Essays on housing affordability: The who, what, where and for how long

A thesis submitted for the degree of Doctor of Philosophy

By

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List of Abbreviations

CPI	Consumer Price Index
HDI	Household Disposable Income
ABS	Australian Bureau of Statistics
FHOG	First Home Owners Grant
HILDA	Household, Income and Labour Dynamics in Australia
FGT	Foster, Greer, Thorbecke
GPO	General Post Office

Abstract

If housing costs increase faster than incomes, households may be subject to affordability stress, which may put homeownership out of reach, or raise household debts levels to the extent that trade-offs of spending on essential non-housing goods and services must be made. Housing affordability is an important element of economic and social wellbeing that has long been part of policy agenda of Australian governments. In this thesis, the concept of housing affordability is redefined, based on the use of a residual approach. This focuses on the residual income that remains after housing needs are met, which is then compared to a poverty line or budget standard. The alternative approach, based on the ratio of household income spent on housing, is used most commonly in studies of housing affordability, but is applied uniformly across housing situations (renters and homeowners), locations and household types and is less precise in identifying those that are experiencing problems with income and/or housing costs. Four new models are developed to identify the types and situations of households that are subject to affordability stress, where in metropolitan areas they tend to live, and how long the experience of affordability stress last. Using data from the Australian Bureau of Statistics *Income and Housing Surveys*, *Household, Income and Labour Dynamics in Australia* (HILDA), and 'after housing' budget standards, the ordered probit method is applied to identify variables that predict housing stress, including types of housing arrangements and ownership, age, family composition, and level and sources of income. The influence of location and the built environment on whether a household is in housing affordability stress is assessed through a model that includes transport and distance variables for New South Wales and Victoria. In Sydney, affordability stress increases at greater distances from the city centre and inner suburbs, but in Melbourne, distance from the city centre is related to falling housing costs. The difference between the two cities is attributed to their built environment,

which evolved historically in a path-dependent way. The duration of the experience of housing stress is assessed using survival analysis. The results show that renters and single households, especially single males, aged under 65 are particularly vulnerable to long periods of affordability stress, especially when they experience life events that result in reduced levels of residual income.

Declaration

In accordance with Monash University Doctorate Regulation 17.2 Doctor of Philosophy and Research Master's regulations the following declarations are made:

I hereby declare that this thesis contains no material that has been accepted for the award of any other degree or diploma in any university or equivalent institution, and to the best of my knowledge, contains no material previously published or written by another person, except where due reference is made in the text of this thesis.

Part of the material in Essay One has been accepted by the journal *Economic Papers*, in an article titled 'What Types of Australian Households are in Housing Affordability Stress?' The authors are Luc Borrowman, Gennadi Kazakevitch and Lionel Frost, who contributed equally to the work for the paper.

Signed: 

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Introduction

Housing affordability has long been part of the economic and social policy agenda in Australia. Since World War II governments have considered decent housing to be the right of every citizen, and developed plans and policies to improve access to housing markets.[1] Once a household has secured adequate housing, it can make further important life decisions with greater freedom. If housing costs increase faster than incomes, households may be subject to affordability stress, which may put homeownership out of reach, or raise household debts levels to the extent that spending on other essential goods and services is compromised.[2] Lower income groups spend a higher percentage of incomes on housing, and bear disproportionate share of increasing rental costs than higher income groups do (Quigley & Raphael, 2004). The issue of housing affordability is complicated by housing being both a basic need and a form of investment, and by the price inelasticity of supply in the Australian housing market. Any increase in supply that exerts downward pressure on rents and house prices, thus reducing housing costs, is also likely to reduce investment returns for existing homeowners. Furthermore, housing affordability stress is potentially interrelated with broader aspects of a market economy and society. Labour market outcomes are an important element in the reduction of housing stress (Burke, Pinnegar, Phibbs, Neske, Gabriel, Ralston & Ruming, 2007), while those who are in housing stress may experience health issues that reduce the quality of human capital and rates of labour force participation (Bentley, Baker, & Mason 2011). Effective housing policy thus requires a base of evidence as to the types of households that are most likely to experience limited access to affordable housing.

In this thesis the concept of housing affordability is redefined based on a residual approach. This approach focuses on the residual income that remains after housing needs are met to determine household affordability stress levels. The alternative measure, the ratio approach, used most commonly in studies of housing affordability, is based on the percentage of income spent on housing. Using data from the Australian Bureau of Statistics (ABS) *Income and Housing Surveys*, *Household, Income and Labour Dynamics in Australia* (HILDA) and 'after housing'

[1] Troy (2012) provides an excellent historical overview.
[2] Yates (2008) provides an excellent overview of housing affordability and housing stress in Australia.

budget standards, the ordered probit method is applied to identify the variables that predict housing stress, including types of housing arrangements and ownership, age, family type, and level and sources of income. This approach is further expanded to include transport costs in the after-housing measure. The influence of location and the built environment on whether a household is in housing affordability stress is assessed through a model that includes transport and distance variables for New South Wales and Victoria. The duration of the experience of housing stress is assessed using survival analysis, which deals with the length of time between which one or more specific events occur. Renters and singles under 65 are more likely to remain in residual stress than other groups. This is paired with the life events that are experienced by households who fall into stress.

The ordered probit model predicts housing affordability stress based on household types and characteristics. 'Household type' is a term used by the ABS to refer to the family status of the 'household reference person' at each Census. A reference person may be single or part of a couple, and may or may not be living with dependent children.[3] The ABS *Survey of Income and Housing* provides data on the characteristics of households, such as the age of the reference person, his or her place of birth, level of education, labour force status, percentage of income derived from government payments, disposable income in the previous year, and location of the dwelling. The ratio approach treats all household types identically and is not adaptable to different household characteristics. A new form of affordability measurement, based on a redefined residual approach and using budget standards, is applied. This allows targeting of the households that are most vulnerable to affordability stress, which can facilitate the design of effective housing policies.

For households that are in housing affordability stress, the opportunity cost of investment in human capital and other necessities will be greater than for those households that are not in stress. The motivation of the thesis is to understand what type of household is required to make such trade-offs in an Australian context. Hence the following key themes will run throughout the thesis:

[3] 'Household composition' refers to the number of families and non-family members living in each dwelling on Census night.

What is housing affordability, who does it affect, where are these households located and for how long is housing stress experienced?

These themes will be addressed through a refinement of the measure of housing affordability. This measure will then be applied in four different models, each of which will address a specific aspect of the general theme.

The thesis comprises three self-contained essays that are linked by the aim of answering the question posed above. The first essay focuses on what housing affordability is and the identification of who is in stress. Two different models, the *Residual expenditure* model and *Depth of housing stress* model are introduced. The *Residual expenditure* model focuses on the characteristics that predict if a household is in stress or not. These include the age, education, location and place of birth of the reference person. The surveys are also separated by housing situation, renters and homeowners, to gain a further level of detail. An ordered probit technique is applied to the data. The model helps in improving the targeting of housing policy and identification of the type of household that would require more assistance in accessing its right to decent housing. The *Depth of housing stress* model measures the depth of stress that different household types are experiencing, revealing which household type has the greatest depth of stress and hence requires the most attention. The sample was divided to compare different type of renters plus the differences between renter and homeowners. This model adapts a poverty measure that accesses the level of poverty to one for housing needs.

The second essay analyses the location of households that are in stress. The *Residual expenditure with transport costs* model builds on the first essay, using the same techniques but with the inclusion of spatial aspects within the model. The model incorporates elements of the historically-evolved built environment of the city it refers to. It also includes a distance element, based on the principle of the supply of urban amenities being inversely related to distance from the centre of the metropolitan area. To complete the picture, the measure of housing affordability that is used includes actual transport costs for particular locations.

The final essay focuses on the length of time that a household is in stress. The *Living in stress* model is introduced; it models the duration between the event of a household falling into stress and the event of that household moving out of stress. Three techniques of survival analysis

are used: non-parametric, semi and parametric. The *Living in stress* model considers the entire sample and sub-samples to provide an understanding of the survival rate in stress. Those in stress are then considered in semi and parametric analysis against different household characteristics, revealing whether these characteristics predict the length of time in stress, thus uncovering a different picture to a cross-sectional survey. This provides information about whether cross-sectional surveys overestimate the size of the problem and the length of time those in stress are expected to remain that way.

The first essay uses cross-sectional survey data from the ABS, and the second and third a panel data source, the HILDA Survey. The different data sources give a more complete picture as they capture different types of individuals. The cross-sectional surveys are more effective at capturing a cohort of the Australian population at a particular time period. There is less of a bias for certain income distribution levels. The usefulness of the HILDA data lies in the information it provides about individuals over time. To provide data, an individual has to be found every year in the survey. As a result, the sample is quite stable in nature, but this makes it harder to generalize for the general population. Households that are unstable in nature, either because they move regularly, refuse to answer the survey or have certain health problems are less likely to remain in the sample. This will bias the survey towards a more positive outcome, rather than provide a true snapshot of the population.

The thesis uses the residual approach to measure housing affordability in an Australian context to examine who is in stress, for how long and where these individuals tend to be located. The three essays are linked by their common approach to measuring housing affordability. The residual measure is adapted for each of the situations, but is fundamentally concerned with the level of income after housing costs are deducted rather than the actual size of these costs. The amount of non-housing requirements changes depending on the household type and hence so does the benchmark for each type. The measure is primarily focused on the short-term situation and identifies households that make trade-offs between different non-housing necessities due to their level of residual income. Thus while the approach in each essay is similar, the data and techniques used are different.

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Essay One: Housing affordability, what is it and who does it affect?

1 Introduction

Access to housing is a cornerstone of economic development and welfare. Once a household has secured adequate housing, further important life decisions can be made with greater degrees of freedom. The development of effective housing policy related to household affordability depends on research into the housing situation of different types of households. Three main research themes are addressed in this essay:

- The scale of the housing stress problem in terms of the number of households in stress.
- Identification of those in stress, and the characteristics of households that are in stress.
- The definition of housing affordability, based on the measure that is used, that captures most effectively the households that are in housing stress and need policy attention.

The term housing stress will be used in this essay. This term can be used for many different concepts, including overcrowding, housing quality and homelessness. However the term is used here in reference to housing affordability. The concept of housing stress is used to properly identify the characteristics, situation and type of households facing housing affordability problems. The question of what housing affordability is requires consideration of the major measures of housing affordability stress. The two main measures of housing affordability stress used are: (1) the residual income that remains after housing needs are met; and (2) the ratio approach, based on the percentage of income spent on housing, which is used most commonly in studies of affordability.

The aim of this essay is to provide substantiated and quantified results to better target those that need affordability policy assistance and to understand what type of assistance could be effective. While the ratio approach is used widely in housing research, it does not allow for the dynamics of housing stress for different household types. Housing is the major item in many household budgets and for low-income groups the financial situation after housing costs have been met is a pressing one. Decisions about the relative consumption of housing and non-housing goods may vary between households that are in stress and those that are not. The *Depth of housing stress* model quantifies the size of the problem and will be applied to the ratio and residual approaches to housing affordability. This model will be developed further to consider differences between

household housing situations. Distinctions will be made between households that live in public- or privately-owned rental accommodation and those that live in owner-occupied properties, with or without a mortgage. This will provide more detailed insight into residual housing stress levels than that offered by means or head-counts. A *Residual expenditure* model will also be developed, based on the variable of interest that is produced by using the residual approach. This dependant variable will then be applied to household characteristics to identify those who are in stress.

For most households housing is the single largest component of household expenditure. Any increase in the cost of housing negatively affects households' budget constraints, purchasing power, standard of living, welfare and consequently, the overall economy and the future of the nation(Berry, 2006, Bostic, Gabriel and Painter 2009). In the short term, shelter is one of life's basic necessities. In the long term, a home is a major component of a family's investment portfolio. For many families, it is the largest investment decision they will make. Therefore, the housing market has flow-on effects throughout the economy. When house prices increase, home owning households believe that their lifetime wealth has increased and this encourages them to consume at a greater level. If a person has access to affordable housing they are better able to gain education and employment. When housing costs are large they restrict household residual income and can lead to household members having to forgo other basic necessities.

The Global Financial Crisis demonstrated the economic importance of housing. The crisis affected mainly the US and European markets, with the Australian market largely unaffected (Burke and Hulse, 2010). With a rapid decrease in house values, household wealth levels decreased, which reduced consumption in general (Yate and Whelan, 2009). This flowed on to reduced employment and incomes, which pushed more households into financial stress. It is important to understand the size of the housing affordability problem and who it affects so that action can be taken.

The measure of affordability used must capture the big picture of those who are in poverty due to low income, high housing costs, or both. The aim is to produce two models that capture the extent and characteristics of those who are in stress. Ideally, housing stress measures should produce a consistent picture from different data sets and across different types of households. Once appropriate stress measures are chosen, the housing experience will be examined to discover who is in housing stress in the two models. The residual stress measure will be used as it best represents

household outcomes after housing needs are met. The measure will be applied to ABS surveys, with the *Residual expenditure* model testing for any significant relationship between household characteristics and residual stress, and the *Depth of housing stress* model testing for the size of the problem. This will show the size of the problem and the characteristics that help predict stress.

The research question is: *What is housing affordability and who is really in housing affordability stress?*

This question includes three components:

(i) Which household type experiences the greatest depth of housing stress as revealed by the *Depth of housing stress* model?

(ii) Which household characteristics predict if a household is more or less likely to be in residual stress, as revealed by the *Residual expenditure* model?

(iii) What type of measure – the residual or ratio approach – should be used to measure housing affordability in the two models?

The methods that will be used fall into three categories. First, a *Depth of housing stress* model is developed. This uses the Foster, Greer, Thorbecke statistic (*FGT),* which has hitherto been used mainly in poverty studies and not applied extensively to housing research. This is due to many housing approaches being input focused, while the *FGT* statistic is outcome focused. The statistic is developed further here to incorporate residual and ratio approaches for different household types or housing situations. Second, a *Residual expenditure* model applies an ordered probit approach to residual measures of housing affordability, to identify significant variables for predicting different residual incomes. Third, budget standards for different household types are developed and improved. These budget standards will be used to develop a residual measure of housing stress that will be used in both models

The essay is structured as follows. Section 2 reviews the literature relating to the conceptualisation, modelling and measuring of housing affordability. Existing and proposed measures of affordability, including the *FGT* Statistic, budget standards and the residual method are identified. In Section 3, the *Depth of housing stress* and *Residual expenditure* models are developed. The different types of measures that will be used within the models will be elaborated upon. The budget standards are explained and developed further within the affordability measure.

In Section 4 the data requirement and the reasons for selecting the particular data will be discussed. The type of data that is used is important in terms of outcomes from the model and for transferability. Section 5, gives the output from the two models. Policy responses derived from these outputs are considered in Section 6. The detail in these policy responses reflect the depth of information yielded by the results. Section 7 concludes.

2 Housing as a socio-economic concept

The general topic of housing covers many elements, ranging from a basic need to a financial investment. The key impacts, measures and approaches taken to understand housing will be shown, to place the essay in the context of current housing research. The impact of housing stress on individuals, including negative effects on mental health and the ability to maintain social networks will be addressed. A better understanding of the measures and types of outputs they give will improve our understanding of the results achieved from different models. The type of output desired can be produced if correct measures are inputted into the model.

The remainder of the essay proceeds as follows. Section 2.1 addresses the economic and social impacts of housing affordability for different types of housing situations. If there is a widening gap in affordability between home owners and renters that favours the former, the impact on housing need will be felt initially by renters in the form of a lack of security and the reduced likelihood of entering homeownership; in the long term, homeowners will benefit through the appreciation of household wealth. Section 2.2 introduces the *FGT* statistics that underpin the *Depth of housing stress* model. Section 2.3 examines the strength and weakness of housing affordability measures that have been used to date. For the ratio measure the most common benchmark is 30 per cent of income, but no justification for the choice of this figure has been advanced in the literature. For the residual measure, the justification for setting of a benchmark at a certain level is discussed in Section 2.4. Section 2.5 summaries the approach that will be taken in this essay.

2.1 Economic and social aspects of housing affordability

Housing is an object that everyone consumes, because shelter is a basic human need. For many, housing is also an investment – a method of creating future wealth. The problem is that the same housing unit may be looked at as a necessity by one person and an investment by another, depending on household characteristics and financial circumstances. Housing expenditure is thus influenced by many factors, including housing prices, housing quality, income levels, the ability of households to borrow, public policies affecting housing markets, conditions affecting the supply of new or refurbished housing and the choices that households make about how much housing to consume relative to other goods. Quigley and Raphael (2004) confirm a common, intuitive finding that lower income groups spend a higher percentage of incomes on housing than higher income groups do. If demand and supply factors are causing rental costs to rise in real terms, because rent payments represent a higher proportion of expenditure by low income household, the rise will have a greater impact on low income households. The cause of housing affordability is multi-faceted and what variables are given weight in such explanations may depend on which interests are promoting affordability explanations. Different explanations have been suggested, including excess demand fed by financial deregulation, the tax environment, easy lending terms and low interest rates (Philips 2011), change in the composition of supply with a drop in social housing numbers (Jacobs, Atkinson, Peisker, Berry, and Balton 2010). .

For households that experience housing stress there can be serious negative consequences that flow on to other aspects of family life. Stability of housing may improve a person's ability to hold a job and improve their mental state. There appears to be a link between housing affordability problems and mental health issues (Bentley, Baker, & Mason, 2011). Mental health issues make it more difficult for people to take an active role in society, which also impacts on the economy by reducing labour force participation and increasing health costs.

Economic conditions affect whether low-income households are able to retain their housing (Burke et al., 2007). Households on low incomes are reliant on employment to meet the costs of renting or buying housing. Often the difference between low income earners who struggle to meet housing costs and those that do not lies in their ability to remain in full-time employment. For many, changes in an employment situation are a tipping point that pushes them out of active participation in the housing market. Labour force status affects both renting and buying housing,

making it difficult for any single policy to be effective and highlights the importance of a strong economy to access to decent housing.

It is commonly thought that home ownership improves the affordability position of low-income earners, giving them greater security and the ability to grow equity in the long term. Haffner and Boumeester (2010) find a growing income gap between renter and homeowners in the Netherlands, with higher income households moving to ownership and low income ones either moving into or remaining renters. The income gap between the two types of tenure widened from 2002 to 2006, with renter incomes falling or remaining stable over time, Haffner and Boumeester (2010) suggested this is part of a longer term trend. If these findings are applicable to Australia they carry policy implications. Homeownership helps households to prepare for later life by forcing savings through mortgage repayments. In establishing the principles of the Australian income support system in the early decades of the twentieth century it was assumed that pension recipients would be outright owners at the point of retirement (Kerneny 1977). Yates' (2008) study of the change in two aggregate variables – housing cost and incomes – shows that the problem of housing affordability in Australia has worsened over time. A growing gap between real house price and income trends moved the housing market away from its fundamentals and this may explain the subsequent softening of the market. Breaking the market down into sub-sections suggests that many private renters face the prospect of never gaining access to the economic and social advantages provided by homeownership (Yates, 2008). Traditional forms of assistance, such as public housing and/or social housing have been reduced, and market-driven policies are now more likely to be used. This has taken direct control away from governments and increased uncertainty, thus a measure of the depth of the problem is required.

