areas of concentration of deep disadvantage among older adults coincide with or differ from areas which contain substantial overall population disadvantage. Areas of concentrated deep disadvantage outside capital cities are somewhat scattered, but occur in both coastal and inland regions in both east and west coast locations.

Figure 4 shows the spatial distribution of our relative economic advantage variable, and demonstrates that areas of concentrated elder deep disadvantage are generally different from those of concentrated elder advantage, although the latter are also spread between capital city and balance of state. The proportion of older adults in this group was somewhat higher than those in our disadvantage group (as can be seen from the map legend, which shows that even areas with the lowest concentrations contained proportions of relatively advantaged older adults of between 3.5 and 9.9 per cent), so all five natural breaks groupings are shown on the map. All the capital cities show some areas of concentrated relative advantage, with this being particularly pronounced in Canberra and Sydney. Many of these concentrations reflect the overall socioeconomic status of these areas: for example, the corridor of suburbs in Melbourne's east are areas of generally high income (Vu *et al.* 2008). Concentrations of advantage among older people are less common outside the capital cities (as suggested by our national results), and only 20 of the 102 small areas in the top two groups of this distribution fall outside the capital cities.

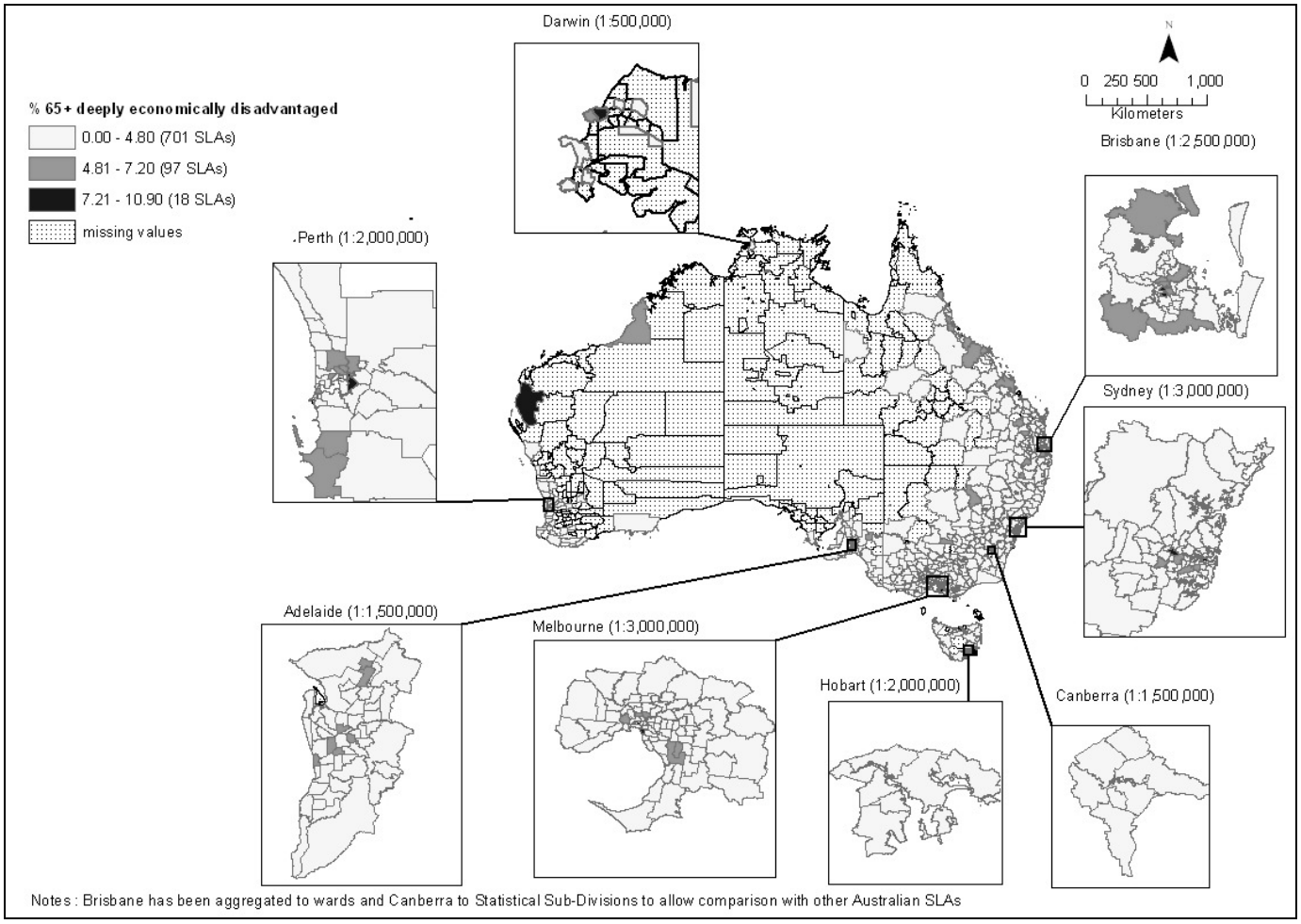
Many small area differences are quite difficult to see on the maps shown in Figures 3 and 4, but enlarged maps help overcome this problem. In order to better examine the geography of disadvantage and advantage, we have provided in Figures 5 and 6 maps which combine our two variables for the Sydney area only (Figure 5) and for the Gold Coast area of Queensland (Figure 6). On these maps, the shaded areas represent the disadvantage variable (with the darkest colours representing the most concentrated disadvantage) while the dots represent the advantage variable – the larger the dot, the more concentrated the advantage.

