SPATIAL ANALYSIS OF HOUSING STRESS ESTIMATION IN AUSTRALIA WITH STATISTICAL VALIDATION

Azizur Rahman

Lecturer, School of Computing and Mathematics, Charles Sturt University, Wagga Wagga, NSW, 2678, Australia. Email: azrahman@csu.edu.au
Adjunct Associate Professor, University of Canberra, Canberra, ACT 2601, Australia. Email: azizur.rahman@canberra.edu.au

Ann Harding

Professor, National Centre for Social and Economic Modelling (NATSEM), University of Canberra, Canberra, ACT, 2601, Australia.
Email: ann.harding@natsem.canberra.edu.au

ABSTRACT: A large number of Australian households are experiencing housing stress. Decision makers at the national and regional levels need reliable small area statistics on housing stress, to most efficiently and fairly target assistance and policy design. This paper studies small area housing stress estimation in Australia and examines various distributive scenarios of the estimates through spatial analysis of a synthetically microsimulated data. Results reveal that one in every nine households in Australia is experiencing housing stress, with private renter households being most greatly affected. About two-thirds of Australian households with housing stress reside in the eight major capital cities, principally in Sydney and Melbourne. The statistical local area level estimates of housing stress are much lower in Canberra, compared to the other major cities. Scenarios of the spatial analysis identify small area level hotspots for housing stress across Australia. A new approach for validating the results of microsimulated data produced by the microsimulation modelling technology reveals statistically accurate housing stress estimation for about 94.3 percent of small areas.

KEY WORDS: ASRE analysis; housing stress estimates; microsimulation modelling; spatial microdata; statistical local area; validation technique.

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1. INTRODUCTION

Housing stress has emerged as a widely discussed public policy issue among politicians, academics and policy makers in Australia. With the unprecedented growth in housing prices - and rents - throughout the past decade, many Australians are increasingly finding housing unaffordable (Rahman, 2011; Yates, 2011). Between 1995 and 2005, real house prices in Australia increased by more than 6 percent per year, with an average annual increase of almost 15 percent from 2001 to 2003 (Yates, 2011). This was well above the average annual increase in the 20 years to 1995 of just 1.1 percent and the 50-year average (from 1960 to 2010) of 2.5 percent per year. These data are illustrated in Figure 1 and contrast with the significantly slower growth in Gross Domestic Product (GDP) per capita and average earnings over much of the period. A significant increase of the real house prices is marked from 2001 onwards.

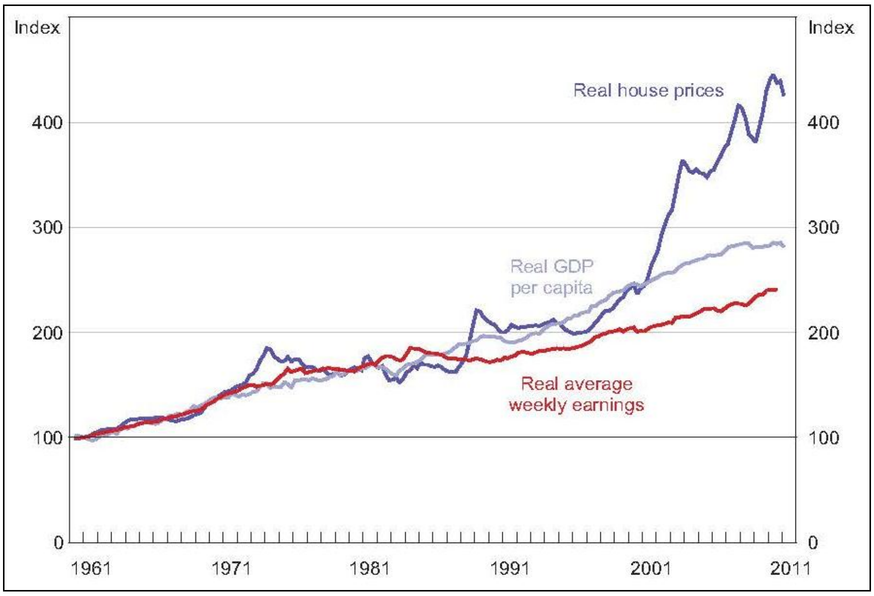

Figure 1. Real House Prices, GDP Per Capita and Earnings.
Source: Yates, (2011).

Compared with other economically advanced nations, Australia is often reported as having experienced relatively rapid growth in real house prices over the past 20 years or so (Tumbarello and Wang, 2010). Just over the five year period from 2000 to 2004, Australia had the third highest rate of house price inflation among Organisation for Economic Co-operation and Development (OECD) member countries, ranking behind only Britain and Spain (Productivity Commission, 2004; The Economist, 2011). Moreover, a recent report of the Australian Bureau of Statistics (ABS) shows that established house prices increased by an average of 33 percent between 2002-03 and 2006-07 (ABS, 2008). Within this time period house rents have also increased rapidly. For instance, within only a 12 month period ending in August 2007, house rents increased in Perth by 36.4 percent, Melbourne by 23.4 percent, Australian Capital Territory by 22.7 percent, Sydney by 18.8 percent, and Brisbane by 13.5 percent (Pearson, 2007). So, housing stress has become an important financial challenge for households, especially for low and middle income groups and an important public policy concern for the national, state and local governments.

About 1.7 million people in this country are in housing stress (Sandel and Wright, 2006). Households with relatively low income and housing costs greater than a certain proportion of household income (for instance, more than or equal to 30 percent) are typically defined as being in housing stress (Rahman, 2009). The concept may also be extended to describe inadequate housing for a proportion of the population. Most of the policy debates on housing stress to date have been confined to the national or state level (Wood *et al.*, 2005; Harding *et al.*, 2004; Nepal *et al.*, 2010; Rahman, 2011; Flood, 2012). This is largely due to the ready availability of data at this coarse geographic level in the sample survey files available from the ABS. However, methodological advances in spatial microsimulation modelling mean that it is now possible to generate synthetic spatial micro-population data (Rahman *et al.*, 2010a).

As in many other countries, substantial spatial differences in socioeconomic growth and wellbeing exist across Australia (Chin *et al.*, 2005; Harding *et al.*, 2006; Stimson *et al.*, 2008). Australian housing programs include subsidising housing costs and rent assistance; mortgage subsidies; and land development planning for housing. All of these policies have had significant impacts on individuals and their living standards, experiences, choices, constraints, decisions and lifestyle preferences (Melhuish *et al.*, 2004; Kelly *et al.*, 2006; Rowley and Ong, 2012; Rahman *et al.*, 2013). In addition, housing acts as a proxy for a host of other factors relevant to economic disadvantage and social inequalities at small area levels. Small area level housing stress statistics also vary with the demographic and socioeconomic conditions of households - and with geography (Rahman, 2011). So, there is a keen interest in understanding who is struggling to afford to buy or rent a house and the impact at small geographic area levels.

This paper studies a spatial analysis of the estimation of statistical local area (SLA) level housing stress in Australia. One of the arguments frequently evoked in the literature is that microsimulation modelling technology based small area estimation lacks vigorous tests of statistical reliability for the microsimulated estimates. So this paper also offers a new statistical approach for validating the results of small area housing stress statistics.

2. A REVIEW OF THE LITERATURE

Typically *housing stress* describes a financial situation of households where the cost of housing – either as rental, or as a mortgage repayment – is considered to be significantly high relative to household income. A range of definitions for describing the situation of housing stress are available in the literature. The following subsections will discuss all methods of measuring housing stress and compare different definitions.