2.2 Poverty line measures

Most countries have an official poverty line that is used to assess the wellbeing of their people. The poverty line classifies people as to whether they are in poverty or not, but provides no further information. Foster, Greer, and Thorbecke (1984) developed a measure that takes the poverty line and examines the relevant data in more detail to uncover the depth of poverty. What is now known as the Foster, Greer, Thorbecke statistic (*FGT*) has been used in several fields over the past 25 years (Foster, Greer, & Thorbecke, 2010). It has been applied, for example, in studies of premature

mortality and poverty, international adult literacy, child malnutrition, aggregate productivity of economic departments and the extent of obesity in the population. The *FGT* statistic was first manipulated to reflect the depth of housing stress by Chaplin and Freeman (1999), and in this essay the technique will be extended to other measures of housing affordability.

The output from doing so is a numerical value (housing measure), that will change in line with the following axioms - monotonicity, transfer and transfer sensitivity. The monotonicity axiom refers to the impact on the results of a reduction in the income of any low-income household. The transfer axiom refers to the change in the statistic if the income of a poorer household is increased in relation that of other income groups. The transfer sensitivity axiom is the same as the transfer axiom but reflects the relative initial income levels of the two households involved. The rate of increase will be smaller the higher the initial income of the two households (Chaplin & Freeman, 1999). This means that the depth of the housing issue is uncovered by using this method, through a value being given to the statistic that may be compared against other household type and time periods. It reveals the depth of housing stress due to the axioms being satisfied. This poverty measure gives more information than simply counting the number of households in stress or the mean value of the section of the sample in stress. It quantifies the size of the problem and captures inequality in the data, based on the axioms.

The Australian Council of Social Service (2012) uses a poverty line measure that classifies households as in stress if their income is below 50 or 60 percentage of the median income for Australia. Income is measured after the deduction of housing costs, using the average housing cost for the median income. This income is compared to median income, rather than a budget of goods. Changes in the percentage of households defined as living in poverty can result from changes to the median income, rather than the circumstances of those in poverty. This measure of poverty does not reflect the situation for those in poverty, as it does not provide a context to the measure. When the median income increases more households entered poverty using this measure, but this does not necessarily mean that more households are worse off.

2.3 Measures of housing affordability

The measures of housing affordability that may be used range from input-focused ones such as the ratio approach to the output-focussed residual approach. The choice of measure will affect the results obtained from any model. Gabriel, Jacobs, Arthurson, Burke, and Yates (2005) provide an excellent introduction to the different measures of housing affordability from an Australian perspective. The advantages of the ratio approach lie in its simplicity: few variables are included and they are readily available over time, easy to explain and rely on limited subjective assumptions. The weaknesses of the measure are the absence of a clear rationale for the 30 per cent benchmark, and the application of a single measure across all housing situations, locations and household types. The ratio approach assumes that all families and individuals have the same ability to pay and does not consider non-housing costs (including food, medical and clothing) or issues of housing quality and overcrowding.

The residual measure is made up of two components – the residual income and a poverty line or a budget standard to compare it against. Residual income is the amount that remains after housing costs have been paid. Depending on data quality, expenses such as insurance, rates and upkeep may be included, but the measure is often restricted to direct costs, such as rent, mortgage repayment and utilities. The poverty line provides perspective to this residual income. The residual measure makes the relationship between housing and non-housing expenditure explicit. It better reflects changes in housing situations, household type and age. It targets low income households effectively and is valuable for small area studies. Against these advantages, the method has the drawbacks of being dependent on subjective assumptions. It requires more data and is more complex and time-consuming to use than the ratio approach.

Gabriel et al. (2005) also include entry into the housing market in their measures. The emphasis is on the ability of households to enter homeownership and how much of the current stock is accessible to a particular household, which allows for a focus on long-term patterns on expenditure. The gap in affordability between tenure types will widen if entry into homeownership is difficult. Households should not rationally enter into homeownership if doing so forces them below a certain level of residual income. The residual approach is more focused on short-terms outcomes but research on the long-term situation is required.

The ratio measure is the most commonly used approach to evaluate housing affordability. This measure is defined in different ways. According to the '30 per cent' approach a household has to spend 30 per cent of income on housing. The '30/40' approach specifies that a household should be regarded as being in stress if it spends more than 30 per cent of income on housing and is in the bottom 40 per cent of the surveys equivalent income distribution. This lower segment of the income distribution represents an equivalent distribution that assigns values for different individuals (adult, young children and teenager) to make all households equivalent to a single person, thus allowing comparisons between households of different sizes. The '30/10-40' approach is applied to households that are in the 10 to 40 percentage of the income distribution. These measures are used with different types of income variables. Nepal, Tanton, and Harding (2010) find that the 30/40 approach is less sensitive to the use of different types of income, net or gross. The 30 per cent measure is quite sensitive to the type of income used, with the largest differences between disposable and gross income, and captures households at the higher levels of the income distribution. The 30/10-40 rule excludes households with extremely low income who in fact may genuinely be in housing stress and hence may under-estimate the number of households in housing stress. Nepal et al. (2010) recommend the 30/40 approach as the most robust of the three measures.

Marks and Sedgwick (2008) and Wood and Ong (2009) use the conventional ratio approach and data from HILDA in Australia, the most comprehensive panel data set in Australia that takes a random sample from the population. Higher income owners felt most of the increase in housing stress and most households that were in stress managed to escape it. This was also done with a range of variables to show what influenced the length of stay in states of affordable and stressed housing based on the ratio approach. Weak links between the ratio approach and financial wellbing reveal the need for an improved measure (Yates, 2007; Rowley and Ong, 2012).

When using the ratio measure, the benchmark percentage does not change for those on lower incomes, so households could spend less than the benchmark amount on housing and still be in poverty. This is a consequence of the measure not considering income levels after housing costs have been met. If a household has no income remaining after non-housing necessities have been paid for the appropriate amount of rent would be zero. It is difficult to set a minimum standard price for housing because the product varies in its distribution of standard and price. The notion that a household can adequately meet its non-shelter needs if it has at least a certain

percentage of income left after paying for housing implies that the lower the income of a household, the lower the amount it requires for non-shelter needs. Rather, the normative ratio diminishes with income, to zero below certain incomes.

The idea of using an after-housing concept of poverty was first raised in Australian discourse in 1975, in the Commonwealth Inquiry chaired by Professor Ronald Henderson. The Inquiry recognised that housing costs tend to make first claim on income and show wide variation associated with differences in tenure and locations, in contrast to the basic cost of other necessities (Commission of Inquiry into Poverty, 1975). The key author on alternative measures of housing affordability is Michael Stone, who highlights the use of shelter poverty and advocates a sliding scale of housing affordability that changes in relation to income (Stone, 1983, 1993). Stone's work culminated in the development of the residual method (Stone, Burke, & Ralston, 2011).

Several studies of housing affordability use the residual income measure in an Australian context. Burke (1998) uses an after-housing poverty measure to obtain an overview of the scale of after-housing poverty. Landt and Bray (1997) promote a similar approach but focus on rental housing affordability. Both of these papers are handicapped by the absence of budget standards. Subsequent papers make adjustment and refinements to the Henderson standard, using a poverty line approach. The poverty line is more directed to basic human necessities rather than necessities in the context of society. Several works draw on the Henderson standard to develop residual income housing affordability measures, but do not extend to the alternative framework of budget standards.[4]

Compared to the ratio approach, the residual method works more effectively in targeting the low-income groups that are usually most at risk of housing stress (Gabriel et al., 2005). The residual income benchmark is not universal. It is socially grounded in space and time. It offers a more precise and finely honed instrument for assessing housing needs and its assumptions are clearly stated. From the housing policy perspective, it has the potential to contribute to effective revision of housing subsidy formulas that would result in a more targeted and efficient allocation of subsidies. In addition, residual methods could be used to refine residential mortgage

[4] See for example Bourassa (1996); Chotikapanich, Flatau, Owyong, & Wood (2003); Siminski & Saunders (2004); Kazakevitch & Borrowman (2009).

underwriting by yielding more accurate assessments of risk. Residual income is a normative standard of the minimum income required to meet non-housing needs at a basic level after paying for housing. As a normative concept an affordability standard must have some independent logic or theoretical basis, against which the actual circumstances of households can be, measured (Stone et al., 2011). In this essay this is provided by the budget standards that are created separately from the individuals in the surveys.

Affordability expresses the challenges that each household faces in balancing the cost of actual or potential housing on the one hand, and non-housing expenditure on the other hand, within the constraints of its income (Stone, 2006). If each household seeks to maximize utility, it will do so by consuming housing at the level that maximises utility within the constraints of household income. This level of consumption will occur when the cost of housing equals the marginal benefit received from that housing. Some households may live in undesirable conditions; others may have low incomes that give them few choices. In all cases, households will make the choice that is best for them subject to a budget constraint (Stone, 2006). In assessing these choices, one has to consider the interactions between incomes, housing costs and the cost of non-housing necessities. The residual income approach does not yield a simple rule of thumb ratio. Instead, it leads to a sliding scale, which recognizes that true affordability is sensitive to differences in household type and income (Stone, 2006).

The residual income approach to affordability recognises that the distinctive physical attributes of housing make it the largest and least flexible claim on after-tax income for most households. The appropriate indicator is the tension between housing costs and income, with the difference between them constituting residual income (Stone et al., 2011). Food items have low price variance and high supply elasticity, so essentially any household could, in principle; meet the physical food standard with an amount represented by the specific monetary standard. By contrast, housing is a heterogeneous product due to its high unit cost and durable, immobile nature, and is thus characterised by high price variance and low elasticity of supply, even within a given market (Stone et al., 2011).

This makes it hard to price housing and assign a budget value to it. If housing budgets are set at a very low level of the rent distribution, such as the 35^{th} percentile of rents, then most households would not be able to find adequate housing at this price. Most households would in

fact require an income greater than what is budgeted to secure adequate housing. However if rents or the budget for housing is set at the median level, half of all households will be able to find cheaper housing than that is budgeted. Some households would then be able to spend less than the monetary standard for housing and hence need less income than the total budget, while others might have to spend more than this (Stone et al., 2011). This highlights the difficulty in setting the correct level for housing budgets that is consistent with affordable levels of housing, thus highlighting the desirability of using actual housing costs rather that the budgeted housing costs.

Stone argues that residual income after housing costs are met is insufficient to meet non-shelter needs if it less than the budget for non-shelter items (Stone, 1993; Stone, Werby, & Friedman, 2000). In his original work on budget standards, Saunders (1998) acknowledged the difficulty of budgeting housing costs, as house prices are highly sensitive to location. Any attempt to allow for location-specific budget costs may also subject the analysis to problems of incorrect pricing. The pricing in this case refers to the amount that should be included in the budget standard, once considering other location, size and quality it is difficult to give one price to housing. Thus in this essay housing cost (price) is removed and actual cost used instead.

Wulff, Yates, and Burke (2001) and Yates and Wulff (2000) find that between 1986-1996, much of Australia's lowest-cost housing stock was occupied by higher income earners, forcing lower income earners to accept what they can get, thus sometimes appearing to over-consume. The use of average housing costs or external measures does not reflect what a household might experience. After-housing measures implicitly equate budget standards housing costs as actual housing costs, thus instead of using the budget standard housing (price), housing is removed and the budget are then compared to incomes once housing expenditure is accounted for. Local housing markets may be more or less diverse, both in price and in quality, and this diversity is ignored when using average prices. The presence or absence of a low-cost sector within local rental markets will always be an important determinant of the capacity for low-income households to locate a home that they can afford to rent (Waite & Henman, 2005).

Henman and Jones (2012) develop a theoretical framework using residual income and budget standards in an Australian context. This linking of poverty and living standards research may provide a better understanding of housing outcomes. It changes the scope of the problem from what is affordable to the standard of living that may be achieved once housing costs are taken into

consideration. Instead of focusing on the cost and availability of housing, the approach examines the situation for households with housing treated as a fixed cost. Disposable residual income is compared to the appropriate budget standard for that household, with the focus thus directed more at outcomes rather than inputs.

Stone et al. (2011) uses residual income in debating the use of affordability standards, examining the use of budget standards and the difference in results that could occur when it is used in place of the ratio approach. At low incomes the ability to pay housing costs is lower than that specified in the ratio approach but at higher incomes the ability is greater. Where the crossover occurs depends on the household type one is considering, with larger families requiring more income for non-housing goods. Stone, Burke, Ralston (2011) use this approach to examine the maximum housing repayment that a household type could afford given its income, and compare this to the figure derived through the ratio measure. The aim is to explain how households are still able to purchase housing even though payments are much higher than the 30 per cent ratio. The technique is then applied to the rental market, where for given household types the percentage of the rental market that was affordable is specified. Measures are also made of the outcomes when income and location changed for the same household type. The use of budget standards shows that at low incomes many households will have no income remaining to spend on housing.

Waite, Henman, Banks, and Curtis (2010) use the residual measure to examine the situation in Queensland for those that were receiving government assistance. The third year that the household was receiving support is used to look beyond the initially disruptive period when government support is first required. The deficit that those on payments had in their third years is examined, using average after-housing low-cost weekly budgets. Those in receipt of student payments and the unemployed had the largest deficits between their current level of support and required budgets.

2.4 Budget standards

The budget standards were first published for the Commonwealth Department of Social Security in 1998 by Professor Peter Saunders, who was working for the Social Policy Research Centre (Saunders, 1998). At the same time, Henman (1998a) examined the impact of durables and the cost of children on household budgets. The different types of households, distinguished by

characteristics such as the ages of children and the age and job status of parents are taken into account. Detailed breakdowns of the cost of each household type, differences in lifecycle and the location of the household in different cities are included. This allows the budget standards to capture a large proportion of the data sets given the household types available. Two budget levels are used: (1) if 50 per cent of Australian households owns a specific good or uses a specific service, the good or service is included in a 'modest but adequate' budget; and (2) a 'low cost' budget with a benchmark of 75 per cent. In other words, the items that are owned by 50 per cent of the population are seen as a reflection of a 'modest but adequate' living standard; whereas the 'low cost' living standard is defined by ownership or use by 75 per cent of the population.

Budget standards are flexible and may be customised to incorporate alternative assumptions (Saunders, 1998). Alternative prices and lifetimes for items may be included, the cost of household durables may be treated differently, and items may be removed or added depending on their lifespan (Henman, 1998b). Once one knows what items are required, the process of pricing them begins. The treatment of durables is one of the assumptions made in the budget standards approach that has met with criticism as the items had to have their life span predicted, then divided by that time to derive a weekly cost. In the short term it is possible for a household to avoid these costs, which raises the issue of whether they should be included (Mudd, 1998; Whiteford & Henman, 1998). However, the approach develops clear statements of assumptions that remove uncertainty about the construction of the measure, with the option to exclude durables if suitable.

Norms of consumption vary by country and region. Budget standards are relative measures to compare the standing of households, taking these variations into account. This is a different approach from those that use poverty level measures, in which the price of a basic basket of goods that one needs to consume to be able to survive is calculated. The budget standards approach is based on what households choose to consume and how much income that requires, while poverty level approaches measure how much income households require to consume a basket of necessities.

The use of residual income and budget standards is an effective alternative to the traditional ratio approach. Combining the two elements allows housing affordability situations to be examined after housing costs have been taken into consideration. The budget standard gives the residual income value to what the measure is trying to uncover. Many households have little control over their housing costs – payments are set by mortgages and leases, and households do not usually

have perfect mobility to move to cheaper housing in the short term. Housing should therefore be treated as a fixed cost to households. The problem of the housing element within the budget standards context is acknowledged by Saunders (1998). The difficulty of deciding where in the distribution housing should be set is also an issue, as the use of average housing costs or external measures may not reflect what a household might experience (Wulff et al., 2001; Yates & Wulff, 2000). A current choice is likely to be the best one, given current constraints (Stone, 2006). The use of an after-housing measure, which implicitly equates budget standards housing costs as actual housing costs, is a way of avoiding the problems associated with pricing housing (Waite & Henman, 2005). Thus this essay uses the disposable income that remains after actual housing costs have been taken into consideration as a measure of residual income.

2.5 Summary of measures

The difference between the ratio and residual approaches lies in how the normative level of adequacy for non-shelter items is defined. The ratio approach defines this as a fraction of income, 70 per cent, which is considered to be the minimum share of income that must be available after housing costs are met in order to avoid hardship in meeting non-shelter needs (Stone et al., 2011). The residual income approach defines the normative level of adequacy for non-shelter items as a monetary amount that is independent of income, but may vary depending on household type and the non-housing cost of living as a function of time and place.

The negative aspects associated with the residual method of measuring housing affordability presented by Gabriel et al. (2005) should not preclude its use. Assumptions are stated explicitly and hence may be checked for appropriateness and changed if necessary. That a method requires more data and is time-consuming to apply is not an *a priori* reason to eschew it. It may be difficult to transfer the residual measure across locations due to different costs, especially in regard to housing. Following the Henman and Jones (2012) framework, taking out housing costs from the residual measure and using actual housing costs from the survey participants instead removes the largest discrepancy between locations. The approach also uses a normative level based on the budget standards.

The households that are captured when using the residual income approach may have problems with income and/or housing costs. Income may be so low it does not cover non-housing

expenses, even if the household has no housing costs. Income could cover non-housing costs, but not housing costs. High housing costs could place even high- or middle-income households in a situation of affordability stress (Gabriel et al., 2005).

3 Methodology

This essay will capture those who are in stress through two models. The first, *Depth of housing stress* will identify the household type that is most in stress and examine differences between housing situations. The characteristics that predict greater levels of stress are shown in the *Residual expenditure* model. The type of household and the housing situation cannot be included in the *Residual expenditure* model without causing modelling issues. The two models complement each other, and in using them the problem of household stress will be approached from different angles to offer more accurate observations than would be the case if only one model was used. The *Depth of housing stress* model aims to quantify the extent of the housing stress problem through the use of a poverty model. The *Residual expenditure* model aims to uncover who is stress and has a significant relationship with affordability problems. This will be achieved with the use of an ordered probit model and a residual measure of housing affordability.

3.1 A *Depth of housing stress* model

The inequality measure that will be used has been adapted to take housing affordability measures into account. Chaplin and Freeman (1999) introduced this extension to the original measure, using the ratio approach as their measure of housing affordability. The measure will be extended further to compare the differences between ratio and residual approach. The model will be applied to housing situations and will examine the depth of the problem, in ways that are not possible using the head count or averages methods.