Looking at the Sydney map (Figure 5), the concentration of deep disadvantage in Sydney's inner western suburbs is clear, and there is generally substantial distance between these areas of high disadvantage concentration and areas of high advantage concentration in Sydney's northern and eastern suburbs. While the western suburban areas which show up as having high concentrations of disadvantage match with areas of generally fairly low socioeconomic disadvantage, the inner western area of Marrickville has moderately high concentration of both advantage and disadvantage, and is surrounded to the north and east by relatively concentrated advantage.

The Gold Coast map suggests a less clear division between areas of high advantage and high disadvantage. While most of the areas with high concentrations of disadvantage have

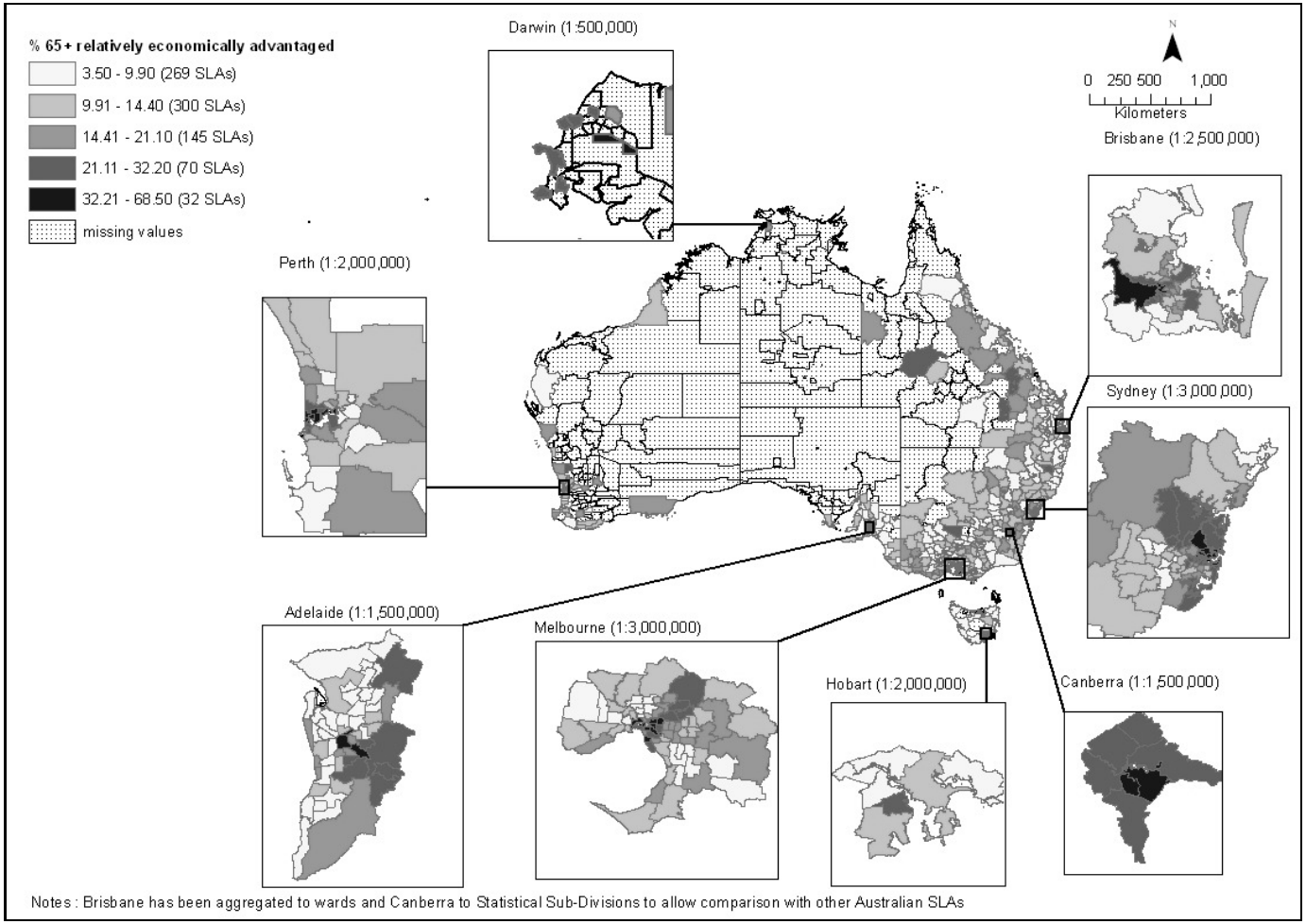
correspondingly low concentrations of advantage, the dark-shaded regions to the north of the area also have moderately high concentrations of advantage. Similarly, areas of disadvantage often appear adjacent to areas of high advantage, suggesting a relatively low degree of spatial clustering in this region, and substantial extremes in the well-being of older residents.