Measures of Housing Stress

Housing stress can be measured by combining two basic quantities - the income and expenditure of a household. A household can be considered under housing stress when it is spending more than an affordable expected proportion of its household income on housing. The affordable expected cut-off point of housing expenditure can vary with the circumstance of households as well as location of dwelling.

As a general rule of thumb, a household spending at least 30 percent of its income on housing can be considered under housing stress (see King, 1994; Landt and Bray, 1997). Some researchers use a different threshold of housing expenditure by restricting the definition to households within different income quintiles. For example, an income threshold of more than 25 percent for housing costs is used by the National Housing Strategy (1991) and Foard *et al.* (1994). Additionally a commonly used definition of housing stress is specified in Harding *et al.* (2004), where a threshold of more than 30 percent of housing costs was used, but only for those households having income in the bottom 40 percent (lowest two quintiles) of the equivalised income distribution. Another definition restricts the designation of 'being in housing stress' to those households spending more than 30 percent of their income on housing and belonging to the bottom 10^{th} to 40^{th} income percentile of the income distribution (ABS 2005). It is noted that any threshold-based definition is an arbitrary slice through a continuum, meaning that small area level estimates of a percentage of households in housing stress would be better treated as estimates of small areas with the greatest percentage of households in housing stress. More explicitly, if an area has a very high percentage of households suffering from housing stress under one of the above definitions, the area probably ranks highly on percentage of households suffering from housing stress however defined.

The residual income approach to housing stress measure looks at what different household types can afford to spend on housing after taking into account the other necessary expenditures of living (Stone *et al.*, 2011). Although it is an alternative to benchmarking the income and expenditure ratio measures of housing stress commonly used in Australia, this approach requires an operationalised residual income standard that is not only difficult to quantify but also arbitrary according to varying circumstances of households. This means that a household has a housing related financial stress problem if it cannot meet its non-housing related needs at some minimum level of adequacy after paying for housing (Stone, 2006a). The appropriate indicator of the tension between housing costs and incomes is thus the difference between them - the residual income after paying for housing, rather than the ratio of costs to income.

Defining a residual income standard involves use of a socially-defined standard of adequacy for non-housing items. Thus, while the residual income logic has some conceptual broadness, a particular residual income standard is not universal, but socially grounded in space and time (Stone, 2006b; Stone *et al.*, 2011). Issues involved in selecting such a standard for non-housing necessities can be difficult and complex.

Both the ratio approach and the residual income approach suggest that as the housing costs behaviourally tend to make the first claim on disposable income, a household has a housing stress problem if, after paying for housing, it has insufficient (residual) income to meet its non-shelter needs at some normative level of adequacy. The difference between the two approaches is how they define the normative level of adequacy for non-shelter items. The ratio approach defines it as a fraction of income: traditionally 75 percent. More recently 70 percent has been defined as the minimum share of income that must be available after housing costs in order to avoid hardship in meeting non-shelter needs

(Nepal *et al.*, 2010; Rahman, 2011). By contrast, the residual income approach defines the normative level of adequacy for non-shelter items as a monetary amount that is independent of income but very dependent upon household composition and the non-housing cost of living as a function of time and place (Burke *et al.*, 2010).

Types of Ratio Measures

A rationale for the use of the 30/40 rule based ratio measure is given in this subsection. It is noted that this ratio measure not only provides continuity with traditionally used measures, but also it is simple to apply and easy to understand.

The definitions of housing stress by three '*rules*'-based ratio measures are as follows:

1) *30-only rule*: A household is considered to be in housing stress if it spends more than 30 percent of its disposable or gross income on housing costs;

2) *30/40 rule*: A household is considered to be in housing stress if it spends more than 30 percent of its disposable or gross income on housing costs and the household also belongs to the bottom 40 percent of the equivalised disposable income distribution; and

3) *30/(10-40) rule*: A household is considered to be in housing stress if it spends more than 30 percent of its disposable or gross income on housing and falls into the bottom 10^{th} to 40^{th} income percentile of the equivalised disposable income distribution.

Although the cut-off point of housing costs for all these definitions is the same, there are some concerns associated with each of these rules. For example, is gross income or disposable income the appropriate base income to calculate housing costs for measuring housing stress? (Gross income is the income of a household from all sources before deducting tax and the Medicare levy, whereas disposable income is the income that remains to a household after deducting the estimated personal income tax and the Medicare levy from gross income.) If a researcher uses 30 percent of gross income as a base, then after possible deductions that figure may be around 40 to 45 percent of actual disposable income. Hence, 30 percent of gross income should equate to a reasonably high proportion of actually received income for housing and other costs. In addition, the *30/40* and *30/(10-40) rules* both restrict the definition to those households that are within the bottom 40 percent of the equivalised income distribution. The issue here is: why is the cut-off point at the lowest 40 percent of income distribution? For the latter rule, why are households in the bottom 10 percent of the equivalent income distribution being omitted?

In general, when the individuals have a higher income, they have greater choice in how to spend it. For lower income households, almost all of their income may be spent on basic necessities, including food, clothing and housing. This group is at higher risk of not being able to afford increasing housing costs or they may not have any choice on housing. For the higher income households, paying more than 30 percent income on rent or a mortgage is more likely to be a choice, perhaps to live in a more convenient or desirable area, or to pay off extra on the mortgage to shorten the term of payment. However, there is a possibility that the households in the third quintile (40^{th} to 60^{th} income percentile) of the income distribution – who usually are known as *middle class earners* - may also have financial hardship in meeting high housing costs, and may have only limited choices to do with housing. By choosing the bottom 40 percent of income distribution as the cut-off, the middle class earning households are excluded from the definitions.

Although middle class income households are at a lower risk of housing stress than low income households, they may be at a level of 'marginal housing stress' because a substantial rise in interest rates, housing prices, or job loss etc. may cause the middle class income households to fall into housing stress. Moreover the 40 percent cut-off is the same regardless of the area in which the individual or household unit is living. Hence no account is taken of housing costs which vary with location; for example the high rents of Canberra and Sydney compared to the low rents of Adelaide are not taken into account in these definitions.

A very severe form of housing stress is the risk of homelessness and may apply to households in the lowest 10 percent of income distribution. This group is quite vulnerable to rising housing costs. Note that many homeless are homeless due to a situation of financial hardship where individuals are unable to afford housing costs or to keep a place to live. Rapidly increasing housing costs could force more of the lowest earning households into homelessness. So the exclusion of households within the lowest income decile from the 30/10-40 rule may overlook this severe form of housing stress. In addition, this definition cannot be used as a means of strategic policy intervention for poverty and housing assistance programs due to its exclusion of the most disadvantaged households. However, some studies do argue that the reported incomes of households in the bottom 10 percent of the income distribution do not always accurately reflect their living standards, and their inclusion in the definition may overestimate housing stress (see ABS, 2005), which is why the ABS argues for the 30/10-40 rule.

A Comparison of Various Ratio Measures

A comparison of the three rules of measuring housing stress is provided in Table 1. Note that none of these definitions takes into account the fact that housing costs vary according to area. The specified rules use relative income of household and the general rule (30 only) uses the absolute household income.

Table 1. A Comparison of the Different Measures of Housing Stress.

30 only rule	**30/40 rule**	**30/10-40 rule**
General definition – ‘a household is in housing stress if it spends more than 30 percent of its income on housing costs’.	Specified definition – ‘a household is in housing stress if it spends more than 30 percent of its income on housing costs and the household also belongs to the bottom 40 percent of the equivalised income distribution’.	More specified definition – ‘a household is in housing stress if it spends more than 30 percent of its income on housing and places into the bottom 10th to 40th income percentile of the equivalised income distribution’.
Assessing all forms of housing stress in one flag.	Ignores any *marginal* housing stress.	Ignores both the *marginal* and *severe* housing stress.
Only the absolute household income is considered.	The relative income of the household is taken into account.	The relative income of the household is used.
It is free from equivalised household income cut-off.	It is based on equivalised household income cut-off by the bottom 40 percent.	It is based on equivalised household income between 10 to 40 percentiles.
Has been used in the past.	Widely used in Australia.	Used on a few occasions.
No account is given to the size of income unit.	Proper treatment is given to the size of the household income unit.	Proper treatment is given of the size of the household income unit.