There are three variations of the model that will be introduced. The households that are of interest are treated differently in each of these variations. The first adaption treats households as in poverty if income levels are below the poverty line for that household type. The second treats households as in ratio stress if more than 30 per cent of household income is spent on housing. The last approach treats groups of households as in residual stress if their residual income is below the budget standard for that particular household type. Therefore the household type that is

considered to be in difficult housing affordability circumstances will vary due to the measure and outputs from each of the approaches.

The depth of stress that a household type finds itself in after meeting housing costs is a numerical value (housing measure) that in this case changes in line with the monotonicity, transfer and transfer sensitivity axioms introduced in Section 2.2. By using this method the *Depth of housing stress* model quantifies the level of stress that can be compared against other household types. The depth is shown by reflecting the changes experienced by those in stress, focussing on those with low residual income, rather than using a mean or head count method. The first equation in Chaplin and Freeman (1999) was used in regards to poverty and reflected the depth of poverty for the household type. An extension of the equation was then adapted to target the housing experience, using the ratio approach. This essay applies a different affordability measure, based on residual stress. Residual income is compared to the budget standards to give a housing depth approach that is outcome focused.

FGT statistics were created in response to general dissatisfaction with the measures that were available at the time. The level of detail that can be gained from looking at the mean of a sample may be limited by the impact that outliers have. The *FGT* statistics looks beyond simple measures and provides a more complete picture of a given situation. The equation requires the number of households in the total sample, a poverty line and income for each household that is below this poverty line, so that the distance from the poverty line can be specified.

The original FGT statistic measure for poverty

$$F(\alpha) = \frac{1}{n}\sum_{i(in\ poverty)}\left(\frac{\hat{g}_i}{\hat{z}}\right)^{\alpha} \qquad \alpha \geq 0\ ,$$

(1)

Where:

α - the concern for the depth of poverty;

i – individual households;

i(in poverty) - individual household i which is poor;

$\hat{y}\imath$ - income of household i;

$\hat{z}$ - poverty line below which an individual household is poor;

$\hat{g_\iota}$ - income gap ($\hat{z} - \hat{y\iota}$) for household i;

n - total population of poor and non-poor households;

The original *FGT* statistic model was changed to generate more effective empirical data relating to housing affordability issues. A housing measure was included instead of a poverty line to examine the distance from the benchmark that is set for households. The most commonly used measure, the ratio approach, was then applied to the statistic.

The Depth of housing stress model transformed for housing stress using ratio approach.

$$F(\alpha) = \frac{1}{n}\sum_{i(ratio\ stress)}\left(\frac{\breve{g}_i}{\breve{z}}\right)^{\alpha} \qquad \alpha \geq 0, 0 < \left(\frac{\breve{g}_i}{\breve{z}}\right)^{\alpha} \leq 1$$

(2)

Where:

α - the concern for the depth of affordability problems, in this case is given the value of 3 taken from Chaplin and Freeman (1999).

$\breve{y\iota}$ - ratio measure of household i;

$\breve{z}$ - ratio cut-off point;

i (ratio stress) - individual household i which has $\breve{y\iota} > \breve{z}$;

$\breve{g_\iota}$ – ratio gap ($\breve{z} - \breve{y\iota}$) for household i;

n - total population of affordable and unaffordable households;

In equation (2), z is set at 30 per cent of income spent on housing; if a household spends more than this percentage on housing it is considered to be in ratio stress and is included in this measure. $\breve{g_\iota}$, captures the percentage by which this benchmark is exceeded for a particular household. In this case the household is limited to a value of greater than 0 and equal to or less than one, so that it does express concern for the depth of housing affordability problem without excess weight to a particular household. The variables used are weekly housing costs (rent, mortgage repayment and rates) and weekly household disposable income (after taxes and benefits).

The Depth of housing stress model transformed for housing stress using residual approach.

$$F(\alpha) = \frac{1}{n}\sum_{i(residual\ stress)}\left(\frac{\bar{\bar{g}}_i}{\bar{\bar{z}}}\right)^{\alpha} \qquad \alpha \geq 0, 0 < \left(\frac{\bar{\bar{g}}_i}{\bar{\bar{z}}}\right)^{\alpha} \leq 1$$

(3)

Where:

$\bar{\bar{y}}\imath$ - residual income for household i;

$\bar{\bar{z}}$ - budget standard for this particular household; i (residual stress) - individual household i which has $\bar{\bar{y}}\imath < \bar{\bar{z}}$;

$\bar{\bar{g}}_\imath$ – residual gap$(\bar{\bar{z}} - \bar{\bar{y}}\imath)$ for household i;

n - total population of affordable and unaffordable households;

In equation (3) residual income is limited to zero, which has the same impact as limiting the maximum value for a particular household to one. It is similar to saying that someone has zero income when comparing a household depth of poverty to a poverty line. The households that are included as stressed in the equation are those that have been assigned a zero once residual income is recoded, which means that they have residual income that is less than the low cost budget standard. The benchmark in this case is the budget standard that was developed earlier. The approach is to examine the income that remains after housing costs have been paid and the distance this residual income is from the benchmark. The approach is more closely linked to the original work in which the benchmark was set at poverty line than equation (2).

Equations (2) and (3) set out two different measurements of housing affordability and these approaches are compared. The ratio approach is most commonly used. The equation has been adapted using a similar method to that of Chaplin and Freeman (1999). The residual approach sets a benchmark as the budget standard for the household type in question. The benchmark will therefore change depending on the year and household type in question. The results are for each survey by household type.

The *Depth of housing stress* model, using equation (3), is developed further to determine whether the situation can be broken down to reflect not just the residual method but also the state of the rental market for tenants that have different types of landlords (public or private). In this

situation a type of landlord variable – with real estate agents compared to state/ territory housing authorities – is used. This approach uses the residual method, in which those with low incomes are more targeted. It will reveal how household types experience the rental market by landlord type. This information would not have been revealed using the ratio approach, because it would show no public housing tenant as being in stress.

Whether a household rents or has a mortgage has implications that extend beyond housing needs in both the short and long term. Equation (3) includes all homeowners; this may be disaggregated further to specify those with and without a mortgage. The same applies to the renter market, with the total rental market including both private and public tenants. Research suggests that there is a growing gap in affordability between homeowners and tenants (Haffner & Boumeester 2010; Yates, 2008). Equation (3) captures the short term situation and does not take into consideration differences between housing situations in regard to future wealth. In equation (3), a household that is considered as stressed is assigned a zero; thus its members would have to sacrifice at least one other living expense to make ends meet.

3.2 A *Residual expenditure* model

An ordered probit technique is used to produce a spread of results, rather than the simpler probit method that is limited to yes/no responses. This gives a more detailed output in terms of whether an explanatory variable remains significant over a range of options. More information about the impact of a variable is provided, allowing an assessment of whether it allows a household to not just move from residual stress but to higher levels of residual income. The variable has a significant relationship with residual income levels if it remains significant across the three groupings. The dependant variable in the model is the residual stress measure developed in Section 3.3, in which residual income is compared to different budget standards. The budget standards that are used are dependent on the type of household. In previous research on housing affordability the results are based on either a head count method or mean values for that section of the population. The ordered probit technique provides more detailed data based on the impact that each variable has upon the likelihood of a household being in stress.

The Model is defined as follows:

$$y_i * = \boldsymbol{x}_i \boldsymbol{\beta} + \epsilon_i \qquad \epsilon_i \sim N(0,1), \forall i = 1, \dots, N. \qquad (1)$$

Where:

$\boldsymbol{x}$ - vector of independent variables;

β - vector of coefficients;

ϵ - Is assumed to be normally distributed across observations

y^* - is unobserved, what is observed is:

$$y = \begin{cases} 0 & \text{if } y^* \leqslant 0 \\ 1 & \text{if } 0 < y^* \leqslant \mu_1 \\ 2 & \text{if } \mu_1 < y^* \leqslant \mu_2 \end{cases} \qquad (2)$$

Where:

μ – are unknown parameters to be estimated with β

The Ordered Probit technique uses an observation *y*, an observed ordinal variable, the value of which is determined by the continuous, unmeasured variable *y** (housing stress), to fit the parameter vector β in (1). In the model, residual stress (*y**) is the latent variable; the observed variable (*y*) depends on whether a particular threshold parameter is crossed, to predict if a household is, may be, or is not in residual stress. The threshold points are derived by the coefficients within the model.

x - [*AGE, EDUC, STATEHHC, GOV, DISPPH, BORN, METRO, HOUSEHOLD TYPE*]

These characteristics may provide improved understanding of and targeting of policies to the issue of housing affordability. *AGE* are the variables representing the age of the head of the household, with the age converted into dummy variables. *EDUC* is the post-high school education level that the head of household has obtained. *STATEHHC* is the State that the household resides in. $LFSCP$ is the working status of the head of the household. GOV is the percentage of total household income provided by government transfers. $DISPPH$, is the disposable income of the previous years and is used to understand the situation for the household in the previous time period. $BORN$ captures the differences between individuals who are born in Australia and those who are born in other countries. $METRO$ separates individuals based on their location within Australian States. Household type controls for the heterogeneity that exists within the same household types.

Table 1. 1

Variables required for the residual stress measure of housing affordability

Variable name	Variable in the Income and Housing Survey	Explanation
hhcomp	Dcomph	The type of the household
Agerp	Agerhbc	Age of the reference person
Sexrp	Sexrh	Sex of reference person
Budget standard		The budget assigned to this household requires hhcomp, agerp and sexrp

Source: ABS (2000-01, 2002-03, 2003-04, 2005-06, 2007-08, 2009-2010); Saunders (1998).

Table 1.2

Variable definitions

Variable name	Variable in the Income and Housing Survey	Explanation	Values
Dependant variable			
Y		This is based on how y* compares to the budget standard for that household type	$y = 0$ if $y^* \leqslant LC$ $y = 1$ if $y^* > LC$ & $y^* \leqslant M$ $y = 2$ if $y^* > M$
Independent variables			
AGE	age	Age recoded into ten year brackets starting from 15, till 65 then all above 65 in one groups	*AGE1*=15-24 *AGE2*=25-34 *AGE3*= 35-44 *AGE4*=45-54 *AGE5*= 55-64 *AGE6*=65+
EDUC	Highest non-school qualification	Recoded into three groups bachelor or post grad, other post school qualifications and no qualification.	*EDUC1* =bachelor or higher *EDUC2*=other post school *EDUC3*=no non-school qualification
STATEHHC	State or territory	Same as original variable	*STATEHHC1*= NSW *STATEHHC2*= VIC *STATEHHC3*= QLD *STATEHHC4*= SA

			STATEHHC5= WA *STATEHHC6*= TAS *STATEHHC7*= ACT & NT
LFSCP	Labour force status	Same as original variable	*LFSCP1*= employed *LFSCP2*= unemployed *LFSCP 3*= not in the labour force
GOV	Percentage of income made up of government payments	Government transfer/ Total income	*GOV0* = 0% *GOV1* = 0%< x ⩽ 20 *GOV2* = 20< x ⩽ 80 *GOV3* = 80< x
DISPPH	Previous financial year HH disposable income	Same as original variable	
BORN	Born in country	This was recoded into born in Australia or not.	*1* = not born in Australia 0= if born in Australia
METRO2	Metropolitan/Ex-metropolitan (excludes ACT/NT)	Same as original variable	*1* = live outside of metropolitan 0 = if live in metropolitan area
HOUSEHOLD TYPE	Dcomph	Groups by similar household types	*SINGLE UNDER 65, COUPLE UNDER 65, NON-PARENT OVER 65, PARENTS SINGLE PARENTS*

Source: As for Table 1.1.

The key to the *Residual expenditure* model is how the dependant variable is defined. Disposable income for a household reflects the amount of money that the household has at its disposal once taxes and benefits have been taken into account. Most households make decisions based on this amount. This is then reduced by housing costs, such as mortgage repayments or rent, but also includes housing bills, such as utilities. Most of these costs may be treated as fixed, as a household has little, if any, control over them in the short term. This procedure provides the residual income for a household and it is this value that is of interest to us.

The following equations make the dependant variable that is used in the ordered probit:

$(DI - HC) < BS_{ah^{(x)(LC)}}$ Then household is assigned 0

$(DI - HC) > BS_{ah^{(x)(LC)}}$ & $(DI - HC) < BS_{ah^{(x)(M)}}$ Then household is assigned 1

$(DI - HC) > BS_{ah^{(x)(M)}}$ Then household is assigned 2

This procedure provides the residual income for a household*:* $(DI - HC) = RI$

DI - Disposable Income

HC - Housing Costs

RI - Residual Income

BS - Budget Standards

The Budget standard that are in use:

$BS_{ah^{(x)(LC)}}$ - after-housing budget standard for that particular household type and is the low cost benchmark

$BS_{ah^{(x)(M)}}$ - after-housing budget standard for that particular household type and is the Modest benchmark

x - household type for household of interest

ah - After Housing

There are two ways that the elements can be applied. The model here will use the after-housing income gap as the measure of affordability. There are two budgets used in the equations below: a low cost budget (*LCB*) and a modest budget (*MB*). These show household budgets once housing costs have been met, and are adjusted for household type for the time period of interest. Thus the dependant variable compares the residual income against a budget standard for that time period and household type.

The model will be run on the entire sample. Owners with a mortgage and renters that match a budget standard will also be included; hence households with multiple sources of disposable income and zero or negative disposable income will be excluded. This is a common approach and is generally used because they tend to represent business owners who have greater assets than their income shows. This will also be done for each of the surveys, so that the likelihoods for each of the variables can be compared across the six surveys. The model is run on each survey and the result compared across outcomes to see if results hold consistently.

3.3 Housing affordability measures

To assess the after-tax income situation of households, the model will use disposable income variables from the ABS surveys. The income of interest is the residual income that remains after housing costs are met. The housing cost that will be considered is actual housing costs, which is based on the housing that households can find and afford. The use of average housing costs or external measures may not reflect what an individual household might experience. After-housing measures are more appropriate, as they implicitly equate budget standards housing costs and actual housing costs.

This residual income will be compared to the budget standard without housing cost. This will produce an income gap, as specified by Waite and Henman (2005). There are two ways that the elements may be applied. This essay will use the income gap as a measure of affordability, hence:

Disposable income (DI) minus actual housing cost (HC) compared to budget standard without housing cost (income gap).

The second approach is to consider the amount of income that remains to be spent on housing and is considered to be an affordable amount for the type of household concerned, as they have already paid for non-housing necessities:

Disposable income (DI) minus budget standard without housing, compared to actual housing cost (HC) (housing gap).

It is this after-housing income gap that is of interest, and will be tested through the models. The size of the gaps in the two measures are the same, while this essay uses an income gap approach, the difference between what is affordable housing cost for a particular household and what they pay may also be measured. For example, if disposable income is 100, non-housing requirements are 50 and housing costs equal 60, the income gap is 10, (100 – 60) = 40. Hence the non-housing requirement is 50 but available amount is 40, thus the income gap is 10. Using the second approach, 100 minus 50 equals 50, which gives a housing gap, between what is an 'affordable rent' (50) and actual rent (60), of 10. This means that the income gap may also be used to look at housing gaps. If there is an income gap the same will be true in terms of a housing gap.

Residual income is created for each of the households within the surveys and is matched to budget types that best describe the household concerned. In situations that do not match the household, the residual approach cannot be applied to that particular household type and these are omitted from the analysis. For cases in which there is a match, the actual residual income for a household is recoded into one of three values. The value of zero applies to a household that has a residual income that is less than the low budget standard for that household type. The household in question will be forced to make trade-offs and go without some necessities due to its level of residual income. Below the low-cost budget refers to a situation in which it is increasingly difficult to maintain an acceptable living standard, resulting in an increased risk of deprivation and disadvantage (Waite & Henman, 2005). Budget standards differ between societies – what might be considered a necessity in one country may not be so in others. Thus the measure is also based on location and time. The second value that may be given is one, where the household lies between the low and modest budget standards. These households have more than the basic level of residual income but will still have had to make some sacrifices and be careful with their spending. The third outcome is given a two, where households have a residual income that is above the modest budget standard and therefore have greater levels of discretion in their spending. This residual

measure is more outcome-driven than the ratio measure, as it reflects household spending potential once housing is taken into consideration. The ratio measure also differs in that it considers the cost of housing as an input, but not what is available to households after housing costs have been met.

The available budget standards data, originally from 1997, were not updated to cover all of the years of interest, from 2000 to 2010. Other authors have updated the budget to the time period that they are interested in, but do not include the years in between (Gabriel et al., 2005; Stone et al., 2011). Henman's (2001) Modest and low cost budgets (see Herman, 2001, Appendix A1, A2) is the source of the budget standard used here and the index is applied to these budgets so that the models can be produced.

Gabriel et al. (2005) include four budget levels: low cost budget standard, modest but adequate budget standards, results from the ABS survey Household Expenditure Survey and the Henderson poverty line with and without a housing component. The updated results that will be obtained here use a different method of indexation. Gabriel et al. (2005) use CPI figures to index their budgets; the budgets presented here will use a composite measure of CPI without housing and Household Disposable Income (HDI) from the ABS (2011, 2012). This indexing method was first used by Burke et al. (2011), but the data has since been updated by the ABS and the index presented here will reflect this. The composite approach is used because of the divergence between CPI and HDI over time. The relative purchasing power of household has changed and this should be reflected in the budget standards.

In developing countries the poverty perspective would use the absolute method of indexation. The basket of goods that a person requires to survive includes food, clothing and shelter and does not change much over time. Thus the method of indexation should be absolute and use just the CPI. The method of indexation used here is different, the basket of goods would be expected to change; this is due to the definition of what is required in each budget. If 75 per cent of households own a particular item then this is considered to be required and is included in the budget. One would then expect the composition of the items in the budget to change over time, hence the method of indexation is relative to the original data. The use of the composition measure captures some of the divergence between CPI and HDI. If HDI is increasing one would expect consumption to increase and the budget standard would have to change to cater for this.

Two types of budgets, as suggested by Saunders (1998), will be developed: (1) the low cost budget standard, and (2) the Modest but adequate budget standards. Ten types of households will be updated to cover the years of interest (see Table 3.3). The purpose of selecting these household types is to try and match the household types with those that are found in the ABS Surveys.