Figure 3 Small area distribution of deep economic disadvantage, people aged 65+, Australia, 2006



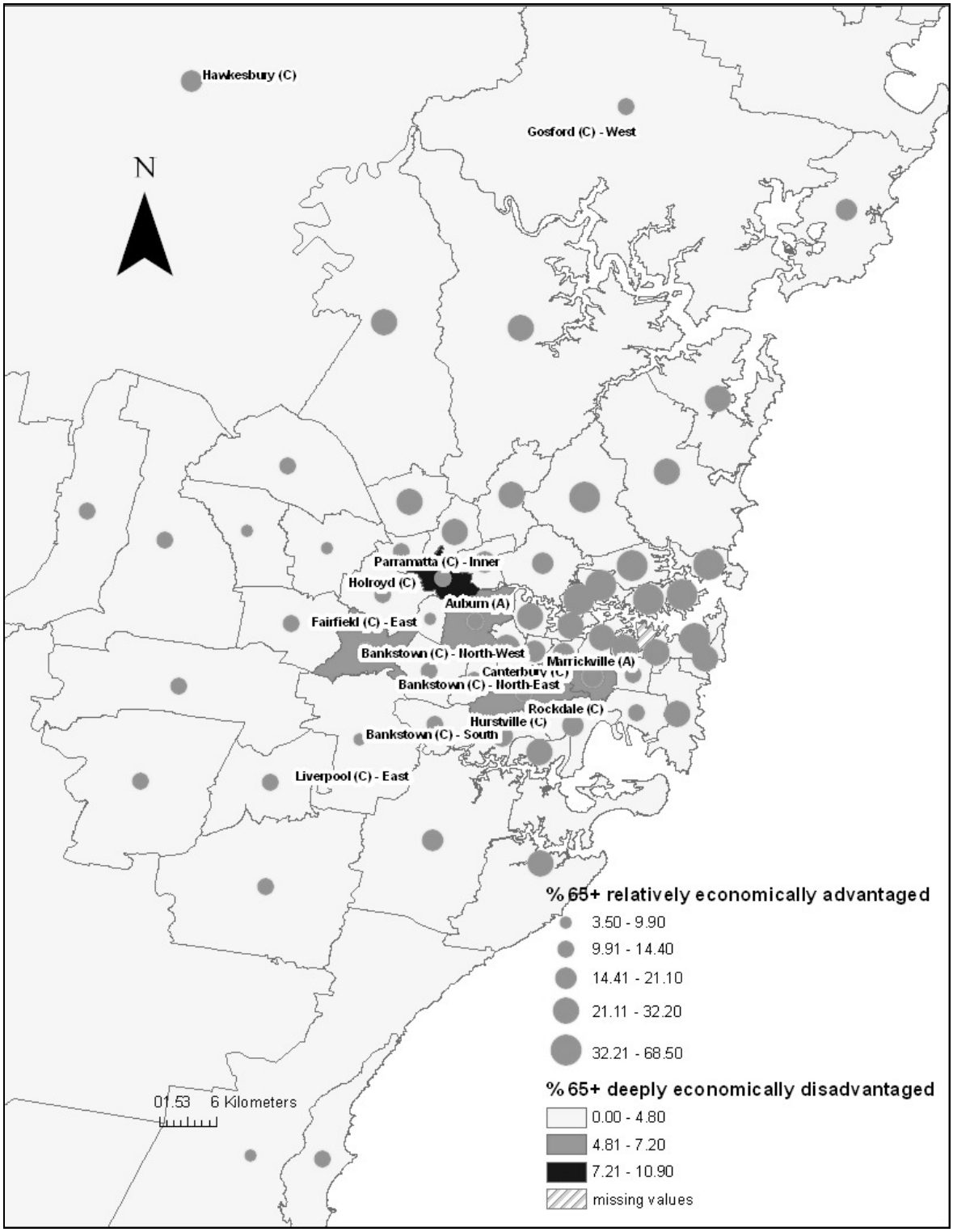
Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06