Source: Rahman, (2011).

The 30/40 rule is the widely used definition of housing stress in Australia. Although this definition may ignore marginal housing stress, it acknowledges the size of the household income unit by using the equivalised household income distribution. Whereas, the 30/(10-40) rule is also based on equivalised household income distribution, it is more restricted and occasionally uses a definition that ignores both the severe and marginal forms of housing stress. Nevertheless the availability of suitable data, methodological tools and specific research interests in each of these definitions is useful.

It is noted that, in all the definitions, households with negative and nil incomes have been removed from the analysis. In survey data, few households have reported nil or negative incomes. These are often excluded from any analysis related to income distribution and financial well-being, as research from the ABS has shown that the expenditure of these households is similar to that of households earning much more, so these incomes are considered an unreliable measure of a household's standard of living (ABS 2005).

Moreover, the distributions of housing stress measured by the three different rule-based variants are presented in Figure 2. It is obvious from the figure that not only does the percentage of households in housing stress vary under different definitions, but also the density of the SLAs varies with the percentage of housing stress across Australia.

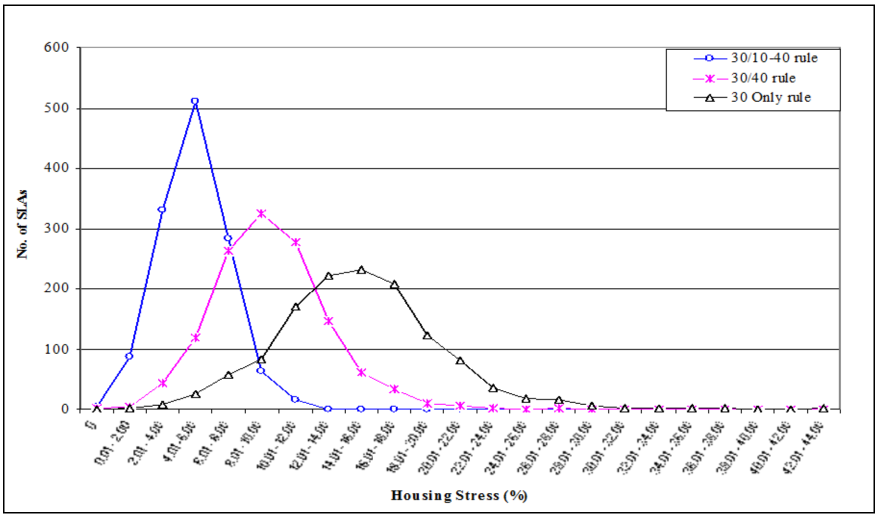

Figure 2. Distribution of Housing Stress for Three Variants in Australia.
Source: Rahman, (2011).

The graph of the ‘30/40 rule’- based variant of housing stress shows that approximately 67 percent of the SLAs have housing stress households of 7 to 11 percent, with a mean of 9.52 percent and a coefficient of variation (C.V.) of 34.95. In addition, the graph of the ‘30/40-10 rule’-based variant shows that most SLAs (about 87 percent) have housing stress households of 3 to 7 percent, with a mean of 4.91 percent and a C.V. of 41.85. The ‘30 only rule’ variant of housing stress reveals that about 51 percent of the SLAs in Australia have households with a rate of housing stress of 13 to 17 percent, with a mean of 14.68 and a C.V. of 36.71.

According to Karl Pearson the C.V. is a very powerful tool for comparing the variability of two or more series of variants (Gupta and Kapoor, 2008), where a variant having the lowest C.V. is considered to be more consistent than the others. In this regard, since the C.V. for the ‘30/40 rule’- based variant of housing stress estimation is the lowest compared with the variation measures for the other two variants, this variant (‘30/40 rule’- based definition) of housing stress estimation is more consistent than the others. Furthermore, in terms of the distributional pattern of these three curves, the ‘30/40 rule’-based housing stress variant also shows a more rational pattern towards the usual normal curve, while the ‘30/(40-10) rule’ and ‘30 only rule’-based variants resemble leptokurtic and platykurtic curves respectively. From the statistical point of view, the ‘30/40 rule’-based housing stress estimation is more consistent and appropriate at small area levels in Australia.

The ‘30/40 rule’-based definition is also accountable and valid for using socioeconomic policy analyses that link with the housing stress issue. For instance, one of the significant policy implications of this definition is that this rule is widely used as the basis for determining household eligibility for entry to public rental housing and/or receipt of commonwealth rent assistance (CRA). Moreover, the definition has been used by many researchers and public and private organizations including the National Housing Strategy (1992), ABS (2002), Harding *et al.* (2004), Yates and Gabriel (2006), and recently in estimating figures used by the Australian Prime Minister and subsequently published by the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA, 2008). Therefore, this paper uses the ‘30/40 rule’- based variant to define households in housing stress as those with equivalised household gross income in the lowest two quintiles (bottom 40 percent) of all household incomes in Australia, who are spending more than 30 percent of their gross household income on either renting costs or mortgage repayments.

3. METHODOLOGY

This section briefly presents the research methodology – which is a spatial microsimulation modelling technology (MMT) approach of small area estimation. The method is rapidly becoming popular in the developed world and has now a wide range of applications (see for example, Rahman, 2011; Rahman *et al.*, 2013; Rahman and Harding, 2014) including simulation of the small area impact of changes in income taxes and cash transfers (Ballas and Clarke, 2001; Harding *et al.*, 2009); the development of small area measures of poverty and social exclusion (Tanton *et al.*, 2009; McNamara *et al.*, 2007; Miranti *et al.*, 2011); the small area modelling of activities of daily living status and/or the need for different types of care (Williamson, 1996; Lymer *et al.*, 2008); the development of the SimObesity model to examine small area obesity among children (Procter *et al.*, 2008); small area health-related conditions (Ballas *et al.*, 2006a; Rahman and Harding, 2011; Rahman and Harding, 2013) and the socio-economic impacts of major job gain or loss at the local level (Clarke, 1996; Ballas *et al.*, 2006b).

Spatial-level Microdata Generation

Creation of a synthetic micropopulation dataset at the small area level, such as the SLA level in Australia, is very challenging. Small area estimation technologies have become useful tools to overcome this challenge. Although there are two methods (statistical and geographic) in small area estimation for generating small area microdata, this paper uses the geographic approach also known as spatial microsimulation modelling (SMM). A detailed description of various methods, their properties, suitability and applications are reported in other studies (Rahman, 2009; Harding and Tanton, 2011; Rahman and Harding, 2014). The MMT approach of microdata simulation involves some complex procedures, whose gradual evolution has been described in detail in other research (see for example, Chin and Harding, 2006; Rahman *et al.*, 2010b; Cassells *et al.*, 2010; Rahman, 2011; Rahman *et al.*, 2013).