Table 1.3

Household and Budget types

Household Type	Budget	Details
Male Single	Low cost	Renter, aged 40, unemployed
	Modest but adequate	Renter, aged 40, full-time
Female Single	Low cost	Renter, aged 35, unemployed
	Modest but adequate	Renter, aged 35, full-time
Aged Single	Low cost	Female 70, not in labour force, public renter
	Modest but adequate	Female 70, not in labour force, outright owner
Aged Couple	Low cost	Both 70, not in labour force, public renter
	Modest but adequate	Both 70, not in labour force, outright owner
Couple	Low cost	Female 35, Male 40, both unemployed, private renters
	Modest but adequate	Female 35, Male 40, both full-time, private renters

Couple with one Child	Low cost	Female 35, Male 40, Girl 6, private renters, Male full-time, Female not in labour force
	Modest but adequate	Female 35, Male 40, Girl 6, private renters, Male full-time, Female not in labour force
Couple with two Children	Low cost	Female 35, Male 40, Girl 6, Boy 14, private renters, Male unemployed, Female not in labour force
	Modest but adequate	Female 35, Male 40, Girl 6, Boy 14, private renters, Male unemployed, Female not in labour force
Couple with three Children	Low cost	Female 35, Male 40, Girl 6, Boy 14, Girl 3, private renters, Male unemployed, Female not in labour force
	Modest but adequate	Female 35, Male 40, Girl 6, Boy 14, Girl 3, private renters, Both Full-time
Single Parent with one Child	Low cost	Female 35, Girl 6, not in labour force, private renters
	Modest but adequate	Female 35, Girl 6, full-time, private renters
Single Parent with one Child	Low cost	Female 35, Girl 6, Boy 10, not in labour force, private renters
	Modest but adequate	Female 35, Girl 6, Boy 10, full-time, private renters

Source: Henman (2001).

This section has shown which household types were selected from within the dataset for indexation using a composite of CPI without housing cost and HDI. The method allows one to attempt to maximize the number of matches between household types in the ABS surveys and the budget types.

3.5 Software used

The software used was SPSS and Stata. SPSS was used initially to examine the entire data set and recode the variables into the required form. It was also used when merging data. Stata was used in the econometrics of the paper, in particular in the running of the ordered probit model. This provides detailed output based on the impact that each variable has upon the likelihood of a household being in different residual income levels. The first program within Stata uncovers the marginal effects after estimation of an ordered probit (Cornelissen, 2006). This was used to examine the marginal impact of each of the variables within the groups that have been used and whether the variables predict the chances of a household being in a stressed or non-stressed group. Jann (2007) was used in the presentation of the results in order to present the model effectively.

3.6 Expected output

The two models used generate different outputs, due to the approaches taken and the origins of the models. The *Depth of housing stress* model quantifies the effects of the different measures being used, hence revealing any possible overestimation of the problem. It also quantifies the size of the problem by household type and situation. This shows the depth of the problem based on household type and situation. The *Residual expenditure* model shows the predictive ability of variables in determining the likelihood of a household being in stress or non-stress. The model is run on the entire dataset that the household types match with the budget standards, plus sub-sections of the sample to further examine the model by only selecting households in particular housing situations (renter, homeowners with mortgage). This allows identification of the explanatory variables that have a significant relationship with different levels of residual stress, thus allowing the characteristics associated with different levels of stress to be understood.

4 Data

The data that are used for this analysis cover the years 2000 to 2010. This gives a good coverage and the variables are consistent. The size of the surveys ranges from 5,000 to 14,000 observations. They are produced by the ABS and are published approximately every two years. Outside of these surveys, there are variations in the variables that are available, which is why these surveys were chosen.[5] Once the variables were selected within each of these files the data was merged across the same survey by the unique household number and person number within the household assigned to each input. The definitions or categories for some variables changed between surveys, which required reclassification of the variables to match across all six of the surveys to provide consistency. For example, 'year moved to Australia' was different depending on the survey, and was changed to *Born* or *Migrant*. The data used for the budget standards was from Henman (2001). All of the budgets standards were taken from the original data source and then indexed.

5 Results

The results that have been produced by the two models are shown in the following sections. The first output, from the *Depth of housing stress* model, reflects a poverty line approach to the situation. This uses a depth of stress measure of housing stress to quantify the problem, rather than a mean or head-count approach. This provides a better reflection of the true state of residual stress. The second output, from the *Residual expenditure* model, is in the form of coefficients and margins. Ordered probit models were run on each survey to uncover who is in stress in the entire sample, and then run on subsection of the sample, renters and homeowners with a mortgage. The models are shown in the Appendix, with the marginal effects for the variables of interest to determine if they move in the expected manner.

[5] The surveys used are called the income and housing survey from 2000-01, 2002-03, third edition 2003-04, second edition 2005-06, reissue 2007-08 and the reissue of 2009-10 (Australian Bureau of Statistics, 2000-01, 2002-03, 2003-04, 2005-06, 2007-08, 2009-2010).

5.1 Depth of housing stress

The output from this model is a numerical value, produced from equations (2) and (3) that can be compared to other values. This output is produced for an entire grouping – in this case that of a housing situation in a particular survey by household type. The higher the number produced, the greater the depth of housing stress, due to the gap between residual income and budget standard or the percentage of income spent on housing being greater than the benchmark level. Table 1.4 shows the output from equation (3), in which the residual method was used for each of the household types individually for each survey. The table ranks each of the outcomes from the equation and those with the highest value (greatest residual stress) have been assigned one plus the actual values produced from equation (3). This means that they suffered a greater level of housing stress as a type in comparison to other household types.

Table 1.4

Overview of the residual approach to depth of housing stress

Rankings in each years for household type		single male	single female	age single	aged couple	couple	couple plus one	couple plus two	couple plus three	single plus one	single plus two
	2000	0.0680	0.0475	0.0180	0.0200	0.0198	0.0331	0.0249	0.0325	0.0502	0.0477
Rank		1	4	10	8	9	5	7	6	2	3
	2002	0.067	0.055	0.021	0.022	0.019	0.033	0.032	0.026	0.036	0.048
Rank		1	2	9	8	10	5	6	7	4	3
	2003	0.044	0.045	0.022	0.015	0.019	0.024	0.031	0.024	0.032	0.031
Rank		2	1	8	10	9	6	4	7	3	5
	2005	0.056	0.049	0.027	0.014	0.015	0.024	0.026	0.021	0.050	0.027
Rank		1	3	5	10	9	7	6	8	2	4
	2007	0.058	0.052	0.026	0.016	0.023	0.018	0.021	0.015	0.034	0.031
Rank		1	2	5	9	6	8	7	10	3	4
	2009	0.067	0.054	0.029	0.018	0.023	0.031	0.024	0.026	0.039	0.037
Rank		1	2	6	10	9	5	8	7	3	4
Rank Average ranking		1.2	2.3	7.2	9.2	8.7	6.0	6.3	7.5	2.8	3.8

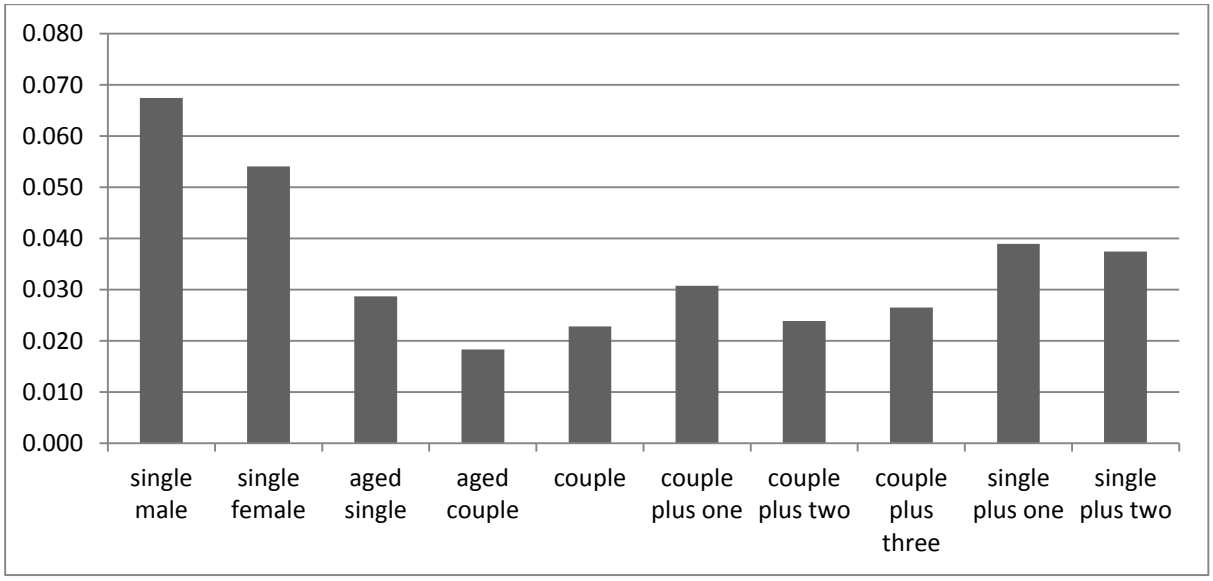
Source: Author's calculations using ABS (2000-01, 2002-03, 2003-04, 2005-06, 2007-08, 2009-2010).

Note: The greater value of *FGT*, the greater the depth of stress. A worse ranking in a particular year is given a 1.

The average ranking across the six surveys shows that single households suffer the greatest depth of housing stress, followed by single plus one. Singles, especially single males, return consistently worse results than those of other household types. The *FGT* values from equation (3) shown in Figure 1.1 reveal that singles suffer greater depth of housing stress not just in ranking but in the actual value from the equation. The single value is more than double that of couples. This reflects the nature of the market, in which a household made up of one individual would consume the same amount of housing as one made up of a couple, but may be expected to have lower earning potential.

Figure 1.1.

The Residual approach and FGT values by selected household types, 2010



Source: As for Table 1.4.

The output that is produced here compares two different measures of affordability. Ideally the two measures would produce a similar picture of the situation. A difference between the results creates potential problems for policymakers, as they will be required to make a decision about the measure that reflects the affordability situation most accurately. Table 1.5 shows the differences in output when equations (2) and (3) are used. The two equations are similar, except for the measure of housing affordability used. One uses a ratio, the percentage of housing cost to income; the other the residual approach, in which the low budget standard is used, similar to a poverty line approach in equation (1). The table has the actual values from the two equations. It shows that in

all household types and surveys the ratio approach has a higher result. The graph shows that the size of the difference between each of the household type. The ratio approach provides a very similar outcome for single and single parents. The ratio approach captures a much greater share of the sample and this reflects in a greater level of depth.

Table 1.5

Difference in output between residual and ratio approaches

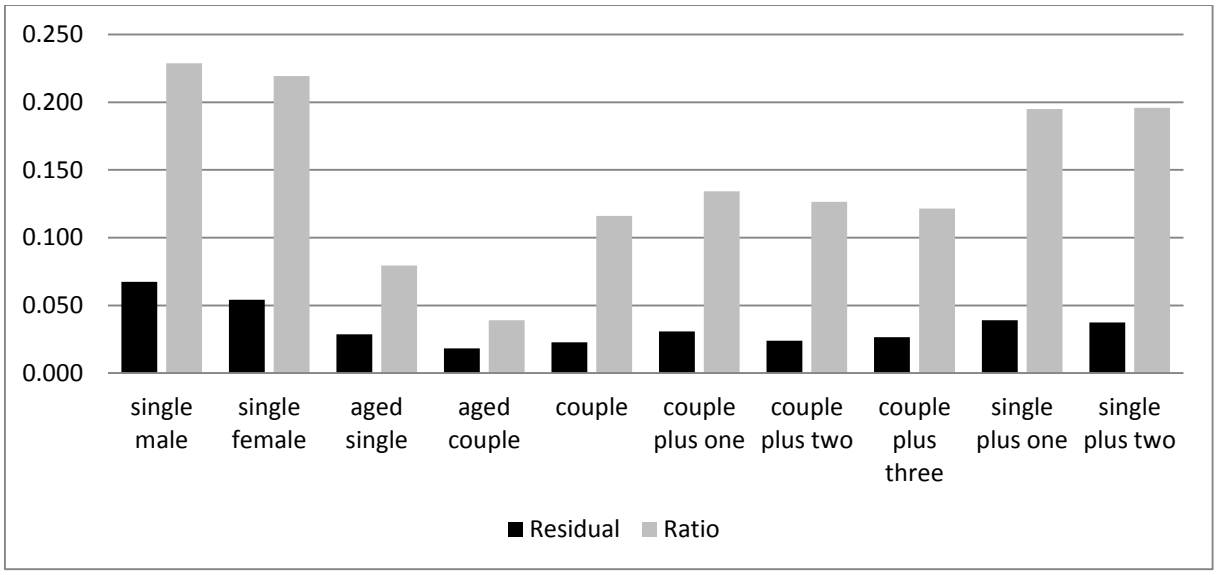
Measures for each years by household type	measure	single male	single female	aged single	aged couple	couple	couple plus one	couple plus two	couple plus three	single plus one	single plus two
2000	residual	0.068	0.048	0.018	0.020	0.020	0.033	0.025	0.032	0.050	0.048
	ratio	0.189	0.195	0.051	0.027	0.086	0.105	0.092	0.080	0.179	0.183
2002	residual	0.067	0.055	0.021	0.022	0.019	0.033	0.032	0.026	0.036	0.048
	ratio	0.199	0.211	0.065	0.034	0.084	0.123	0.100	0.099	0.184	0.162
2003	residual	0.044	0.045	0.022	0.015	0.019	0.024	0.031	0.024	0.032	0.031
	ratio	0.184	0.219	0.071	0.030	0.101	0.122	0.114	0.105	0.153	0.164
2005	residual	0.056	0.049	0.027	0.014	0.015	0.024	0.026	0.021	0.050	0.027
	ratio	0.201	0.214	0.078	0.036	0.113	0.126	0.127	0.104	0.203	0.149
2007	residual	0.058	0.052	0.026	0.016	0.023	0.018	0.021	0.015	0.034	0.031
	ratio	0.208	0.255	0.084	0.030	0.109	0.122	0.115	0.113	0.190	0.176
2009	residual	0.067	0.054	0.029	0.018	0.023	0.031	0.024	0.026	0.039	0.037
	ratio	0.229	0.219	0.079	0.039	0.116	0.134	0.126	0.121	0.195	0.196

Source: As for Table 1.4.

Figure 1.2 shows that the two aged household types are similar between the two measures. This reflects the decreasing housing costs that these types are likely to experience as they begin to pay off their mortgages. For singles it is clear that there is a large difference between the two measures and this highlights the difference in the measure, with the residual also considering non-housing requirements. Singles have lower non-housing requirements, thus the use of the same percentage for different household types does not reflect different levels of non-housing expenditures.

Figure 1.2

Comparing differences in rankings with residual and ratio measures, 2009



Source: As for Table 1.4.

The differences in output raise the question of which measure shows the most accurate and relevant picture of the situation. The area of interest is that of low-income earners or those who have low amounts of income with which to buy basic necessities. To address this question, Table 1.6 shows where the *FGT* comes from when it is compared to the different levels of residual income. The households that are included in equation (3) are those in residual stress, and hence are only from group zero. This is not the case for equation (2), where a household is classified as ratio stressed if it has to spend more than 30 per cent of income on housing. Those who are in ratio stress have a residual income that comes from a range of sources. In Table 1.5, the couple household type has more households in ratio stress, adding to the *FGT* statistics from groups one and two, which have incomes greater than low income budget after housing cost. Table 1.6 shows the percentage contribution of each group to the statistics. These households would not be included in the more targeted residual approach.

This demonstrates that the residual stress approach targets only those with a low level of income after housing costs, their residual income. The placement of these households in group zero reflects their true situation in terms of actual disposable income and consumption decisions. This is compared to the ratio stress approach, in which those with higher levels of residual income

are considered as being in ratio stress. If a household has an income level higher than the low budget level after housing costs are met, it is incorrect to classify it as stressed. The ratio approach looks at the percentage of income that is spent on housing, which may not take into account those who spend a large percentage on housing but still have ample income remaining. To do so would result in poorly targeted policy based on incomplete information about the true state of household stress. This is also reflected in the *FGT* statistics being greater for (2) in all surveys and household types.

Table 1.6

The source of the ratio stress by residual income levels

Single male			Couple			Couple plus one		
Residual stress	May be in residual stress	Non-residual stress	Residual stress	May be in residual stress	Non-residual stress	Residual stress	May be in residual stress	Non-residual stress
0.56	0.09	0.34	0.47	0.16	0.38	0.50	0.18	0.32

Source: As for Table 1.4.

Note: Percentage within household type might not sum to 100 due to rounding.

In many studies of housing affordability, public housing is ignored because such households are classified as not in stress using the ratio approach. Public housing in Australia is delivered at the state and territory level and rent setting practices in terms of the level of rents and income taken into account vary. However in most cases rents for the last two decades have been of the order of 25 per cent of household incomes. As a result, households in public housing are not considered to be in stress under the ratio measure. If private rents, which are set by the market and subject to competition, increase more quickly than public rents, private tenants are more likely to be in difficulties than public ones. Most of the income of public housing tenants is derived from government payments, which are increased, in the case of pensions, by the Consumer Price Index and the Pension and Beneficiary Living Cost Index, whichever is higher and in the case of other income support recipients (e.g. New start and Family allowances), by CPU only. Entry into public housing is based on family circumstances, whereas private tenants are selected by landlords, who are assumed to act in a profit maximizing manner.

The results presented here take advantage of the effectiveness of the residual measure in targeting low-income earners, to provide more precise information. Equation (3) is used, with the section of the population being separated by household type and by landlord type. The two landlord types selected – State/ Territory authority and private estate agent – allow comparisons between public housing and private renting to be made. A household living in public housing is required to give a set percentage of income to the State authority in the form of rent, but at low income levels the remaining income may be too low to buy non-housing necessities. With the ratio approach, housing is considered to be affordable if it requires spending less than a certain percentage of household income, but the reality can be very different when one looks at what the remaining income can purchase. The ratio measure does not consider what the non-housing requirements are for different household types.

Table 1.7 compares the difference in the size of *FGT* statistics between the two forms of renting. Intuitively, private renters should be in a worse situation. For most of the household types shown, residual stress is greater when housing is allocated by private landlords, rather than public housing authorities. However, public housing is characterised by higher residual affordability stress in four of the ten household types selected in at least one of the surveys. This is not the case in all surveys. High residual stress affects households with dependent children, except for those of single parents with two dependent children. This type of tenancy would not be considered to be in ratio stress as to ratio of rent to income is less than the nominal cut off point. This reflects a problem in using a ratio measure to calculate the level of rent that should be paid; this procedure fails to take into consideration the different levels of non-housing consumption that are required for each household type.

Table 1.7

Number of times public housing has greater depth of stress than private renters

Household type	Landlord type: Public	Total number of surveys
Single male	1	6
Single female	1	6
Age single	0	6
Aged couple	0	6
Couple	1	6
Couple plus one	1	6
Couple plus two	1	6
Couple plus three	2	6
Single plus one	1	6
Single plus two	0	6
Total	0	6

Source: As for Table 1.4.