Figure 4 Small area distribution of relative economic advantage, people aged 65+, Australia, 2006



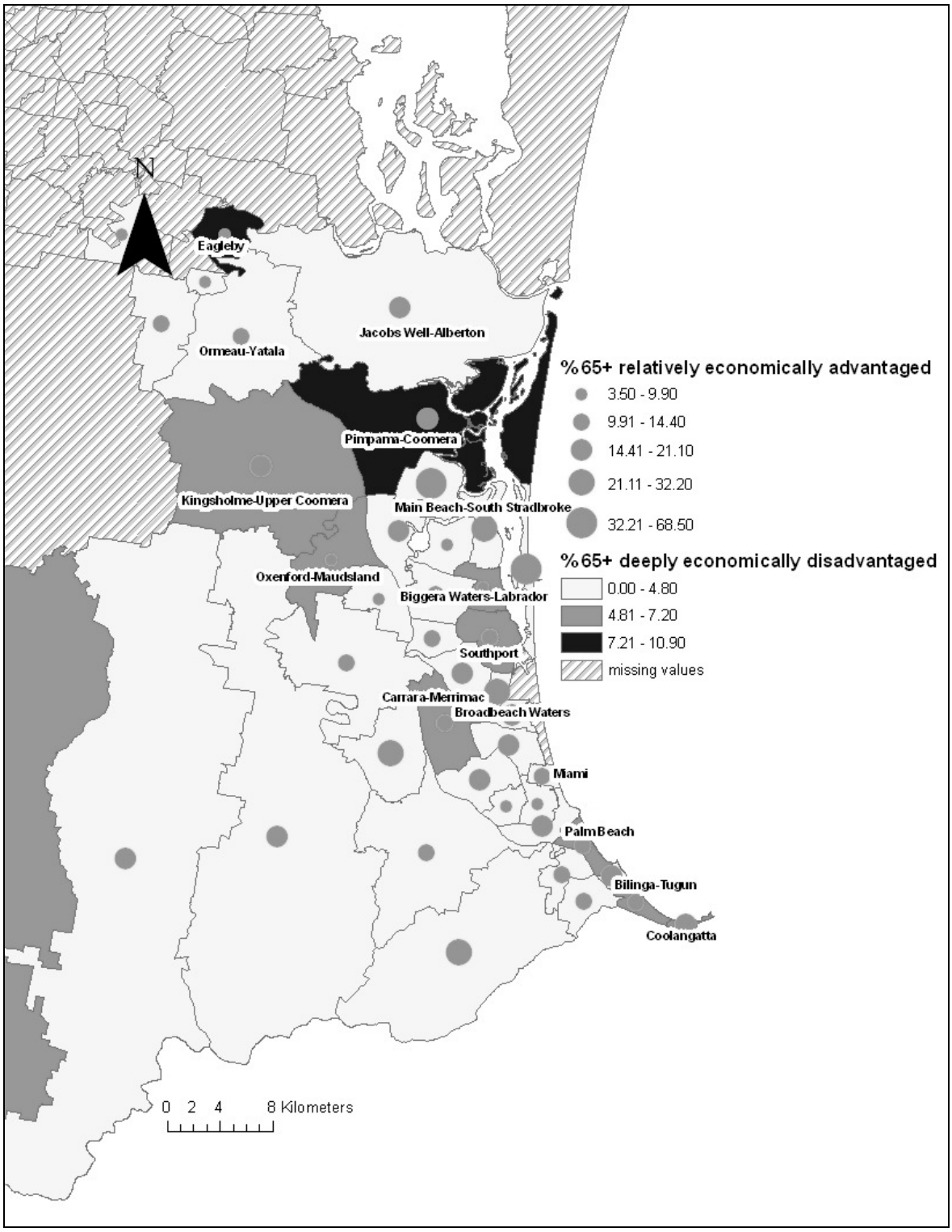
Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06

Figure 5 Small area distribution of relative economic advantage and deep disadvantage, people aged 65+, Sydney, 2006



Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06

Figure 6 Small area distribution of relative economic advantage and deep disadvantage, people aged 65+, Gold Coast, 2006



Data source: SpatialMSM/09C applied to SIH03/04 and SIH05/06

Further analysis of our data is continuing. In order to further understand the nature of the differences between areas of high concentration of deep economic disadvantage and relative advantage for older Australians, we will analyse characteristics of the areas with the most concentrated elder economic disadvantage and those with the most concentrated elder economic advantage. Such an analysis will allow us to examine the locational characteristics (such as unemployment, industry structure, education levels, age distributions, household composition and population poverty rates) of those areas in which highly disadvantaged older Australians and their more affluent counterparts live.