To produce SLA level housing stress estimates in Australia, a SMM was designed that uses a range of datasets that come from the Australian Bureau of Statistics. These datasets have custom designed tables from the Census. In summary, the ABS sample survey in question is reweighted to match the small area Census benchmark tables, resulting in unit records for households and individuals for each SLA in the model. General discussion about these datasets and various steps of microdata generation are contained in Rahman (2011). The model generates reasonable microdata (by an *accuracy index criterion (AIC)* illustrated in Rahman, 2011) for 1 397 SLAs which contain more than 99.9 percent households. Among 1 422 SLAs across Australia, the model did not produce reasonable microdata for only 25 SLAs (non-convergent SLAs as per the AIC), which had very small or no populations and were typically located in very remote areas. The overall microdata generation process is depicted in Figure 3.

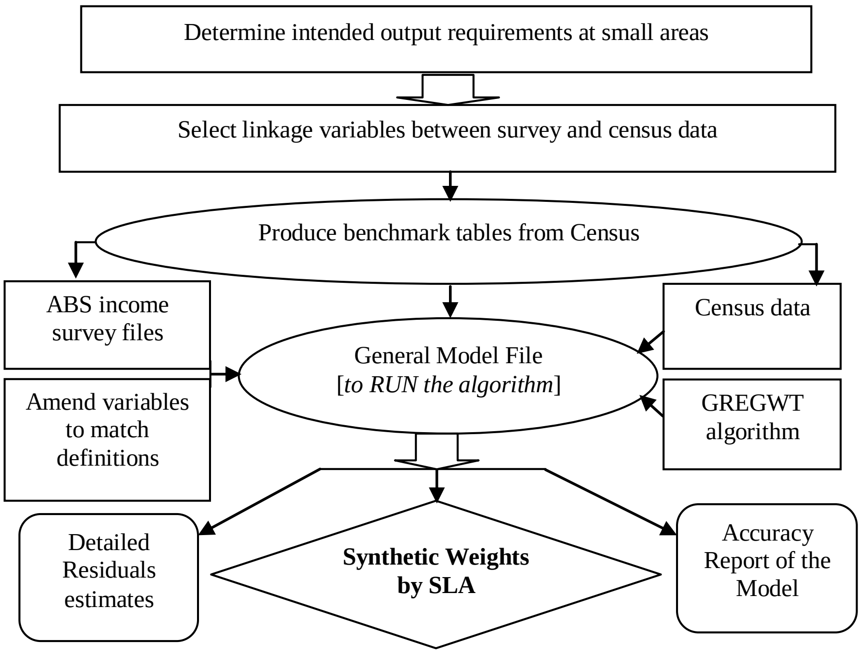

Figure 3. A Process of Synthetic Spatial Microdata Generation.
Source: Rahman, (2011).

Clearly, the process starts by using the SAS language to run the general model file, which contains the path to all input data files and the GREGWT algorithm. The main calculations in the iteration process for the GREGWT algorithm operate separately for each *id* number of small areas (that is SLA codes). This complex process tracks numerous matrix and/or vector calculations towards achieving convergence for each SLA in the minimum number of iterations. In addition, it also does analysis for extreme data units to determine whether the extreme units have effects on the overall calculations. However, the output keeps records on only the top 30 extremes.

Although the GREGWT program follows the Newton-Raphson approach of iteration, the entire execution process of the model follows just a few successive algorithmic steps, which can be described as:

Step 1: Read in the general model file.

Step 2: Read in benchmark tables, Census data and microdata records from Survey of Income and Housing-Confidentialised Unit Record Files (SIH-CURFs) with SIH-linkage file mentioned in the general model file.

Step 3: Query the individual records within the microdata according to the classifications of the general model file.

Step 4: Change original weights to a new set of weights following a truncated Chi-Square distance function for an appropriate allocation of households/individuals towards the small area benchmarks.

Step 5: Apply the *Newton-Raphson* method of iteration to determine the best set of new weights by minimising the total distance between the new-synthetic weights and original weights.

Step 6: When convergence has been achieved and/or predefined number of iterations reached, the corresponding new set of synthetic weights is retained by the process and considered as the best reweights.

Spatial Microsimulation Model Outputs: The 1st Stage

Basically there are three outputs from this initial phase of the model. First of all, the core output is the file of synthetic household weights by SLAs in Australia. This file is considered as the most significant output of the model because of its usefulness in the next computational stage of the model (for getting small area microdata and the estimates). The second and third outputs of the model are, respectively, details about residual estimates of the synthetic weights and a convergence report of the model. These two outputs are associated information about the synthetic weights produced by the model. For example, the residual estimates file shows the accuracy of the new weights according to various benchmark classifications. In the spatial microsimulation process, a modeller's expectation is to minimise the overall residual estimates as much as possible, to ensure the consistency and reliability of the synthetic weights. In addition, the convergence report provides information about whether or not the GREGWT reweighting algorithm has converged to the benchmarks for a specific SLA. When the convergence rate seems reasonably low, then the modeller may need to revisit the specification of the model for modification.

Note that the "*synthetic weights"* file (see Table 2) is the central requirement in the MMT approach of small area estimation. The synthetic weights output file is often known as the synthetic or simulated spatial microdata new-weights, and it is the only output to be used in the next stage of the model for producing ultimate small area estimates. If this stage of the model can generate more accurate synthetic weights at small area levels, then the final small area estimates of interests are likely to be statistically more reliable.

Table 2. An Illustration of Households *Synthetic Weights* Produced by the GREGWT Algorithm for SLA level Microdata at in Australia.

Turning the national level household weights in the Survey of Income and Housing (SIH) – CURFs data *into*						Household (HH) *synthetic weights* for the SLA levels microdata			
Unit record	HH ID	Wkly income	Wkly rent	Other variable	HH weight	NSW SLA1	NSW SLA2	NSW SLA3	Other SLA
1	1	7	3	.	1029	0	10.2	0	.
2	2	11	4	.	157	0	0	0	.
3	3	11	4	.	157	0	0	0	.
4	4	11	4	.	157	0	0	0	.
5	5	11	0	.	1003	2.45	9.64	16.38	.
6	6	11	0	.	1003	2.45	13.54	16.38	.
.	.	.	.	.			.	.	.
.	.	.	.	.	**GREGWT reweighting**		.	.	.
53220		.	.	.	.	.	.	.	.
					8.4 million	**12465**	**25853**	**27940**	.
					No. of HHs in AUS	**No. of households in SLAs**			

Source: Rahman, (2011).

Model Outputs: The 2nd Stage

To produce small area estimates of housing stress we have to run the second stage of the housing stress model. This section describes various parts of the 2nd stage of the model for SLA level housing stress estimation.

Typically, three input files are essential for the second stage of the housing stage model. They are

1) SIH-CURFs;

2) Synthetic weights; and

3) The Consumer Price Index (CPI) file.

These three input files are connected by a SAS program file that is known as the second stage program file. This SAS file not only contains all the linkage paths towards the input files, but also it programs the definition of the housing stress measure, various logic operations and codes of summary statistics for small area estimates. It also indicates a pathway to an *outputs folder* where the demanded small area estimates could be stored.

The output from the second stage model is the ultimate file for small area housing stress estimates in Australia. This research considers the SLA in Australia as a small area. So, the ultimate output file will contain a range of data for the SLA level housing stress estimation. In particular, the file contains data for the following attributes presented in Table 3.

Table 3. Attributes of the Final Outputs file of the Model.

○ SLA ID; ○ Total number of households; ○ Fully owner households; ○ Buyer households; ○ Renter public households;	○ Renter private households; ○ Other tenure type households (i.e., hospital, hostel, military tenure etc); ○ Total housing stress; ○ Owner in housing stress;	○ Buyer in housing stress; ○ Renter public in housing stress; ○ Renter private in housing stress; ○ Other tenure households in housing stress.

Source: the Authors.

The output file provides household level estimates of total numbers as well as percentages for each characteristic in the above table. The model can also produce persons' level small area estimates for these variables.