Note: For each survey that public housing has greater depth of stress a one is added for that household type.

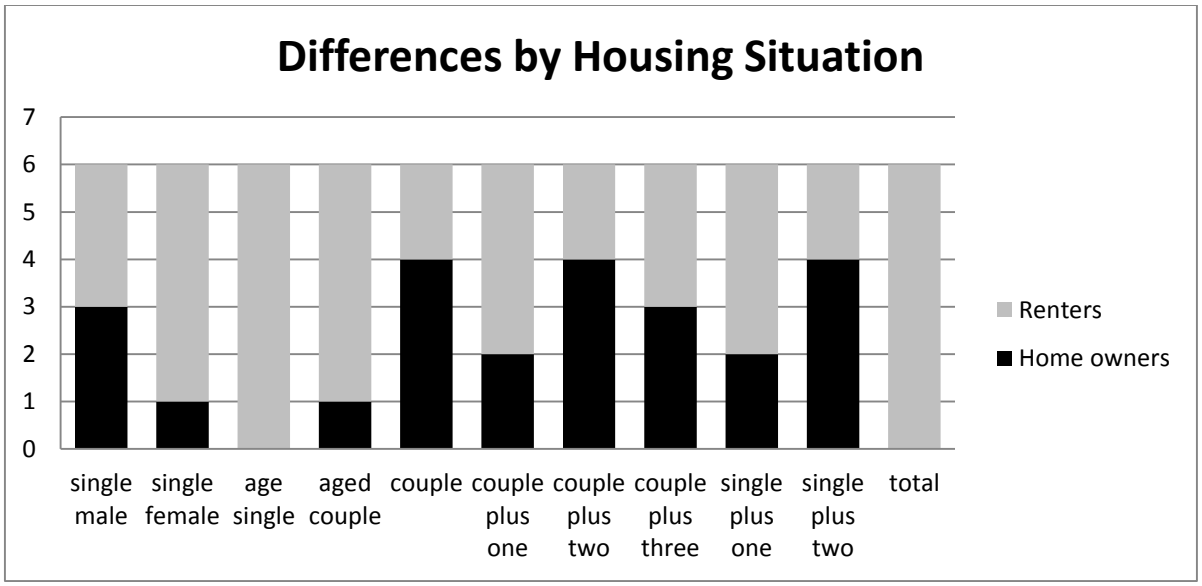
There is a general perception that homeowners are in a better situation than renters, especially in the long run. This is due to housing expenditure meeting a necessity of life while at the same time forcing households into saving for the future. Some of the money that is spent on housing can be recouped when the asset is either sold or lived in mortgage free, while renters are never able to get a return from their rent payment. This logic has resulted in many policies that are targeted on getting households into homeownership. Using the statistic that takes the total sample of homeowners and applies equation (3), is the level of homeowner stress greater than that of renters? Where should policies be directed to' once needs have been identified?

The results are more concerned with the short term situation, with only those households with residual incomes that are below the low-cost budget included in the measure. The short term situation is one in which the gains from investment, such as capital gain or paying off the mortgage, have not yet occurred and none of the benefits of homeownership have been received. The main concern for such households lies in current day-to-day expenses, which are included in the budget standard. If the low budget standard appears to be too high for these homeowners, difficult decisions will have to be made in choosing between different necessities.

The long-term situation, in which homebuyers obtain returns on their investment through home ownership, is not relevant when the household has to select which necessity they should do without given their current low residual income. A house purchase that is not warranted given the buyer's current earning potential may place a household in residual stress. Figure 1.3 shows no divide between household housing situations. If there was a gap between household situations one would expect that all outcomes would have renters with a larger *FGT* than home owners. This does not occur. This contradicts the literature that suggests a growing gap between the two household situations (Yates, 2008).

Figure 1.3

Residual stress levels for different housing situations.



Source: As for Table 1.4.

Note: One for each time a housing situation has the greatest depth of stress.

For most household types, renting is not associated with a greater depth of stress for all surveys. In the short term, homeowners are not necessarily in a better position than renters after meeting housing costs. Figure 1.3 has each of the household types that have corresponding budget standards. The analysis is applied to six surveys, thus each survey is allocated to the housing situation that has the greater depth of stress, between renters and home owners. Couple, couple two children, single with two children are household types for which homeowners have greater depths of housing stress in more surveys than renters, this is reflected with Home owners having four surveys having a depth of stress than renters. This highlights the importance of looking at the depth of housing stress outcomes for households, using the axioms of monotonicity, transfer and transfer sensitivity. The monotonicity axiom has the properties that if there is a reduction in the income of any poor household this should be reflected in the results. The transfer axiom states if a poorer household improves its position to that of a richer one the statistic will reflect this. The transfer sensitivity axiom is the same as the transfer axiom, but reflects the relative initial income levels of the two households involved. The rate of increase will be smaller the higher the initial income of the two households (Chaplin & Freeman, 1999).

The results presented here uncover a more accurate reflection of the true situation and quantify the housing problem more effectively than when this is compared to the mean value of those in stress or a head count method. Singles and single parents have the largest depth of housing stress when using the residual measure. The ratio measure was greater for every household type and survey. Private renting had greater depth of stress in most but not all of the surveys. The difference between affordability models means that there may be important policy implications. This model will allow policy makers to have a greater understanding of the type and depth of the problem that they might face.

5.2 *Residual expenditure* model

The *Residual expenditure* model looks at the different levels of residual income given particular characteristics. The aim is to identify the variables that have a significant relationship with different levels of residual income. The model will show whether the variable has a significant relationship with residual income, in what direction, and whether this holds for different surveys. The model thus generates several outputs, as it is applied to the entire sample and two sub-samples.

This section is separated into discussions of two distinct output types. The first looks at the aggregate affects in each of the models, through an examination of whether the coefficients are significant and if they are positive or negative. A table for *entire*, *renter* and *homeowners with mortgages* is located in the Appendix. Within each of these tables, six models were run for each of the six surveys. The aim is to determine if the aggregate effects remained significant and give consistent results from different surveys. The second type of output looks beyond the coefficients and is broken down into each of the three groups. This shows the likelihood of a household being in that residual income grouping by the household characteristic variable of interest. For example, *AGE2* could increase the likelihood of residual stress and decrease the likelihood of being in the other groups. This marginal effect refers to a unit increase in a particular variable on the likelihood a specific group entering residual stress. The marginal effect of *AGE2*, when the value changes from 0 to 1, specifies the likelihood of entering stress for each group within the model.

5.2.1 Aggregate effects for entire sample

This output is derived from an ordered probit model, run on the whole sample and across the six surveys. The *AGE* variables are significant in most of the cases over 55+. In the entire model, the few *AGE* variables that are significant (*AGE2* and *AGE3*, which include ages 25-44) are negative in direction. Being part of these age groups results in a negative predicted outcome compared to those in *AGE1* (aged 15-25). In *AGE5* and *AGE6*, aged 55-64 and 65+, the impact reverses and becomes positive. There is thus a life cycle effect with the *AGE* variables, in which the situation worsens, compared to *AGE1*, and improves over time, especially in later life. *AGE4* is not significant over the time period in the entire model and could reflect a changing period for households, where mortgages are beginning to be paid off, resulting in greater level of residual income. The model shows that the *AGE* variable has a significant relationship with different levels of residual income. It follows the expected outcome, in which those in middle age are in the worse situation compared to other age groups, with the situation improving slowly as housing costs are reduced.

Both of the *EDUC* variables, bachelor or higher and other post school are significant and positive in the entire models. Those with a post-school qualification have a better residual income level when compared to those without a post-high school qualification, which makes intuitive sense. The main point of interest is that for three of the surveys the second education variables cease to be significant and there appears to be no difference between those with a post-high school qualification other than from university (such as a trade qualification) and those with no qualification. The variable is only significant in three of the six surveys. University education maintains its predictive power more effectively.

The *STATES* variables compare the situation in New South Wales (NSW), Victoria (VIC) and Australian Capital Territory/ Northern Territory (ACT/NT). The most consistent output is *State4* (for South Australia) and *STATE6* (for Tasmania). The *STATE4* variable is significant and positive in five survey, with *STATE6* being similar, but significant in only three of the surveys. The result is not a surprise given that these States are not affected by (rapid increases in population (as is Victoria) and lower average income making government payments have greater purchasing power.

The employment variables are significant and negative. Those who are *unemployed* and *not in the labour force* are worse off in terms of residual income compared to those who are working. The result reinforces the importance of employment opportunities in reducing the problem of housing affordability. Research that examines the relationship between economic conditions and residual stress more closely, to understand how the two variables impact each other, is warranted.

GOV, the percentage of income coming from government payments variable, is significant and negative. Most are negative in terms of residual income, which is as expected. The larger the income from government the greater the likelihood a household will be part of a stressed group. The actual disposable income was not able to be used given that it is part of the dependant variable. The previous year's disposable income was then used, to see how closely linked the two are, how much of a predictor it is, and whether it has a positive significant relationship.

The origin of the reference person (whether born in Australia or not) is an important focus of the model in targeting policy for those who need it the most. In the entire models, four of the years have a negative significant coefficient for those not born in Australia. This demonstrates that further efforts have to be made in this area to assist such households to have better outcomes after paying for their housing needs.

The variable *METRO2* refers to non-metropolitan locations. In the entire models only one was significant and positive, with those living in metropolitan areas having lower residual incomes, which may be a function of higher housing costs in metropolitan locations. Most household types are not significant. Only parents seem to be negative in direction when compared to singles under 65 once all other factors have been controlled for.

Table 1.8

Percent in stress, entire sample, 2000-10

Total	2000	2002	2003	2005	2008	2010
In stress %	0.17	0.17	0.12	0.14	0.12	0.12
May in Stress %	0.25	0.23	0.22	0.20	0.17	0.21
Non-Stress %	0.58	0.60	0.66	0.67	0.71	0.68

Source: As for Table 1.4.

Table 1.9

Significant variables for entire sample, 2000-10

2000	2002	2003	2005	2008	2010
(AGE2)		*(AGE2)*			
(AGE3)					
AGE5	*AGE5*	*AGE5*	*AGE5*	*AGE5*	*AGE5*
AGE6	*AGE6*	*AGE6*	*AGE6*	*AGE6*	*AGE6*
EDUC 1	*EDUC 1*	*EDUC 1*	*EDUC 1*	*EDUC 1*	*EDUC 1*
	EDUC 2	*EDUC 2*	*EDUC 2*		
			STATEHHC3		
STATEHHC4	*STATEHHC4*		*STATEHHC4*	*STATEHHC4*	*STATEHHC4*
			STATEHHC5	*STATEHHC5*	
	STATEHHC6	*STATEHHC6*		*STATEHHC6*	
(LFSCP2)	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*
(LFSCP3)	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*
(GOV1)			*(GOV1)*		*(GOV1)*
(GOV2)	*(GOV2)*	*(GOV2)*	*(GOV2)*	*(GOV2)*	*(GOV2)*
(GOV3)	*(GOV3)*	*(GOV3)*	*(GOV3)*	*(GOV3)*	*(GOV3)*
DISPPH	*DISPPH*	*DISPPH*	*DISPPH*	*DISPPH*	*DISPPH*
		(BORN)	*(BORN)*	*(BORN)*	*(BORN)*
			METRO2		
				COUPLE	
				UNDER 65	
(PARENTS)	*(PARENTS)*	*(PARENTS)*	*(PARENTS)*	*(PARENTS)*	*(PARENTS)*
(SINGLE PARENT)	*(SINGLE PARENT)*	*(SINGLE PARENT)*			*(SINGLE PARENT)*

Source: As for Table 1.4.

Note: Negative predicted coefficients are in parentheses.

In summary, the output from the entire models and the direction of the variables show that the lifecycle is an important factor in housing affordability stress, especially for those in older age, who appear to be in a better situation than other age groups. *EDUC* has a positive impact for most of the surveys; the value of university education holds its value across most years of interest. The employment status, percentage of income derived from government payments and the level of previous financial year's disposable income variables all behave in ways that would be expected of them, which helps show that the outputs from the ordered probit models are logical and consistent with reality. Housing in *SA* and *TAS* has remained affordable and is associated with higher residual income. For a long period of time rents and prices have been lower here than in the other Australian states. This is a function of lower size of population and lower growth rates. Cost of living are lower in these states but government benefits are the same hence, low income individuals will have higher residual income than in other states.. The results regarding household origins and locations warrant further research to try and gain a clear picture of the situation for better policy design. These results were derived on a whole-model level and were not broken down into the three groups that were used.

5.2.2 Aggregate affects for renter and homeowners with mortgage

The sample was separated by the housing situation, with renters and owners with a mortgage being examined further. This enables one to look at the characteristics of the household given its housing situation. The characteristics shown in the model apply to that housing situation only, enabling better targeting of policy. The results here are at the aggregate level but further research could be done into the marginal effect for each of the surveys and housing situations. For these subsamples the impact of the *AGE* variables is reduced for the younger groupings. The only *AGE* variable that maintains its significance is the oldest age grouping, which is positive, compared to *AGE1* (15-24). For owners with a mortgage, the oldest *AGE* variables maintain significance but the younger variables are reduced in significance. This suggests that for homeowners the younger *AGE* grouping is reducing it variation from the base case and becoming similar to *AGE1*.

Table 1.10

Percentage of households in stress, owners with a mortgage, 2000-10

Owners with Mortgage	2000	2002	2003	2005	2008	2010
In stress	16	13	10	11	11	11
May be in stress	16	17	15	14	11	13
Non-stress	68	70	75	74	78	76

Source: As for Table 1.4.

Table 1.11

Significant variables for owners with a mortgage, 2000-10

2000	2002	2003	2005	2008	2010
	(AGE2)	*(AGE2)*			
AGE6	*AGE6*	*AGE6*	*AGE6*	*AGE6*	*AGE6*
	EDUC1	*EDUC1*	*EDUC1*	*EDUC1*	*EDUC1*
	STATEHHC3		*STATEHHC3*		
STATEHHC4	*STATEHHC4*	*STATEHHC4*	*STATEHHC4*		*STATEHHC4*
STATEHHC6	*STATEHHC6*	*STATEHHC6*		*STATEHHC6*	
(LFSCP2)	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*
(LFSCP3)	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*
		(GOV1)		*(GOV1)*	*(GOV1)*
(GOV2)	*(GOV2)*	*(GOV2)*	*(GOV2)*	*(GOV2)*	*(GOV2)*
(GOV3)	*(GOV3)*	*(GOV3)*	*(GOV3)*	*(GOV3)*	*(GOV3)*
DISPPH	*DISPPH*	*DISPPH*	*DISPPH*	*DISPPH*	*DISPPH*
(BORN)		*(BORN)*	*(BORN)*	*(BORN)*	*(BORN)*
					METRO2
(*COUPLE UNDER 65*)				*COUPLE UNDER 65*	
(PARENTS)	*(PARENTS)*	*(PARENTS)*	*(PARENTS)*		*(PARENTS)*
(*SINGLE PARENTS*)					

Source: As for Table 1.4,

Note: Negative predicted coefficients are in parentheses

For renters there is little predictive power on residual income based on education. For the two variables over six surveys only four are significant, signally that for those renting the level of education has less of a relationship with the level of residual income. By contrast, for owner with a mortgage, five of the six surveys for university education have a positive predicted value on residual income. Therefore those who complete a university education are in a better affordability situation when they are a homeowner. The second *EDUC2* variable (completion of a non-university post-school qualification) is not significant and shows no difference for households with no post-school education. Considering the amount of money invested in education, the lack of a significant relationship between this variable and residual income is an area that requires further research.

Table 1.12

Percentage in stress, renters, 2000-10

Renters	2000	2002	2003	2005	2008	2010
In stress	35	34	27	28	22	22
May be in stress	24	21	18	20	21	31
Non-stress %	41	45	55	52	57	47

Source: As for Table 1.4.

Table 1.13

Significant variables for renters, 2000-10

2000	2002	2003	2005	2008	2010
(AGE2)					
(AGE3)					
(AGE4)	*(AGE4)*				
			AGE5		
AGE6	*AGE6*		*AGE6*	*AGE6*	*AGE6*
	EDUC 1			*EDUC 1*	
	EDUC 2		*EDUC 2*		
			STATEHHC4	*STATEHHC4*	*STATEHHC4*
		STATEHHC5		*STATEHHC5*	*STATEHHC5*
	STATEHHC6	*STATEHHC6*	*STATEHHC6*	*STATEHHC6*	
(LFSCP2)	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*	*(LFSCP2)*
(LFSCP3)	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*	*(LFSCP3)*
	(GOV1)				
(GOV2)	*(GOV2)*	*(GOV2)*	*(GOV2)*	*(GOV2)*	*(GOV2)*
(GOV3)	*(GOV3)*	*(GOV3)*	*(GOV3)*	*(GOV3)*	*(GOV3)*
DISPPH	*DISPPH*	*DISPPH*	*DISPPH*	*DISPPH*	*DISPPH*
				(BORN)	
				METRO2	*METRO2*
		COUPLE		*COUPLE*	
		UNDER 65		*UNDER 65*	
(PARENTS)	*(PARENTS)*	*(PARENTS)*			
		SINGLE	*SINGLE*	*SINGLE*	*SINGLE*
		PARENTS	*PARENTS*	*PARENTS*	*PARENTS*

Source: As for Table 1.4.

Note: Negative predicted coefficients are in parentheses.

Variables that are significant in the entire sample continue to be significant in the sub-samples. These include the location variables, *STATE4* and *STATE6*, which are for South Australia and Tasmania respectively. Work status and *GOV* variables continue to have a significant impact on residual income on both sub-groups, in the direction expected. The variable *BORN*, for those not born in Australia is negative and significant in five of the surveys for owners and one for renters, which confirms that this is an appropriate area for research and policy focus. Governments

need to further assist those entering the country in getting established, to provide a sound foundation for the next generation of Australians.