DISCUSSION AND FURTHER WORK

Our findings about the distribution of multiple economic disadvantage and advantage at a national and spatially disaggregated level among Australian seniors provide ample support for the notion of substantial heterogeneity among older people. While neither of the summary measures we examined was extremely common among older Australians, there are nevertheless substantial differences in the economic experience of ageing, and geography is part of this difference. While our national data shows a tendency for capital city areas to contain lower concentrations of deeply disadvantaged older people and higher concentrations of their more advantaged counterparts, our spatial analysis shows more complex patterns of geographic distribution. The presence of substantial concentrations of elderly, low-income rent payers in some capital city areas is particularly concerning due to the high rents in many of Australia's urban areas.

It is also important to note that while the high housing costs associated with renting in the private market affect a relatively small proportion of Australia's 65+ population at present, this may rise in the future with lower rates of home ownership and higher rates of marriage breakdown, resulting in interrupted housing careers (AHURI 2004; Babacan *et al.* 2006; Jones *et al.* 2007; Tanton *et al.* 2008a; Yates *et al.* 2008). In addition, as noted earlier, older Australians on low fixed incomes (of whom there are a great many, as shown in our national data) may struggle to meet the costs of maintaining homes they own outright, especially in Australia's larger capital cities, and in general housing tenure and housing policy are widely viewed as critical issues related to the well-being of older people both presently and into the future (Yates *et al.* 2008).

It should be noted again that a large number of rural and remote small areas are missing from our maps due to sample size and accuracy issues, and that the distribution of deep disadvantage shown in the maps presented in this section might look somewhat different if these areas were able to be incorporated into our analysis. Also, the proportions of older adults with our disadvantage and advantage characteristics might possibly be somewhat larger (or smaller) if more small areas were included in the data. It might also be that our results are influenced to some extent by the ways in which the elderly population is concentrated geographically, with larger sample sizes in these areas allowing us to include more of these types of areas in our modelling. Further analysis of our data relative to the distribution of the older population will help clarify this possible relationship.

Substantial additional work is still being undertaken on this project. First, we are continuing to pursue further validation data for both our income source and housing costs /income variables, which may throw further light on the accuracy of our synthetic estimates. For example, we intend to synthetically generate one or more variables closely related to main source of income, but for which small area validation data may be more readily available.

Conducting further comparisons of the geographic concentrations of deeply economically disadvantaged and economically advantaged older adults generated from our synthetic estimates with those produced by using data directly derived from the Census could further assist us in understanding the extent to which our microsimulation methodology produces results that are similar to those based on actual population numbers. This will involve close examination of areas of apparent high concentrations of our characteristics, and closer analysis of the data on a state by state basis.

It may be that we could improve our estimates of older adults who are paying rent by widening the age group we are examining, and thus our sample size. This would also be of theoretical and policy interest, due to the vulnerabilities associated with moving towards the retirement years while still having substantial housing costs. By extending the age group we are examining to those persons aged 60 or older (for example), we might not only address some of the technical issues related to small sample sizes, but also extend our understanding of economic vulnerability around the retirement years. Our estimates might also be improved by the addition of an extra benchmark variable into our model (for example, age by tenure type). While additional benchmarks run the risk of lower convergence rates, it would still be worthwhile to test the effectiveness of an additional benchmark.

In addition to further refinement of our modelling and validation, an important additional step in this project is to combine our regional weights with an existing national microsimulation model of Australia's tax and transfer system (STINMOD), in order to be able to examine the regional effects of policy changes on older adults. (For earlier examples of such STINMOD spatial applications see Chin *et al.* 2005, Tanton *et al.*, 2008b and Harding *et al.* 2008). Such scenario testing could include changes to pension and other benefit rates or means tests, or changes to tax arrangements.

Finally, we selected a set of variables for this study which describe the economic well-being aspects of social exclusion. In the future, we intend to examine additional variables, using both microsimulation methods and existing data, to further explore both the regional dimensions of differences in the ageing experience, and the ability of spatial microsimulation techniques to increase our understanding of these differences.

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