4. RESULTS AND DISCUSSION

This section reports on a selection of the outputs which are produced by the model.

Households and Housing Stress by Tenure Type

The distributions of Australian households and housing stress by tenure are given in Figure 4. About 70 percent of households are living in their own house, with half of them being buyers. Nearly 27 percent of households are renters, with about 22.5 percent being in private rental. Only 2.9 percent of Australian households are living in other tenures, such as hospital beds, military housing, hotels/hostels etc. Figure 4b reveals that one-third of buyer households (33.2 percent) in Australia are in housing stress. It seems an indication that a proportion of low income households buying their house with the support of first home owners' grant is associated with a high house price, and very low levels of housing supply in many areas, especially in the inner city areas. Additionally, about 59.6 percent private renter households experience housing stress, while just 6.9 percent public renters are in housing stress. So, housing stress estimates for private renters have not only significant influence on the housing stress estimates for renters and overall households, but also have an effect on spatial scales where housing supply is very limited and the demand as well as costs of housing are high for a proportion of low to middle earner households (Rahman, 2011).

a. Australian Households. b. Households in Housing Stress.

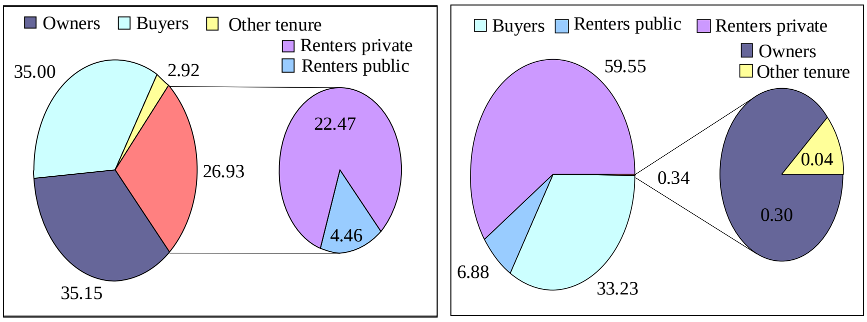

Figure 4. Distribution of Households and Housing Stress Estimates by Tenure Types in Australia, 2011. Source: the Authors.

Although in theory, households living in public housings are paying less than 30 percent of their assessable income in housing rent (AIHW, 2009), in the equivalised household gross income amount they may be paying more than 30 percent of their income in housing costs. The Commonwealth Rent Assistance eligibility is dependent on recipients being on some form of government transfer payment which is also the primary source of income for public housing households. However, as very low income households, these tenure groups are likely to be in housing stress. For instance, in 2005–06, the proportions of public housing households in Australia with an older resident was 28 percent and with a member with a disability was 29 percent, while substantial percentages (about 29 and 33 percent of households with an older tenant or tenant with a disability respectively) of them were still in housing stress, after the Commonwealth Rent Assistance had been received (see for example, SCRGSP, 2007; AIHW, 2008).

Estimates for Different States and Territories

The model estimates a total of 7 128 035 households in Australia, of which 10.9 percent (i.e., 773 073 households) are in housing stress (Table A1 in *Appendix*). One-third of Australian households are located in NSW of which about 11.6 percent of households are in housing stress, and the estimated housing stress number for private renters (i.e., 164 089 households) is almost twice the estimated number for buyers (83 894 households). Victoria is the residence of a quarter of Australian households with about 10.4 percent of households being in housing stress, most of which are buyers and renters. Nearly 11.3 percent of 1 387 069 households in Queensland are estimated to be in housing stress with almost 27.9 percent being private renters.

Although Western Australia contains 701 116 households, of which about 9.9 percent are in housing stress, the estimates for public renters are much lower in WA and Tasmania compared to the estimates for other states and territories. The overall rate of housing stress is also higher in South Australia. About 10.1 percent of 181 666 households are experiencing housing stress in Tasmania. Moreover, only 6.6 and 9.2 percent of households located in the Australian Capital Territory and Northern Territory are in housing stress, with the highest prevalence rate (i.e., approximately 20 percent) in the public renters.

Housing Stress by Statistical Division

Table 4 presents the results of housing stress estimates for various statistical divisions (SD) in Australia. An estimated number of 163 655 (21.2 percent) and 135 702 (17.6 percent) households are experiencing housing stress in Sydney and Melbourne SDs. A relatively smaller but significant number of housing stress households are in other major capital city SDs - such as Brisbane: 66 718 (8.6 percent), Perth: 53 766 (7.0 percent) and Adelaide: 46 749 (6.1 percent).

Table 4. Housing Stress Estimates by the Statistical Division in Australia, 2011.

ID	*SD*[1] Name	HS[2]	%	ID	*SD* Name	HS	%
105	Sydney	163655	21.17	340	Mackay	4368	0.57
205	Melbourne	135702	17.55	155	Murray	4292	0.56
305	Brisbane	66718	8.63	135	North Western	4204	0.54
505	Perth	53766	6.95	620	Mersey-Lyell	3912	0.51
405	Adelaide	46749	6.05	230	Mallee	3404	0.44
307	Gold Coast	25787	3.34	245	Ovens-Murray	3339	0.43
110	Hunter	24764	3.20	215	Western District	3203	0.41
115	Illawarra	17058	2.21	705	Darwin	3171	0.41
125	Mid-North Coast	15777	2.04	250	East Gippsland	3016	0.39
309	Sunshine Coast	14261	1.84	312	West Moreton	2825	0.37
120	Richmond-Tweed	12680	1.64	420	Murray Lands	2657	0.34
315	Wide Bay-Burnett	11991	1.55	435	Northern	2637	0.34
210	Barwon	9783	1.27	425	South East	2153	0.28
350	Far North	9055	1.17	535	Central	1870	0.24
320	Darling Downs	8011	1.04	515	LowerGreat South	1848	0.24
605	Greater Hobart	7856	1.02	415	YorkeLower Nrth	1612	0.21
510	South West	7742	1.00	225	Wimmera	1486	0.19
145	South Eastern	7716	1.00	525	Midlands	1423	0.18
805	Canberra	7700	1.00	710	NT -Bal	1334	0.17
240	Goulburn	7339	0.95	610	Southern	1266	0.16
235	Loddon	6794	0.88	530	South Eastern	1245	0.16
130	Northern	6654	0.86	430	Eyre	1147	0.15
345	Northern	6654	0.86	160	Far West	727	0.09
140	Central West	6568	0.85	545	Kimberley	685	0.09
255	Gippsland	5959	0.77	325	South West	575	0.07
220	Central Highlands	5621	0.73	355	North West	529	0.07
330	Fitzroy	5609	0.73	540	Pilbara	449	0.06
615	Northern	5339	0.69	520	UpperGreat South	430	0.06
150	Murrumbidgee	5234	0.68	335	Central West	224	0.03
410	Outer Adelaide	4500	0.58	***000***	***Australia***	***773073***	***100***

Note: [1]Statistical Division; [2]Total No. of Households in Housing Stress. Source: the Authors.

Thus, Sydney, Melbourne, Brisbane, Perth and Adelaide collectively account for about 60.5 percent of the total number of households in housing stress for Australia. In comparison, only 2.4 percent of housing stress households reside in Hobart, Canberra and Darwin. The remaining 37.1 percent of households reside in non-capital SDs. Seven south-east coastal SDs such as Hunter, Illawarra, Mid-North Coast and Richmond-Tweed in the NSW and the Gold Coast, Sunshine Coast and Wide Bay-Burnett in Queensland – have relatively higher estimates than other non-capital SDs (ranging from 11 991 to 25 787 households) and collectively contain 15.8 percent of all housing stress households in Australia.