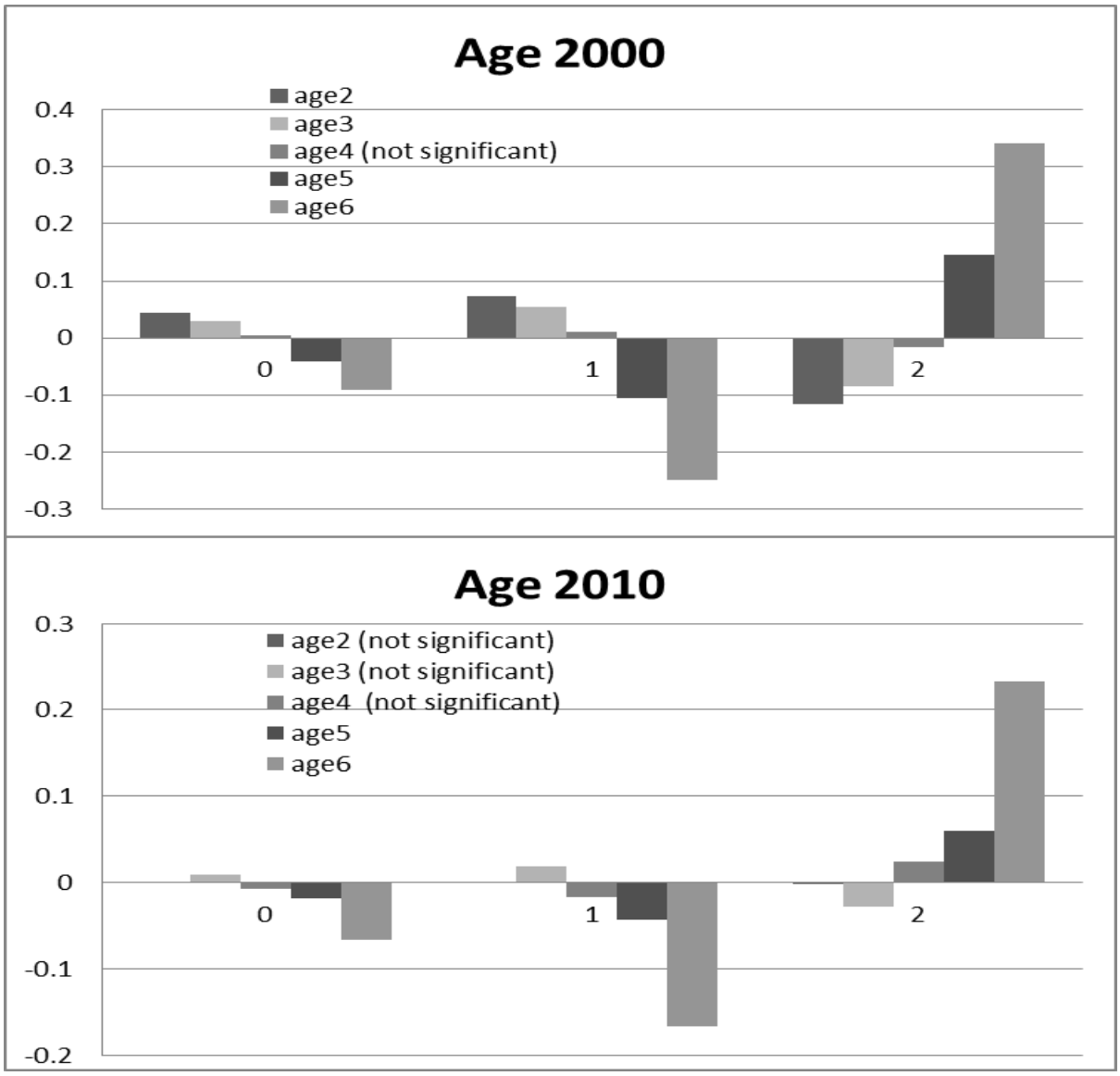
5.2.3 Groups by levels of residual income

The results in this section are broken down into the marginal effects within each group by the independent variables. Each value of the dependant variable is examined individually; there are three values that can be taken, depending on the level of residual stress: in stress (Group One), may be in stress (Group Two), and non-stress (Group Three). The likelihood of a household being in a particular residual stress group for each of the independent variables is shown. The bar that is produced in the graphs sums to zero, so there is an equal amount above the line as below it, hence the likelihood effect of the three groups sums to zero. For example, if the *EDUC* variables have a strong positive impact in Group Three, this will be balanced by negative impacts in the other groups. This makes intuitive sense, if higher levels of education increase the likelihood of being in affordable residual income (group three), then there is less likelihood of them being in residual stress (group one and two). Thus the positive likelihood values for one group equal the negative values in the other two groups.

Figure 1.4 shows that the impact of the *AGE* variables from the entire models on the likelihood of stress decreases as the age of households increases. *AGE2* to *AGE3* all have positive likelihood over Group One and Group Two. These households are likely to be in stress initially, but this likelihood does not hold across the surveys and hence is not significant in 2010. This could be due to a lack of variation in the *AGE* variable, with younger age groups having a similar level of residual stress. A key variable here is the strength of *AGE5* and *AGE6* over all of the surveys, with a strong positive likelihood of household with reference person in these age cohort being in Group Three (affordable housing). While the effects of the Age variables are important, they do not hold their significance for all of the surveys.

Figure 1.4

The marginal impact of age, 2000, 2010



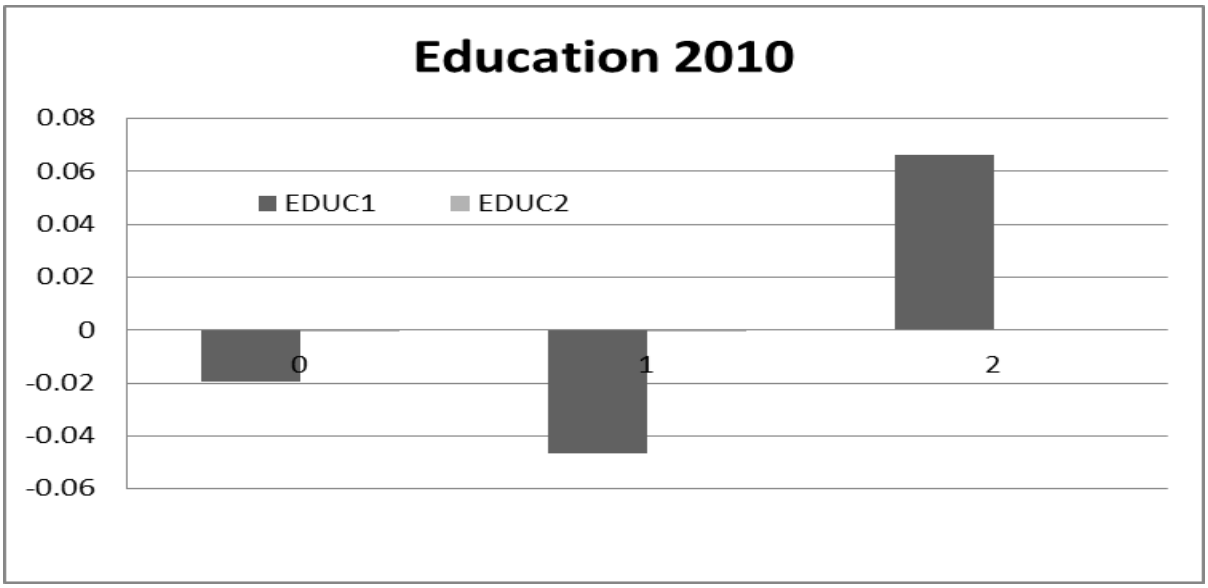
Source: As for Table 1.4.

EDUC may be engineered by households and society though investment in human capital, with information about rates of return to education influencing the allocation of resources. The results from the entire sample (Figure 1.5) show that completion of a university education is linked with a positive likelihood of a household variable being in affordable housing (Group Three) and a negative likelihood of being in residual stress (Group One). Those with a degree or higher qualification are more likely to be living in affordable housing than those without post-school

education. However, non-university qualifications (such as completion of an apprenticeship or post-school training) in the same survey show insignificant results in the 2010 survey, with the marginal effect being so small that it is not visible. Such a finding might alter individual decision making about the benefits of education, which could have negative effects on the economy as a whole.

Figure 1.5

The marginal impact of education, 2010

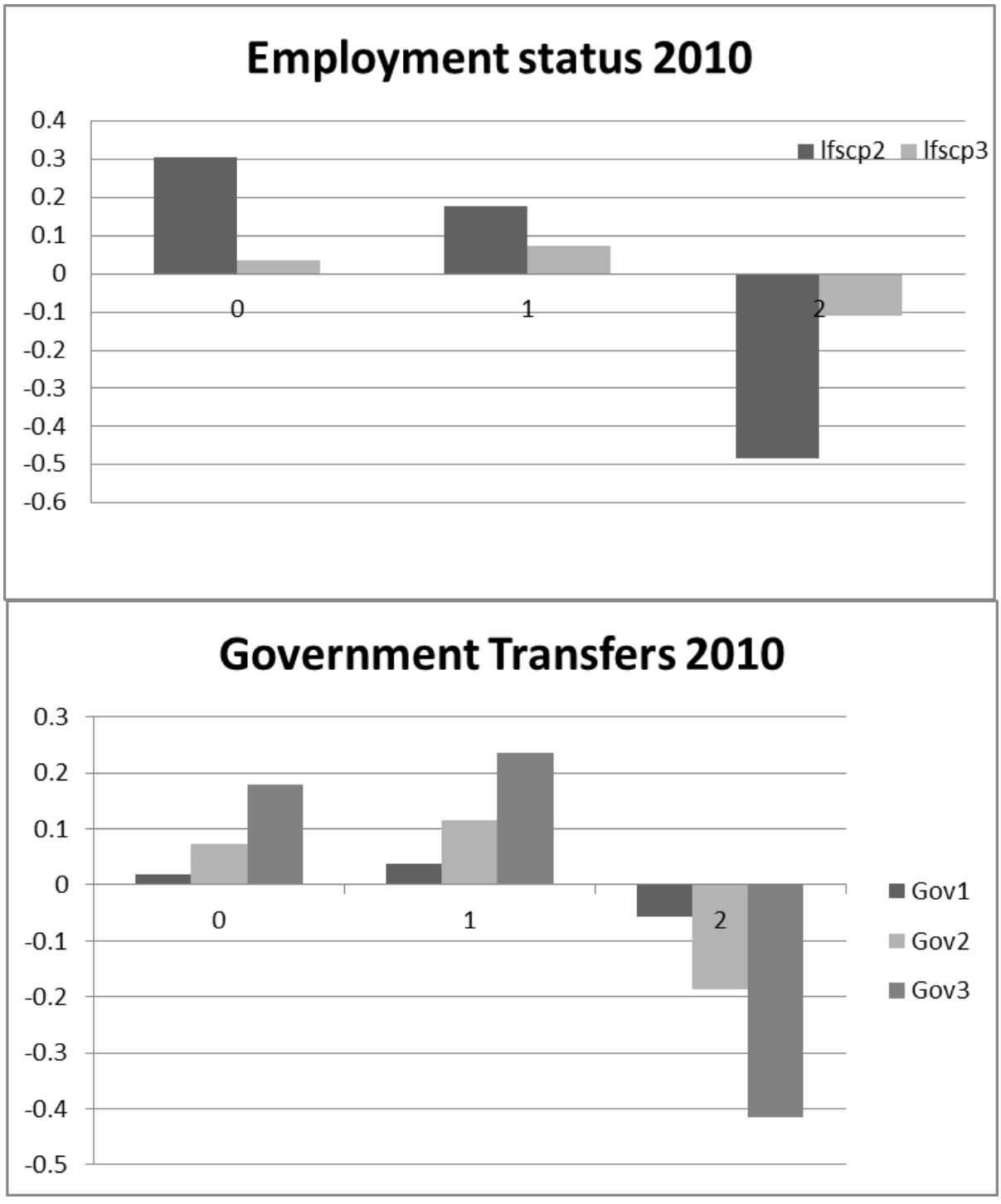


Source: As for Table 1.4

The entire models in Figure 1.6 show that variables relating to a household's employment status (unemployed and not in the labour force) have a similar shape over the surveys, with the unemployed variable having a larger impact on the likelihood of being in residual stress. Those in search of employment have predicted lower levels of residual income compared to those not in the labour force, which may explain why they are looking for work in the first place. *GOV* would be expected to relate negatively to levels of residual income. The output from the entire sample (Figure 1.6) shows that the greater the proportion of household income derived from government payments, the more likely a household are to be in residual stress, as expected.

Figure 1.6

The marginal impact of working and government transfers



Source: As for Table 1.4

The impact of *AGE* on the likelihood of residual stress does not maintain its significance. This could indicate that all household types aged below 55 experience similar problems within the housing market. *EDUC* variables are important in the surveys but only university education holds its value, with other forms of education becoming insignificant. This raises the following question: have non-university qualifications become less important or have those with no qualifications become more important within the economy, leading to higher levels of residual income? Employment status remains important across the surveys and any increase in unemployment rates results in an increased proportion of households falling into residual stress. *GOV* responds in most of the models in a manner expected, with a direct relationship between that variable and the likelihood of a household being in residual stress.

6 Policy implications

The research presented here raises pressing issues that warrant policy attention. The two models provide new information that allows identification and understanding of the problem of housing affordability. The results show the effectiveness of the residual method and that the output from its use is very different from that of the conventional ratio measure. The residual method focusses on outcomes and it allows the development of more precise policies that are targeted at low income earners. It does so through the conceptualisation of housing affordability as a problem faced by households that have residual incomes below the low cost budget.

Housing policy is generally directed at households with low levels of income that are most in need of assistance. The residual method is based on the situation after housing costs are deducted, so one is able to examine the real situation for many households. The cost of housing should be treated as fixed in the short term, so that whatever income is left over after housing costs are met reflects the true income situation of a household. The models used in this essay show that it is possible to use and operationalize the residual approach, providing a more accurate picture of housing affordability for different types of households than the ratio approach.

The *Depth of housing stress* model, which was developed in this essay, is a new method of quantifying levels of housing stress within a sample. It moves beyond the information provided by a simple head count or average approach and gives a value that reflects the depth of the problem.

Given the axioms that the statistic satisfies, it provides more accurate information about the depth of the problem by quantifying not simply the number of households that are in stress but how far below acceptable levels those households sit. The statistic is improved further by using the residual approach, which targets those with low levels of residual income, rather than the ratio approach, which is less targeted. The ratio approach does not consider after-housing income levels, and may include households with higher levels of income. The residual income also changes for different household types to reflect the levels of non-housing consumption that is required. This does not occur when using the ratio approach, as the nominal value of 30 per cent does not change. The *Depth of housing stress* model is a way to operationalize the residual method to better target low-income earners. It provides a more accurate picture of the situation and shows the differences between the residual and ratio measures.

The residual stress method may be adapted to differences in household types, thus measuring affordability with more precision. This is particularly valuable in comparing public and private renting. This is an important area of concern as it is generally presumed that private renters face greater levels of residual stress than public ones. Using the ratio stress approach, those in public housing are not considered to be in stress because they do not spend a sufficient percentage of income on housing. The inabilities to capture households that are not considered to be ratio stressed due to their low level of income spent on housing, but have insufficient residual income to purchase the required necessities of life, are a weakness of the ratio measure.

Households that rent privately are worse off than their public tenant counterparts in most, but not all cases. This may be a result of an inadequate supply of public housing. The outcome highlights the importance of not using the ratio measure for public housing, as the measure does not take into consideration the reality of the situation of these households. This research shows the desirability of including an element of both the residual and ratio approaches when examining the rent levels that public tenants are required to pay. At low levels of income the residual approach may be used, with the ratio measure used as incomes increase. This composite approach would help lower income earners, as the residual approach implies that at low levels of income no rent should be charged. At the same time, higher earners would be encouraged to seek accommodation on the private rental market, as public housing rents would rise directly with incomes.

The statistic was further broken down to examine the differences between homeownership and renting. The conventional view has been that tenants are at a financial disadvantage compared to homeowners. The results suggest that the advantage homeowners receive is not translated into higher residual income in the short term. Homeownership is conducive to better residual income levels in the future, as confirmed by the results for older households, but this should not be a justification for a household taking out a mortgage if it is forced below the low cost budget as a result. Furthermore, the consumption patterns of the two housing situations are very different. Renting tends to be a more short-term proposition and increases the likelihood of residential mobility, as tenants seek better locations, housing, jobs or to move out of affordability stress. Homeownership is a more long-term investment and the residential mobility of home owners is restricted in the short term. A mortgagor who is in stress is likely to face a longer lasting state of affairs. With the *Depth of housing stress* model revealing a problem with the affordability of owner-occupied housing, a policy push for homeownership could lead to undesirable outcomes for homeowners and a situation that might not be sustainable, leading to homeowners having to sell their house not by choice but by necessity. A small increase in the number of unemployed, or an increase in historically low interest rates, could change the affordability stress situation for homeowners quickly. Such households may have been pushed into residual stress by their revealed preference to become homeowners. This is highlighted by the couple and couple with two children household types having a greater depth of stress for homeowners than renters.

For stressed households, trade-offs between necessities must be made after housing costs have been met. This restricts levels of consumption, saving and investment, and the ability to adapt to changes in circumstances. Given the nature of housing consumption, which may be regarded as a fixed cost, a negative outcome is unlikely to change in the short term. The types of trade-offs that are required when households chose to own their home may be addressed by increasing the supply of affordable housing or by changing the nature of the rental market. An increase in supply would reduce the cost of entering housing ownership without the burden of higher prices that occurs as a result of demand-side policies, such as the FHOG. The other option is to improve the rental market and the experience of households within it, so that individuals do not feel the need to enter homeownership at the expense of other necessities. Policy makers need to look at the entire housing market when designing policies. Moving households from one housing situation to another in the short term will not in itself result in better residual incomes. Thus a policy such as

the FHOG, which provides incentives for households to enter into homeownership, is not necessarily conducive to better outcomes in the short term. Policies that target increases in the supply of housing are likely to be more effective.

The policy implications explored so far are derived from the *Depth of housing stress* model. The *Residual expenditure model* builds on this foundation as more variables are introduced. The younger *AGE* variables are often not significant in the *Residual expenditure* model. Thus when looking at the entire sample the *AGE* variables are more significant, but the story for the sub-groups is very different. The *AGE* variables are mainly significant for the older age groups. The level of residual income does not vary based on a person's age, except for *AGE6* (55-64) and *AGE5* (64+). Housing policies that target just one age group category are therefore likely to be less effective than those that make no distinction between the ages of households

EDUC2 does not hold its significance, but this does not imply that post-school, non-university education is not of any value. The model measures the relationship between education and residual income, but education can play other roles. A relationship between university education and higher levels of residual income remains. A closer examination of education and its links to different levels of residual income is needed, given society's level of investment in education. This research is needed to adapt educational offerings that improve people's career outcomes and create better returns to society. This is reinforced when looking at the sub-groups, owners with a mortgage, where there is no significant relationship with *EDUC 2*. The renter's subgroup has few significant relationships with any of the *EDUC* variables.

The value of employment remains throughout the surveys, highlighting the link between residual income and economic conditions. If the latter deteriorates, more households may be expected to fall into residual stress, placing more pressure on government support. This is further shown by *GOV* and its strong relationship with residual stress. The greater the percentage of income from the government, the more likely a household is to be in residual stress.

The location of the household is also an important factor in affordability, especially given the variability in prices around locations. The *STATE* variable of *SA* and *TAS* has a positive relationship with residual income. This could be solely a function of economic conditions, but the role of State governments should also be examined, to determine if effective policies are the reason

for the relationship, and if so, whether these can be transferred to other States. The area that is of concern is the difference in residual income for those who are not born in Australia and those living in a metropolitan area. Policies to help those settling in Australia move into affordable accommodation and not fall in to residual stress may need to be improved. Differences in housing stress between regional and metropolitan areas may encourage movement but further work is needed on the trade-off between location and housing costs. These issues are difficult to target and remedy.

7 Conclusion

The residual stress measure of housing affordability is used in two models to understand the housing stress situations that households are experiencing. The residual measure is effective at targeting lower income earners and can be changed to adapt to different household types. It is outcome-focused, as the household's financial situation is considered after the housing commitments have been made. A household is in stress when its residual income, after housing commitments are met, is less than the low-cost budget levels. This residual approach was used in two different models, the *Depth of housing stress* and the *Residual expenditure*. This measure is further developed, using the budget standard updated to the time period of interest.

The *Depth of housing stress* model was developed in this essay to compare different approaches to measuring housing affordability and compare the housing stress situation for different household types. This model was expanded to examine at different housing situations, from homeowners to public and private tenants. The results show that the affordability situation for public housing tenants and homeowners was not as favourable as might be expected, suggesting that policies could be directed at these housing situations.

The *Residual expenditure* model was developed to examine the effects of a range of variables on levels of residual income. The model shows that differences are less pronounced between ages, except for those aged over 55. *EDUC* is significant for most of the 12 possible outcomes in the six surveys, in the entire sample, but non-university qualification is significant in only three of the six surveys in the relevant sub-sample. *EDUC* and *AGE* had mixed results within the sub-samples, however. Employment and percentage of income from government moved as

expected. South Australia and Tasmania have higher levels of residual income compared to other states. Those in metropolitan areas and not born in Australia are both linked with negative levels of residual income. This shows the variables that should be the target of policy. The model shows that it is feasible to use the residual approach, which improves the accuracy of outputs.

This essay addresses what housing affordability is, through an analysis of housing affordability measures. The residual approach is the most appropriate measure of equality, as quantified through the *Depth of housing stress* model. The issue of who is in stress is addressed by the *Residual expenditure* model, which identifies the variables that have a significant relationship with different levels of residual income.

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9 Appendices

Table A1.1

Stress levels for different housing situations.

household type year	home 2000	renters	home 2002	renters	home 2003	renters	home 2005	renters	home 2008	renters	home 2010	renters	home Total	renters
single male	0.047	0.088	0.068	0.069	0.051	0.040	0.050	0.063	0.064	0.055	0.080	0.062	3	3
single female	0.033	0.059	0.049	0.058	0.038	0.051	0.056	0.045	0.045	0.060	0.047	0.058	1	5
age single	0.016	0.025	0.018	0.033	0.021	0.030	0.021	0.048	0.024	0.031	0.023	0.045	0	6
aged couple	0.019	0.036	0.023	0.021	0.014	0.020	0.013	0.032	0.015	0.028	0.018	0.024	1	5
couple	0.014	0.040	0.016	0.027	0.020	0.017	0.015	0.014	0.028	0.015	0.025	0.021	4	2
couple plus one	0.024	0.058	0.033	0.037	0.023	0.032	0.028	0.012	0.017	0.020	0.031	0.031	2	4
couple plus two	0.025	0.025	0.032	0.036	0.028	0.045	0.027	0.023	0.022	0.019	0.024	0.024	4	2
couple plus three	0.036	0.019	0.026	0.019	0.023	0.030	0.019	0.036	0.017	0.007	0.024	0.038	3	3
single plus one	0.063	0.043	0.031	0.040	0.028	0.036	0.080	0.031	0.023	0.037	0.035	0.043	2	4
single plus two	0.028	0.061	0.058	0.043	0.043	0.025	0.016	0.036	0.057	0.017	0.046	0.035	4	2
total	0.024	0.050	0.028	0.043	0.023	0.033	0.024	0.037	0.024	0.033	0.026	0.040	0	6

Source: As for Table 1.4.

Table A1.2

Stress levels for different landlord types

Landlord types/	Private	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private	Public
Household type	2000		2002		2003		2005		2007		2009		Total	
single male	0.439	0.041	0.117	0.033	0.052	0.084	0.679	0.094	0.054	0.048	0.005	0.001	5	1
single female	0.276	0.018	0.614	0.047	0.298	0.062	0.166	0.067	0.040	0.065	0.006	0.001	5	1
age single	0.021	0.007	0.241	0.010	0.285	0.013	0.387	0.008	0.042	0.032	0.026	0.001	6	0
aged couple	0.900	0.000	0.069	0.010	0.038	0.004	0.355	0.022	0.065	0.004	0.002	0.002	6	0
couple	0.168	0.000	0.102	0.133	0.073	0.000	0.097	0.008	0.018	0.000	0.002	0.000	5	1
couple plus one	0.824	0.000	0.147	0.001	0.044	0.005	0.017	0.007	0.003	0.001	0.003	0.005	5	1
couple plus two	0.025	0.004	0.048	0.028	0.090	0.000	0.076	0.001	0.028	0.000	0.001	0.001	5	1
couple plus three	0.002	0.043	0.026	0.007	0.059	0.000	0.004	0.020	0.008	0.000	0.001	0.002	4	2
single plus one	0.190	0.019	0.082	0.020	0.135	0.008	0.147	0.001	0.061	0.006	0.003	0.008	5	1
single plus two	0.054	0.032	0.099	0.047	0.042	0.017	0.034	0.027	0.026	0.006	0.034	0.001	6	0
total	0.276	0.015	0.191	0.022	0.111	0.025	0.225	0.025	0.033	0.027	0.008	0.002	6	0

Source: As for Table 1.4.

Table A1.3
Residual expenditure for Total data

	2000	2002	2003	2005	2008	2010
AGE2	*-0.297***	-0.136	*-0.234***	-0.00391	0.00116	-0.00032
	(-0.11)	(-0.1*)*	(*-0.1)*	(-0.09*)*	(-0.11*)*	(-0.08*)*
AGE3	-0.217*	-0.0861	-0.143	-0.0228	-0.0213	-0.0832
	(-0.11*)*	(-0.1*)*	(-0.1*)*	(-0.09*)*	(-0.11	(-0.07*)*
AGE4	-0.0408	0.0704	0.0989	0.0981	0.0347	0.0761
	(-0.12*)*	(-0.1*)*	(-0.1*)*	(-0.09*)*	(-0.11*)*	(-0.08*)*
AGE5	*0.404**	*0.499****	*0.291**	*0.512****	*0.330**	*0.191**
	(*-0.22)*	(*-0.17)*	(*-0.16)*	(*-0.18)*	(*-0.17)*	(*-0.12)*
AGE6	*1.022****	*1.158****	*0.829****	*1.135****	*1.101****	*0.793****
	(*-0.22)*	(*-0.18)*	(*-0.16)*	(*-0.19)*	(*-0.18)*	(*-0.12)*
EDUC 1	*0.129**	*0.275****	*0.235****	*0.182****	*0.237****	*0.210****
	(*-0.07)*	(*-0.05)*	(*-0.05)*	(*-0.05)*	(*-0.05)*	(*-0.04)*
EDUC 2	0.0687	*0.0768***	*0.0763***	*0.105****	-0.0075	0.00101
	(-0.04*)*	(*-0.03)*	(*-0.03)*	(*-0.04)*	(-0.04*)*	(-0.03*)*
STATEHHC 3	-0.0222	0.0181	-0.0501	*0.0881**	0.0736	-0.0553
	(-0.05*)*	(-0.04*)*	(-0.04*)*	(*-0.05)*	(-0.05*)*	(-0.03*)*
STATEHHC 4	*0.185****	*0.127****	0.0579	*0.138****	*0.108***	*0.0720***
	(*-0.06)*	(*-0.05)*	(-0.05*)*	(*-0.05)*	(*-0.05)*	(*-0.03)*
STATEHHC 5	0.042	0.00466	0.0757	*0.0990***	*0.163****	-0.00322
	(-0.06*)*	(-0.05*)*	(-0.05*)*	(*-0.05)*	(*-0.06)*	(-0.04*)*
STATEHHC 6	0.115	*0.208****	*0.173****	0.0319	*0.138***	0.00366
	(-0.07*)*	(*-0.06)*	(*-0.05)*	(-0.06*)*	(*-0.06)*	(-0.04*)*
LFSCP2	*-1.100****	*-1.255****	*-1.104****	*-0.916****	*-0.999****	*-1.295****
	(*-0.15)*	(*-0.15)*	(*-0.13)*	(*-0.15)*	(*-0.16)*	(*-0.1)*
LFSCP3	*-0.478****	*-0.479****	*-0.406****	*-0.349****	*-0.415****	*-0.324****
	(*-0.09)*	(*-0.07)*	(*-0.07)*	(*-0.07)*	(*-0.07)*	(*-0.05)*
GOV1	0.135*	0.0639	0.078	-0.119*	-0.107	*-0.165****

	(-0.07)	(-0.06)	(-0.06)	(-0.07)	(-0.07)	(-0.05)
GOV2	*-0.355****	*-0.361****	*-0.342****	*-0.618****	*-0.667****	*-0.519****
	(-0.08)	(-0.07)	(-0.07)	(-0.07)	(-0.07)	(-0.05)
GOV3	*-1.132****	*-1.122****	*-1.064****	*-1.462****	*-1.540****	*-1.186****
	(-0.1)	(-0.08)	(-0.08)	(-0.08)	(-0.08)	(-0.06)
DISPPH	*1.194****	*0.852****	*0.836****	*0.674****	*0.384****	*0.572****
	(-0.09)	(-0.06)	(-0.08)	(-0.06)	(-0.03)	(-0.03)
BORN	-0.0287	-0.0561	*-0.0827***	*-0.0703**	*-0.152****	*-0.0453**
	(-0.04)	(-0.04)	(-0.03)	(-0.04)	(-0.04)	(-0.03)
METRO2	-0.0529	0.0267	-0.0169	*0.0835***	0.0505	0.00749
	(-0.04)	(-0.03)	(-0.03)	(-0.03)	(-0.04)	(-0.02)
COUPLE UNDER 65	0.0125	-0.00344	0.058	0.0884	*0.322****	0.0541
	(-0.11)	(-0.08)	(-0.07)	(-0.08)	(-0.08)	(-0.06)
NON-PARENT OVER 65	0.00593	-0.0571	0.0993	0.0805	0.18	*0.257***
	(-0.2)	(-0.15)	(-0.14)	(-0.17)	(-0.16)	(-0.11)
PARENTS	*-1.124****	*-0.829****	*-0.731****	*-0.372****	*-0.128**	*-0.401****
	(-0.1)	(-0.08)	(-0.08)	(-0.08)	(-0.07)	(-0.06)
SINGLE PARENTS	*-0.330****	*-0.215****	*-0.178***	0.00674	0.0278	*-0.102**
	(-0.11)	(-0.08)	(-0.08)	(-0.08)	(-0.09)	(-0.06)
cut1	10.04***	7.008***	6.630***	5.318***	2.363***	4.123***
Constant	(-0.84)	(-0.62)	(-0.79)	(-0.63)	(-0.37)	(-0.36)
cut2	11.27***	8.097***	7.751***	6.324***	3.227***	5.150***
Constant	(-0.85)	(-0.62)	(-0.8)	(-0.64)	(-0.37)	(-0.37)
N	5205	7967	8938	7880	7252	14550

Source: As for Table 1.4.

Notes: Standard errors in parentheses. ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively. Significant results in italics.

Table A1.4
Residual expenditure for Homeowners with mortgage

	2000	2002	2003	2005	2008	2010
AGE2	-0.282	*-0.392***	*-0.404**	0.0515	0.254	0.0973
	(-0.28)	(*-0.18*)	(*-0.24*)	(-0.18)	(-0.26)	(-0.15)
AGE3	-0.15	-0.223	-0.285	0.141	0.167	0.124
	(-0.28)	(-0.18)	(-0.24)	(-0.18)	(-0.25)	(-0.15)
AGE4	0.107	-0.127	-0.0603	0.261	0.309	0.215
	(-0.28)	(-0.19)	(-0.24)	(-0.18)	(-0.25)	(-0.15)
AGE5	0.536	0.216	0.0312	0.378	0.508	0.264
	(-0.45)	(-0.34)	(-0.32)	(-0.33)	(-0.34)	(-0.22)
AGE6	*1.919****	*1.454****	*0.602**	*0.962****	*1.433****	*0.684****
	(*-0.52*)	(*-0.44*)	(*-0.36*)	(*-0.37*)	(*-0.39*)	(*-0.24*)
EDUC 1	*0.0438*	*0.309****	*0.263****	*0.164***	*0.243****	*0.332****
	(*-0.12*)	(*-0.09*)	(*-0.08*)	(*-0.08*)	(*-0.08*)	(*-0.06*)
EDUC 2	0.113	0.0492	0.0886	-0.0165	-0.0709	0.0329
	(-0.08)	(-0.06)	(-0.06)	(-0.06)	(-0.07)	(-0.05)
STATEHHC3	0.0454	*0.136**	-0.00687	*0.229****	-0.0272	0.071
	(-0.1)	(*-0.08*)	(-0.07)	(*-0.08*)	(-0.09)	(-0.07)
STATEHHC4	*0.255***	*0.301****	*0.155***	*0.270****	0.0552	0.0882
	(*-0.11*)	(*-0.09*)	(*-0.08*)	(*-0.08*)	(-0.09)	(-0.06)
STATEHHC5	0.0468	-0.0459	0.118	0.127	0.0492	-0.0441
	(-0.11)	(-0.09)	(-0.08)	(-0.08)	(-0.1)	(-0.07)
STATEHHC6	*0.249**	*0.206**	*0.310****	0.0194	*0.194**	0.0356
	(*-0.14*)	(*-0.11*)	(*-0.1*)	(-0.1)	(*-0.11*)	(-0.07)

LFSCP2	*-1.484***	*-1.171***	*-1.357***	-0.931*	*-1.517***	*-1.998***
	(-0.27)	*(-0.5)*	*(-0.32)*	(-0.52)	*(-0.53)*	*(-0.3)*
LFSCP3	*-0.462***	*-0.567***	*-0.380***	*-0.322**	*-0.498***	*-0.317***
	(-0.2)	*(-0.18)*	*(-0.16)*	*(-0.18)*	*(-0.16)*	*(-0.12)*
GOV1	0.0651	-0.0534	*-0.152**	-0.0439	*-0.244***	*-0.254***
	(-0.11)	(-0.08)	*(-0.08)*	(-0.08)	*(-0.09)*	*(-0.07)*
GOV2	*-0.740***	*-0.759***	*-0.613***	*-0.847***	*-0.999***	*-0.905***
	(-0.15)	*(-0.12)*	*(-0.11)*	*(-0.11)*	*(-0.11)*	*(-0.08)*
GOV3	*-1.209***	*-1.214***	*-1.038***	*-1.349***	*-1.413***	*-1.300***
	(-0.24)	*(-0.22)*	*(-0.16)*	*(-0.2)*	*(-0.18)*	*(-0.13)*
DISPPH	*1.674***	*1.008***	*0.929***	*0.712***	*0.347***	*0.443***
	(-0.14)	*(-0.13)*	*(-0.08)*	*(-0.11)*	*(-0.06)*	*(-0.05)*
BORN	*-0.201***	-0.0458	*-0.270***	*-0.123**	*-0.310***	*-0.173***
	(-0.09)	(-0.07)	*(-0.06)*	*(-0.07)*	*(-0.07)*	*(-0.05)*
METRO2	0.0601	0.0374	-0.0238	0.0859	0.0376	*0.0949***
	(-0.08*)*	(-0.06*)*	(-0.06*)*	(-0.06*)*	(-0.06*)*	*(-0.04)*
COUPLE UNDER 65	*-0.371***	-0.149	-0.0141	0.0959	0.264**	0.0895
	(-0.18)	(-0.13*)*	(-0.12*)*	(-0.12*)*	(-0.12*)*	(-0.1*)*
NON-PARENT OVER 65	-0.556	-0.377	-0.0273	0.283	0.0223	0.187
	(-0.43*)*	(-0.33*)*	(-0.25*)*	(-0.31*)*	(-0.27*)*	(-0.2*)*
PARENTS	*-1.414***	*-0.868***	*-0.605***	*-0.354***	0.0138	*-0.293***
	(-0.18)	*(-0.13)*	*(-0.12)*	*(-0.12)*	(-0.12*)*	*(-0.09)*
SINGLE PARENTS	*-0.508***	-0.12	-0.121	-0.0855	0.0455	-0.0817

	(-0.2)	(-0.16*)*	(-0.14*)*	(-0.15*)*	(-0.16*)*	(-0.11*)*
cut1	15.27***	8.656***	7.786***	6.229***	2.454***	3.242***
Constant	(-1.39*)*	(-1.32*)*	(-0.88*)*	(-1.1*)*	(-0.67*)*	(-0.56*)*
cut2	16.17***	9.512***	8.594***	6.981***	3.026***	3.958***
Constant	(-1.4*)*	(-1.33*)*	(-0.89*)*	(-1.11*)*	(-0.68*)*	(-0.56*)*
N	1673	2562	3217	2764	2529	4544

Source: As for Table 1.4, *Notes*: Standard errors in parentheses. ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively. Significant results in italics.