Estimates for Various Statistical Subdivisions

To get a much better view at the regional level, the results at the statistical subdivision (SSD) level show that a significantly large number of 20 990 households experiencing housing stress is in the port city Newcastle (Table A2 in *Appendix*). There are several main geographical regional parts where housing stress is concentrated at SSD level in Sydney, Melbourne, Perth, Adelaide and coastal regions in New South Wales and Queensland. Twelve SSDs making up the western, south western, northern and inner parts of Sydney collectively contain an estimate of 150 775 (19.5 percent of total) housing stress households in Australia. The Fairfield-Liverpool SSD in western Sydney individually has the highest proportion of 16.9 percent households in housing stress.

Although Western Melbourne SSD has the third highest estimated number of 17 098 households, the area's rate of 11.5 percent is relatively low. The Greater Dandenong, Hume and Frankston cities and inner Melbourne have housing stress rates of 14.9, 14.1, 12.6 and 12.3 percent respectively. In addition, several SSDs in north, east and south-east metropolitan Perth and the northern, southern, western and eastern parts of Adelaide have noticeably large estimates of housing stress. Some other major coastal centres such as Wollongong, Richmond-Tweed and Hastings in NSW; Gold Coast, Sunshine Coast, Wide Bay-Burnett and Cairns city in Queensland; and the Hobart SSD also have significant estimates.

It is noticeable that low income households residing in the attractive and a high demand Gold Coast region are more prevalently (an average rate of 14.0 percent) in housing stress. This may be because of a very high level of house prices or rents in the Gold Coast areas.

SLA Level Estimates of Housing Stress across Australia

The spatial analysis depicts estimates by SLAs. Typically, the spatial units of analysis vary greatly in population size and presenting results for the estimated number of households in housing stress usually does not mean a great deal when looking at which areas have housing stress. Thus, only the percentage estimates are considered in spatial analysis, and the spatial graph is depicted in Figure 5. For mapping, the quantile classification is used for geographic distribution of the housing stress (but those SLAs that did not meet the *accuracy criterion* in the microdata simulation process are treated as missing). This option examines the relativity of all SLAs in Australia. In view of the fact that city areas are very condensed and unseen in the main map, they are presented in separate boxes.

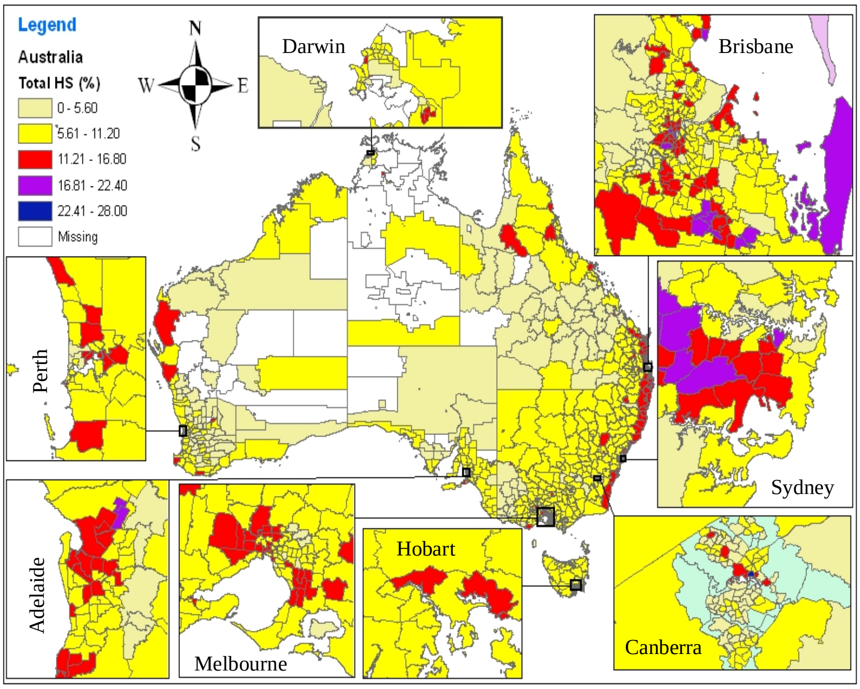

Figure 5. Estimated Proportion of Households in Housing Stress by the Statistical Local Area in Australia, 2011. Source: the Authors.

Findings of the spatial analysis reveal that most of the SLAs in the east-coast and some SLAs in the west-coast regions in Australia have a relatively higher rate (over 11.2 percent) of households in housing stress. Although many SLAs in inland remote regions throughout the country have the lowest rates of housing stress households, small areas across the mining-boom regions in inland Queensland and Western Australia illustrate relatively higher percentage estimates.

The map also reveals that a number of SLAs located within some major capital cities of Australia have significantly high rates of housing stress (ranging from 16.81 to 28.00 percent). Some SLAs in inner locations of Melbourne, Canberra and Adelaide have the highest percentage estimates. For example, SLAs of inner city in Melbourne and Canberra have estimates of 27.0 percent and 23.2 percent respectively. Perhaps, these results are due to the fact that housing in inner city SLAs is always preferable to many high income households who are in housing stress by choice. Housing supply is very much limited in inner city areas. So the house price and rents are too high, and consequently unaffordable to a high proportion of low to middle income households.

Nevertheless, many SLAs from Brisbane and Sydney, with some others from coastal cities in Queensland and NSW, also have the highest rates. It is evident that few SLAs in Sydney: *Fairfield (C) – East,* Canterbury (C), *Bankstown (C) - North-East* and *Auburn (A)* have a significantly high proportion of housing stress. This is because a large number of households live in these SLAs, with a sizable representation of them from the low income households. Also, small sample size problems appear to exist within many SLAs in Brisbane, where the number of households experiencing housing stress is very low, but the percentage estimate is significantly high due to the small value of the denominator.

5. VALIDATION TOOLS

Validation and the creation of measures of the statistical reliability of small area estimates by microsimulation modelling are challenging (Ballas and Clarke, 2001; Hynes *et al.*, 2006; Edwards and Clarke, 2009; Rahman, 2009; Rahman *et al.*, 2010a). At small area levels, the estimated data are typically unavailable from another source. Accordingly, some researchers have suggested re-aggregating the small area estimates up to larger levels, where reliable data are available to compare the results (Ballas and Clarke, 2001; Kelly, 2004), while others have attempted to use alternative methods to determine the accuracy of their model estimates (Hynes *et al.*, 2006; Edwards and Clarke, 2009). Discussions about various validation methods used by researchers are outlined in detail in other studies (i.e. in Rahman, 2011; Rahman *et al.*, 2013; and Rahman and Harding, 2014). This section offers a new validation tool for testing the accuracy of SLA level housing stress estimates in Australia which are produced by the microsimulation modelling technology.

Absolute Standardised Residual Estimate (ASRE) Analysis

In this approach to validation, we first have to calculate an absolute standardised residual estimate (ASRE) for a small area (in this case SLA level housing stress estimation), and then analyse the values of the ASRE to make a decision about the accuracy. The mathematical formulae for the ASRE use the following standard notations:

$\hat{Y}_{ij}$ is an observed household total in the j^{th} data at the i^{th} small area;

Y_{ij} is the total households in the j^{th} population at the i^{th} small area; and

m_r is the number of small areas in a r^{th} region and $r > i$.

The ASRE can be defined as-

$$ASRE = \left(\frac{\delta_{ij}}{\sqrt{AEMSE}} \right)$$

where $\delta_{ij} = \left| Y_{ij} - \hat{Y}_{ij} \right|$ and $AEMSE = \frac{1}{m_r} \sum_m \left(Y_{ij} - \hat{Y}_{ij} \right)^2$ where the

AEMSE is the *Average Empirical Mean Square Error* (see for example, Gomez-Rubio *et al.*, 2008 and Rahman, 2011).

The decision criterion for this validation technique is: 1) when the value of *ASRE* is close to zero or less than 2 for a SLA then the synthetic household estimate is acceptable (i.e. the performance of the model estimate is good); and 2) when the *ASRE* value is at least 2, then it is usually considered as a large error (Field, 2000) suggesting that unexplained errors exist in the model estimates and/or the micro-simulated datasets.

Results from the ASRE Analysis

Results of ASRE analysis for overall households in housing stress confirm that for 1 205 SLAs out of 1 278 (94.3 percent) in Australia, the model determined very accurate housing stress estimates (Figure 6). There are 73 SLAs that have an ASRE measure of at least 2, and many of these SLAs are located in the capital cities and coastal centres such as Wollongong, Newcastle, Coffs Harbour, Tweed Heads, Gold Coast, Hervey Bay, Mackay etc. For instance, a few SLAs in Ipswich show a high value of ASRE, which indicates that the model has produced statistically non-significant housing stress estimates in this area. In particular the SLA: *Ipswich (C) – Central* shows an *ASRE* value of 5.6, which is much bigger than 2. So, for this small area, the estimate of housing stress is not statistically accurate using the ASRE measure.

Ipswich is one of the fastest growing regions in Brisbane and the population characteristics are quite different to the Australian average. In particular, a significantly large number of working population families (about 60 percent) are Technicians & trades workers, Community & personal service workers, Clerical & administrative workers, and Labourers, who tend to have lower incomes (ABS, 2007). But the housing costs in this area are relatively high. The supply of housing in this area is also inadequate with growing housing demand for increasing populations. As a result, the model simulates significantly high estimates of housing stress for the region by considering the micro-level attributes.

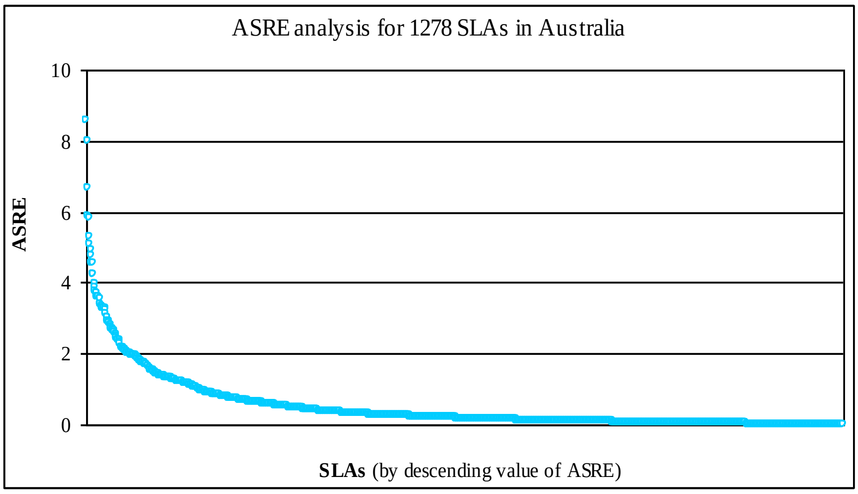

Figure 6. ASRE Analysis for the Estimates of Total Households in Housing Stress. Source: the Authors.

To get an idea of why a non-significant value of ASRE arises for some of these small area estimates, we may check detailed micro-level results for an SLA (such as *Petermann-Simpson* in Alice Springs, NT) along with its geographic characteristics. For the *Petermann-Simpson* SLA, the ASRE value of 8.5 has revealed that the model overestimated the housing stress for overall households. It is noted that *Petermann-Simpson* is one of the functional economic and strategic growing areas in rural central Australia (ABS, 2007; Rahman, 2011). Economic growth in this SLA results from the flow-on effects of providing regional support services to major national projects such as tourism, culture and heritages conservation, mining development, defence construction, forestry and horticultural trials, and a transport and logistics hub servicing the central Australia railway. However, residential land release and housing supply is not consistently adequate in this remote area with its growing population. High demands for housing increase the house price and rents in the area that increase noticeably the money allocated to housing for lower income households and perhaps skew the estimate of housing stress. Sharply increasing housing costs (the average annual change for 2008-09 is estimated as 27 percent) for a large group of low income households (having median weekly income of 961 AUD) residing in *Petermann-Simpson* has influence over a high rate of housing stress.

6. CONCLUSIONS

This paper has empirically examined the statistical local area level housing stress estimates across Australia using a synthetically simulated micro-dataset and analysed the results. It has also demonstrated a new method for validating the results of small area housing stress statistics.

According to our findings housing stress estimate is greatest within several-hotspot areas in Australia. One of the key findings using outputs from the spatial microsimulation model was that in 2011 around one in ten Australian households were experiencing housing stress, with large numbers of these households residing in the east coast states of New South Wales, Victoria and Queensland. When looking at housing stress at a higher geographic disaggregation, findings from the model outputs have revealed that households experiencing housing stress were mostly residents of the Sydney, Melbourne, Brisbane, Perth, Adelaide, Gold Coast, Hunter, Illawarra, Mid-North Coast statistical divisions, along with some other statistical divisions located across the coastal centres of New South Wales and Queensland. The Canberra, Hobart and Darwin statistical divisions all have relatively low housing stress levels.

Breaking the geographic classifications down to a finer level, we find greater heterogeneity in housing stress estimates, but still the households are concentrated in these main locations or spots. Areas with a high proportion of households living in housing stress were those concentrated in the outer fringes of capital cities along the east coast of Australia. Of particular interest was Newcastle, which has the largest estimated number of households (20 990) in housing stress among all of the statistical subdivisions in Australia. More explicitly, the range of estimated numbers of housing stress was from 1 886 households for *Newcastle (C) - Outer West* to 2 826 households for *Newcastle (C) - Inner City* among the nine SLAs in this statistical subdivision. Although the estimated number is the highest for Newcastle, the percentage estimate (about 11.4 percent) was relatively lower than in many hotspot SSDs within the capital and non-capital cities. Some other non-capital coastal cities - such as Wollongong, Richmond-Tweed, Hastings and Clarence etc in New South Wales and Gold Coast, Sunshine Coasts, Wide Bay-Burnett and Cairns City in Queensland - have spatial subdivisions with much higher rates of housing stress. In addition, many statistical subdivisions within capital cities have also demonstrated large estimated figures. Basically, these regional subdivisions are located in the greater western and northern regions of Sydney, in the western, inner, eastern middle, southern and northern outer regions of Melbourne, in the north-west, south-east and Logan City regions of Brisbane, in the north, east and south-east metropolitan regions of Perth, as well as in the northern, southern, western and eastern regions of Adelaide.

Breaking the geographic scale down even further to one of the smallest and administratively helpful areas – the SLA - we can really see which small areas are suffering the most from housing stress. Findings have demonstrated that a large number of SLAs in the New South Wales coastal cities, including Sydney, had the highest numbers of households in housing stress. Most of the SLAs in Melbourne, Adelaide, and Hobart also had significantly high estimates. Moreover, the rapidly growing mining areas around inland locations in different states have resulted in many SLAs with relatively higher estimates of housing stress. This could be because of a significant lack in the supply of housing within these quickly growing mining areas, which in turn creates a high demand of housing and then increasing housing costs for mainly low and middle income households. In contrast, significantly large numbers of SLAs in Brisbane, Canberra and Darwin have much lower numbers of households in housing stress. This is probably because these SLAs are not only small in size but also have relatively smaller household populations. The results of the percentage estimates reveal somewhat opposite results to the number count estimates: that is, many small SLAs with few households show high percentages of households in housing stress, but there are actually only a few households in stress in these locations. Nonetheless, various SLAs in different capital cities indeed confirm significantly large values in housing stress for both number counts as well as percentages.

The validation tool outlined in this paper is the ASRE analysis, where an ASRE for the SLA level housing stress estimate has been calculated and then analysed using a standard cut-off criteria for making a decision. Results have demonstrated statistically accurate estimates for a very high number of SLAs (about 94.3 percent). There are a number of SLAs with statistically insignificant values of ASRE, and most of them are geographically located in the capital cities, including Melbourne, Brisbane, Canberra and Darwin, as well as major coastal centres in the Eastern part of Australia. Additionally, findings suggest that the proposed validation tools can not only check the statistical validity of an SLA level estimate, but can also identify and describe the possible features of the SLAs that may have insignificant results. The SLAs with ASRE values significantly bigger than 2 demonstrate inaccurate housing stress estimates for the respective SLAs. In such a case researchers would undertake further analysis of these micro-level data for these SLAs, along with their geographic attributes.

Looking at future research directions, we are currently finalising estimates of SLA level housing stress estimates by tenure types within eight major capital cities in Australia, comparing the estimates of housing stress between the cities as well as looking at different SLAs within a specific major city. In addition, a proposed technique for estimating confidence intervals around the housing stress estimates will also be explored. Finally, using groupings of various housing costs such as 0-10, 10-20, 20-30 percent etc of the households' income, a new study would estimates the housing stress for different income deciles and then map the estimates within these groups at a chosen spatial scale such as local government area.

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APPENDIX

Table A1. Number of Households and Housing Stress Estimates by Tenure Types for the States and Territories in Australia, 2011.

States & Territories	**Overall Total**	**Owners**	**Buyers**	**Public Renters**	**Private Renters**	**Other tenure**
	HH[1] **(**HS%[2]**)**	HH (HS)	HH (HS)	HH (HS)	HH (HS)	HH (HS)
NSW	2328200 (11.57)	836696 (0.098)	760241 (11.04)	114423 (17.84)	548464 (29.92)	68376 (0.135)
VIC	1781601 (10.42)	665595 (0.074)	649015 (11.00)	57158 (17.23)	364009 (28.53)	45824 (0.103)
QLD	1387069 (11.29)	452587 (0.127)	480441 (9.80)	49455 (15.66)	362374 (27.90)	42211 (0.142)
WA	701116 (9.91)	226922 (0.087)	270603 (8.90)	29681 (14.91)	151063 (26.94)	22847 (0.153)
SA	583284 (10.54)	208924 (0.064)	208090 (9.94)	42311 (15.19)	104603 (32.66)	19356 (0.103)
TAS	181666 (10.11)	70923 (0.059)	62269 (10.31)	10912 (14.04)	32428 (31.96)	5134 (0.136)
ACT	116911 (6.59)	35567 (0.008)	45761 (4.52)	9453 (20.05)	24101 (15.44)	2027 (0.000)
NT	48188 (9.35)	8432 (0.43)	18174 (7.08)	4533 (19.32)	14668 (15.67)	2380 (0.042)
AUS	7128035 (10.85)	2505646 (0.091)	2494594 (10.30)	317926 (16.72)	1601710 (28.74)	208155 (0.13)

Note: [1]No. of Households; [2]Proportion of Households in Housing Stress. Source: the Authors**.**

Table A2. Lists of the Thirty-Five SSDs with the Highest Estimated Numbers, and Highest Percentages of Households, Experiencing Housing Stress across Australia, 2011.

ID	SSD Name	**HS**[1]	%	ID	SSD Name	HS	**%**[2]
11005	Newcastle	**20990**	11.4	10525	Fairfield-Liverpool	17464	**16.9**
10525	Fairfield-Liverpool	**17464**	16.9	12501	Coffs Harbour	3055	**16.7**
20510	Western Melbourne	**17098**	11.5	10520	Canterbury-Bankstown	15935	**16.1**
50515	North Metropolitan	**16090**	10.1	30710	Gold Coast East	10889	**15.5**
10520	CanterburyBankstown	**15935**	16.1	12007	Lismore	1758	**15.4**
40505	Northern Adelaide	**15626**	11.9	10540	CentralWestern Sydney	15352	**15.2**
10540	CentralWestern Syd.	**15352**	15.2	12005	Tweed Heads&Coast	3611	**15.1**
10515	St George-Sutherland	**14748**	9.8	20575	Greater Dandenong City	6384	**14.9**
10505	Inner Sydney	**14589**	12.1	12010	RichmondTweed SDBal	7311	**14.9**
10570	Gosford-Wyong	**14365**	13.0	12503	Port Macquarie	2338	**14.6**
20505	Inner Melbourne	**14264**	12.3	20535	Hume City	6453	**14.1**
50525	South Eastern Metro.	**13417**	11.0	30715	Gold Coast West	11732	**14.1**
20565	Southern Melbourne	**13338**	9.1	12505	Clarence(excl.CoffsHarb)	5146	**14.0**
40520	Southern Adelaide	**12689**	10.0	31507	Hervey Bay City Part A	2589	**14.0**
20550	Eastern Middle Melb.	**12316**	8.3	30905	Sunshine Coast	11195	**14.0**
30715	Gold Coast West	**11732**	14.1	30705	Gold Coast North	2533	**13.9**
10545	Outer Western Syd.	**11640**	11.2	30520	Caboolture Shire	6324	**13.8**
10553	Blacktown	**11322**	13.2	30545	Redcliffe City	2806	**13.6**
30905	Sunshine Coast	**11195**	14.0	12510	Hastings(excl.Prt Macqu)	5238	**13.5**
11505	Wollongong	**11142**	11.6	30530	Logan City	7670	**13.4**
50520	South Western Metro.	**11003**	9.9	10553	Blacktown	11322	**13.2**
30710	Gold Coast East	**10889**	15.5	31505	Bundaberg	2954	**13.2**
20580	SuthEast Outer Melb.	**10446**	11.9	14515	Lower South Coast	3362	**13.0**
40510	Western Adelaide	**9800**	11.6	30910	Sunshine Coast SD Bal	3066	**13.0**
30507	Nrthwest Outer Bris.	**9339**	8.4	10570	Gosford-Wyong	14365	**13.0**
20530	Northern Mid. Melb.	**9199**	10.1	14003	Bathurst	1381	**12.7**
10555	Lower Northern Syd.	**9140**	8.2	20585	Frankston City	5484	**12.6**
50510	East Metropolitan	**8934**	10.1	11507	Nowra-Bomaderry	1433	**12.6**
10530	Outer SuthWest Syd.	**8837**	11.9	35005	Cairns City Part A	5485	**12.5**
10560	Central North Sydney	**8815**	6.6	23005	Mildura Rural City A	2110	**12.4**
40515	Eastern Adelaide	**8634**	9.8	30720	Gold Coast SD Bal	633	**12.4**
10510	Eastern Suburbs	**8568**	9.8	30501	Inner Brisbane	4227	**12.4**
30511	Sutheast Outer Bris.	**8345**	10.5	20505	Inner Melbourne	14264	**12.3**
60505	Greater Hobart	**7856**	10.3	24005	Greater Shepparton A	1948	**12.1**
20555	Eastern Outer Melb.	**7826**	9.1	10505	Inner Sydney	14589	**12.1**

Note: [1]Arranged by No. of Households Experiencing Housing Stress, and [2]Arranged by Percentage of Households Experiencing Housing Stress. Source: the Authors.