Table A1.5
Residual expenditure for renters

	2000	2002	2003	2005	2008	2010
AGE2	*-0.363***	-0.0357	-0.0939	0.0766	-0.00439	0.0696
	(-0.14)	(-0.12*)*	(-0.11*)*	(-0.12*)*	(-0.13*)*	(-0.09*)*
AGE3	*-0.291***	-0.174	-0.0659	-0.0717	0.118	-0.152
	(-0.15)	(-0.12*)*	(-0.12*)*	(-0.12*)*	(-0.14*)*	(-0.09*)*
AGE4	*-0.647****	*-0.229**	0.00328	-0.137	-0.113	-0.0673
	(-0.17)	*(-0.13)*	(-0.12*)*	(-0.13*)*	(-0.15*)*	(-0.1*)*
AGE5	0.194	-0.135	-0.0104	*0.628***	0.274	0.119
	(-0.44*)*	(-0.3*)*	(-0.38*)*	*(-0.3)*	(-0.3*)*	(-0.19*)*
AGE6	*0.877**	*0.547**	0.34	*1.089****	*0.907****	*0.496***
	(-0.47)	*(-0.32)*	(-0.4*)*	*(-0.31)*	*(-0.32)*	*(-0.2)*
EDUC 1	0.212	*0.185**	0.0781	0.0404	*0.275****	0.101
	(-0.14*)*	*(-0.1)*	(-0.1*)*	(-0.09*)*	*(-0.1)*	(-0.07*)*
EDUC 2	0.0103	*0.117**	0.021	*0.158***	-0.0225	-0.039
	(-0.09*)*	*(-0.07)*	(-0.07*)*	*(-0.07)*	(-0.07*)*	(-0.05*)*
STATEHHC3	-0.0919	0.0224	-0.0349	-0.0897	0.082	0.0347
	(-0.1*)*	(-0.08*)*	(-0.08*)*	(-0.09*)*	(-0.09*)*	(-0.06*)*
STATEHHC4	0.198	0.125	0.142	*0.180***	*0.170**	*0.172****
	(-0.13*)*	(-0.09*)*	(-0.09*)*	*(-0.09)*	*(-0.09)*	*(-0.06)*
STATEHHC5	0.109	0.0756	*0.168**	0.057	*0.321****	*0.113**
	(-0.12*)*	(-0.09*)*	*(-0.09)*	(-0.09*)*	*(-0.1)*	*(-0.06)*
STATEHHC6	0.138	*0.406****	*0.450****	*0.241***	*0.280***	0.0701
	(-0.15*)*	*(-0.12)*	*(-0.1)*	*(-0.11)*	*(-0.12)*	(-0.07)
LFSCP2	*-1.255****	*-1.059****	*-1.347****	*-0.857****	*-1.134****	*-1.333****

	(-0.26)	(-0.2)	(-0.2)	(-0.18)	(-0.22)	(-0.13)
LFSCP3	-0.669***	-0.664***	-0.710***	-0.699***	-0.724***	-0.512***
	(-0.16)	(-0.13)	(-0.13)	(-0.12)	(-0.14)	(-0.09)
GOV1	0.0145	-0.249**	0.0827	-0.112	-0.0894	-0.0839
	(-0.16)	(-0.12)	(-0.14)	(-0.15)	(-0.14)	(-0.11)
GOV2	-0.691***	-0.857***	-0.898***	-1.004***	-0.987***	-0.803***
	(-0.14)	(-0.12)	(-0.12)	(-0.13)	(-0.13)	(-0.09)
GOV3	-1.562***	-1.626***	-1.506***	-1.741***	-1.765***	-1.509***
	(-0.19)	(-0.17)	(-0.16)	(-0.16)	(-0.16)	(-0.12)
DISPPH	1.084***	0.759***	0.817***	0.530***	0.333***	0.464***
	(-0.13)	(-0.11)	(-0.09)	(-0.12)	(-0.06)	(-0.05)
BORN	0.00549	-0.0508	-0.0492	-0.0453	-0.202***	-0.0352
	(-0.09)	(-0.07)	(-0.07)	(-0.07)	(-0.07)	(-0.05)
METRO2	0.0615	-0.00498	-0.0492	0.0268	0.112*	0.122***
	(-0.08)	(-0.06)	(-0.06)	(-0.07)	(-0.07)	(-0.04)
COUPLE UNDER 65	0.128	-0.0543	0.285**	0.203	0.535***	0.0711
	(-0.18)	(-0.13)	(-0.12)	(-0.13)	(-0.13)	(-0.1)
NON-PARENT OVER 65	-0.0827	0.347	0.491	-0.510*	0.0887	0.0735
	(-0.45)	(-0.3)	(-0.39)	(-0.3)	(-0.3)	(-0.19)
PARENTS	-0.826***	-0.480***	-0.505***	-0.0792	0.0899	-0.362***
	(-0.16)	(-0.14)	(-0.14)	(-0.15)	(-0.13)	(-0.09)
SINGLE PARENTS	-0.0492	0.16	0.278**	0.327***	0.358***	0.138*
	(-0.15)	(-0.11)	(-0.11)	(-0.12)	(-0.13)	(-0.08)

cut1	8.859***	6.000***	6.235***	3.628***	1.686***	2.763***
Constant	(-1.24)	(-1.07)	(-0.94)	(-1.19)	(-0.63)	(-0.56)
cut2	10.12***	7.039***	7.562***	4.680***	2.764***	4.106***
Constant	(-1.25)	(-1.08)	(-0.95)	(-1.2)	(-0.64)	(-0.56)
N	1306	2195	2298	2081	2016	3992

Source: As for Table 1.4. *Notes*: Standard errors in parentheses. ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively. Significant results in italics.

Table A1.6

The composition index

Year	Per cent	Valued used
Dec-1997	1.30	0.013
Dec-1998	1.50	0.015
Dec-1999	1.58	0.016
Dec-2000	3.61	0.036
Dec-2001	2.00	0.020
Dec-2002	1.82	0.018
Dec-2003	1.27	0.013
Dec-2004	5.36	0.054
Dec-2005	3.50	0.035
Dec-2006	3.81	0.038
Dec-2007	5.89	0.059
Dec-2008	5.75	0.057
Dec-2009	0.32	0.003
Dec-2010	0.72	0.007
Dec-2011	1.40	0.014

Source: ABS (2011, 2012)

Essay Two: The role of transport costs and location in housing stress

1 Introduction

Where households live affects their well-being and how they interact with others. Residential location is a function of a range of factors, only some of which households are able to control. The design and layout of a city will influence where households live within it. The ability to access housing is determined by the level of supply of housing, which affects not only the costs of housing, but also its location. If the supply of housing is deficient some households will have to live in areas that are inconvenient to jobs and amenities. A city's housing supply is influenced by its layout and historic evolution, as planning and construction decisions made in the past exert a continuing impact on the current level of supply. Compared to other necessities, the consumption of housing is highly dependent on what has occurred previously, as built environments evolve in a path-dependent way.

Households may have to live in locations that do not reflect their preferences, due to the level of housing costs. A location that is distant from a city centre and lacking in amenities may provide lower housing costs, but how does this outcome affect household budgets? The location of a household affects housing costs, but can also flow through to transport costs. Differences in transport costs by location are influenced by the layout of the city and travelling behaviour. Differences in transport costs based on location will be smaller if most households drive within a city. This will be very different if there is greater range of transport options and greater level of housing density.

This essay focuses on where Australians who are in housing stress are located. To do so requires the built environment and transport costs to be taken into consideration. The built environment refers to urban design, land use, and transportation systems, and encompasses patterns of human activity within the physical environment (Handy, Boarnet, Ewing, & Killingsworth, 2002). The built environment also includes the stock of physical capital embodied in the urban landscape and the pattern of land ownership and usage. It is highly sensitive to initial

planning decisions, the availability and choices of technology, geography and human alteration of the land. Spatial equilibrium models hold that households chose locations within a metropolitan area that allow them to maximise utility, with differences in transport costs being exactly offset by differences in housing costs. The models treat the urban area is a monocentric, featureless plane, and are therefore concerned only with distance and transportation technology (Glaeser, 2008). The distance variable used here does not consider the distance to the city centre as the crow flies, but rather the distance to the city centre when driving, which is the form of transport used for most trips within metropolitan areas (Mees et al 2008). This is influenced by the quality of road systems and the availability of other forms of transport, which affect congestion levels and the impact of distance on housing locations. While a household might not travel to the city often, distance to the city acts as a proxy for household location in relation to that of other households. The location of households does not directly mean that they will have to travel to the city. Yates et al (2005) show that a large proportion of people live and work in the relatively same area, even on the outer areas, thus the trade-off between transport and housing in not necessarily a linear one.

If distance is a predictor of housing affordability stress, the location of housing plays a role in housing affordability. In general, the supply of amenities may be expected to diminish the further a household lives from the centre of a metropolitan area. In this essay, a city centre is represented by the location of the General Post Office (GPO). If distance plays a role in housing stress, this can reflect the congregation of households in housing stress at the same location. Once this occurs there is a cumulative effect that makes it harder to escape stress and fewer opportunities to advance.

If all households in a given location are in stress they may struggle to react to changes as they lack the resources to adapt. The quality of housing will decrease if households lack the resources to maintain and improve their housing, which will have a cumulative effect on house values. This adds another layer of socio-economic stress over existing patterns of social and spatial disparity in the Australian urban environment. In the capital cities, an apparent widening of the gap between rich and poor communities has raised fears about concentrations of poverty and social exclusion, particularly if the geography of these communities is such that their residents are increasingly isolated from urban services and employment centres (Baum & Gleeson, 2010).

In this essay, the built environment of two capital cities, Melbourne in Victoria and Sydney in New South Wales, will be explored. The origins of the cities and the different legacy effects that accumulated as they developed over time will be examined. Melbourne and Sydney were founded for different purposes, and geographic variations between their sites shaped the locations of the town centres in relation to their ports. Melbourne was more decentralised and faced fewer geographical barriers to expansion, and thus conforms more closely to the scenario of spatial equilibrium models than Sydney does. Transport costs and household locations are included in the model, with the built environments being an exogenous variable that helps to explain differences in results.

The research question addressed in this essay is:

How do the built environment and transport costs affect the geography of housing stress?

This essay aims to uncover whether distance from a city centre is a predictor of levels of housing affordability stress. A measure of housing affordability that takes into consideration the location of a household will be used, through the inclusion of transport costs in the measure of housing affordability. There are three elements within the research question. The first is the nature of the built environment of Sydney and Melbourne. As the models are the same in terms of variables, with the only difference being in the location of the households, any variation between the results may be attributed to the built environment of the cities. The second is the measure of housing affordability, which considers the geography of housing stress by incorporating transport costs. The third is the issue of whether distance from the city centre is a predictor of residual stress.

The model used isolates the predictive power of distance on residual stress levels. If distance has no predictive power once transport costs have been incorporated within the housing affordability measure, stressed households are not likely to be concentrated in particular locations and may be distributed more in line with spatial equilibrium models. If households that are in stress are located at random distances from the city centre it is unlikely that distance is significant. If distance is significant, it would indicate that there are factors that are making stressed households occur at specific distances from the city centre.

The benchmark that has generally been used in the literature is the ratio approach, in which a certain percentage of income spent on housing is deemed to place a household in stress. In most

cases the percentage is set at 30 per cent. In this essay, the residual approach will be used to consider the amount of income that remains after fixed costs – normally only housing – have been accounted for. Use of the residual measure is possible due to the type of benchmark that it incorporates, the budget standards, which comprise eight elements. The elements that are treated as fixed – housing and transport costs – are removed. The two values – residual income, the amount left after housing and transport costs are met, and budget standards without housing and transport adjusted for the household type and the State the household is located in – are then compared. Thus a measure for housing affordability is proposed that uses transport costs to consider the location of the household. Once a value has been assigned to each household, depending on the comparison between their residual income and the appropriate budget standards, the model is applied to Victorian and New South Wales data. The major contribution of this technique is to specify the predictive power of distance. The findings of the essay are that distance does predict the level of housing affordability stress and that the predicted results vary according to the State that the household is located in. These variations are driven by differences in built environment.

A *Residual expenditure with transport costs* model is introduced in this essay. It applies ordered probit techniques that predict different levels of residual income, the level of disposable income after housing and transportation costs are met, by controlling other characteristics to see if distance is still significant. Distance variables, specified as distance from the city centre, are added to basic independent variables, such as education, age and government transfers as a proportion of income. If residual income increases at greater distances from the city centre increases, households will be able to find lower-cost housing by moving to the edge of the metropolitan area. Such a result would indicate that housing costs decrease more quickly than any increase in transport costs in relation to distance. If the reverse applies and moving further out does not improve housing affordability situations, this would indicate that any decrease in housing costs is outweighed by increases in transport costs.

The two locations that will be included in the analysis are New South Wales and Victoria, the most populous states in Australia. The model is applied separately for each of these locations as the distance variables play a very different role depending on which State is being considered. The result for each State is looked at individually. The only difference between the two models is

the location of the households included. Thus any differences in the results may be attributed to the built environment that households are experiencing.

The essay structure is as follows. The next section (Section 2) reviews the literature relating to affordability measures in the context of the trade-off that households face between housing and transport costs, the location and stock of housing, price gradients with distance, and definitions of the built environment. This leads to the methodology (Section 3) and data (Sections 4) sections, in which the built environments of Melbourne and Sydney are introduced. In Section 5, an analysis of the impact and predictive power that distance has on the two cities is conducted. The marginal effects of the model are explored, in terms of the likelihood of households being in different types of stress based on their distance from the city centre. The cities' built environment and distance are then linked to show the importance of the built environment and distance on housing affordability. A discussion of policy implications is in Section 6, and Section 7 concludes.

2 Role of built environment in housing affordability

To understand how households experience their location the components of the conceptual framework are introduced. How are spatial and transport costs accounted for within a measure of housing affordability? Traditionally, these costs are not included in measures of housing affordability. To further this point the trade-offs that households have to make between locations and cost are explored. Location might reduce a household's housing costs, but this may have to be traded-off with higher transport costs. Such trade-offs will be affected by the built environment of cities. Higher use of private transport and greater levels of population density will impact the trade-offs between locations.

2.1 Measures of housing affordability: the spatial and transport cost context

As discussed in Essay One, measures of housing affordability typically focus on housing expenditure by households. At a current level of housing supply, what level of housing expenditure does a household commit to? In consuming housing, are households able to spend less than a certain benchmark? Vidyattama, Tanton, and Nepal (2011) use a measure that examines the impact of transport costs on the number of households that are in housing stress. They define a household as in stress if 30 per cent of household income is spent on housing and transport, and if it is in the

bottom two quintiles of the income distribution. This measure is improved by the use of disaggregated zonal data to develop comprehensive indicators of commuting costs, which may be compared across regions. The outcomes are very different once commuting costs are considered (Mattingly & Morrissey, 2013).

Siminski and Saunders (2004) find that in comparing the incomes of households between regions, a more appropriate measure of income would be the income that remains after housing costs have been met. Housing costs in this case include rent, mortgage repayments with interest and principal, maintenance and body corporate fees. Data from the 2001 Census and 1998/9 *Household expenditure survey for Australia* indicate that higher housing costs in major cities are not offset by lower transport costs. Households living in rural areas have very high travel costs, which more than offset their low housing costs. As a measure of housing affordability, the value of the residual approach is made clear by Stone, Burke, and Ralston, (2011), who take a household disposable income and subtract from it the budget standard for that household type. Housing costs are removed from the budget standards, and the amount remaining is what the household can afford to spend on housing. At zero or very low levels of income a household will be unable to afford any housing costs, but once non-housing necessities are paid for all new income can be spent on housing. This is in contrast to the ratio approach which is based on a set percentage of income for housing costs.

Analysis of the rental market on a spatial basis also shows a continuingly polarized urban environment, given the expenditure available to different household types for housing (Burke et al., 2011). Access to public transport is crucial. All classes of public and private housing available to low-income earners are overrepresented in areas of poor public transport accessibility. The low-cost private rental housing markets for Melbourne and Sydney are located in areas with significant transport disadvantages (Burke & Stone, 2014).

Patterns of housing affordability are dependent on location. Fisher, Pollakowski, and Zabel (2009) introduce a new measure of area affordability that identifies the supply of housing that is affordable to different households in different locations of a metropolitan region. They then take into account differences in job accessibility, school quality and safety that are associated with housing locations. Adjustments are based on obtaining implicit prices of these amenities from a hedonic price equation. The focus is on the supply of housing units with demand being fixed, using

80 per cent of median income as the income level in which to measure the affordability of the housing stock.

The most recent Australian study that has a spatial component considers Adelaide, Melbourne, Sydney and Brisbane (Kupke & Rossini, 2011). It focuses on first home buyers who deliver essential community services such as health, social services, education, safety and emergency services. Burke and Hayward (2001) also use a spatial analysis in examining Melbourne suburbs to assess how the situation changed during the 1990s, updating their previous work with an emphasis on the top and bottom twenty suburbs. For this affordable house price, the supply-side analysis focuses on the percentage of houses that are available, and on the demand side, what percentage of families find this price to be within their budget constraint.

2.2 Trade-offs between location and costs

There is a trade-off between density and house prices, as households maximise their utility with a given budget constraint by living in more dense housing conditions to offset high transport costs or can choose cheaper housing with less density but then incur the high transport costs. Kulish, Richards, and Gillitzer (2012) use a version of the Alonso-Muth-Mills model of location within a metropolitan area, calibrated to broadly match some of the features of a representative large city (Glaeser, 2008). Households in their model are assumed to be identical in terms of income and preferences. Householders face a choice of whether to live in well located, but smaller and more expensive housing, or in more distant but larger and less expensive housing towards the city fringe. The Kulish et al. (2012) model considers the impact of the provision of transport infrastructure, zoning policies that limit housing density, the inelasticity of housing supply, and population size on housing choices. A key influence on the making of this choice is transport costs. The effect of poor transport infrastructure and higher transport costs are a key influence, with households spending more of their resources commuting, and living in larger more expensive homes. The trade-off many households make in outer urban living is to buy a large home at a lower price, rather than an inner city apartment for much the same price.

Rowley and Ong (2012) argue that as households move a significant distance from their workplace in order to access affordable accommodation, they incur higher transport costs. This trade-off between housing and transport costs is evidenced by households reporting that as they

spend more on fuel costs they become less satisfied within their house and neighbourhood. Spatial patterns of deprivation in Melbourne reflect extreme relative deprivation in peripheral areas, with lower levels close to the City Centre (Baum & Gleeson, 2010). Deprivation in this case is based on the General Deprivation Index, which uses principal components analysis and the resultant factor scores to develop the index score. The suburbs with the highest relative deprivation are post-World War II industrial growth centres such as Broadmeadows and Sunshine (Baum & Gleeson, 2010). Flood and Baker (2010) take distance into consideration and once the effects of age are removed, regional differences are pronounced in determining the incidence of renting and homeownership. Regional differences are insignificant when all household types are considered, but increase in prominence when the generation groups are analysed separately. Housing affordability is diminishing in every Australian capital city, with affordable housing retreating towards the periphery of metropolitan regions, where employment opportunities are relatively weak, local unemployment levels are relatively high and access to public transport and other key urban services is relatively poor (Phillips, 2011; Wood, Berry, Taylor, & Nygaard, 2008). Many long-term renters have moved to the outer regions of cities, where increased commuting distances and greater reliance on private motor vehicles is necessitated by a lack of public transport. Burke et al. (2007) find that about half of a sample of households had already moved in the previous five years to reduce housing costs. This raises the issue of what households have given up for these lower housing costs. Given increased reliance on private motor vehicles, are these households better off after making the trade-off between housing and transport costs? The location of stressed households, once they have made location decisions that are constrained by their income, housing and transport costs, will be determined to see if this deprivation can be captured.

2.3 Built environment

The term ‘built environment’ refers to elements of planning, land use, and transportation systems, and encompasses patterns of human activity within the physical environment in urban areas (Handy et al., 2002). The built environment is constantly changing, sometimes quickly, but the pace of change may be highly sensitive to the effects of previous choices made about city planning and building. The built environment impacts on where households will be located and whether a dwelling is considered affordable given the land and commuting costs associated with that location. The trade-offs that households make between living close to a city centre, where housing costs are

high and transport costs low, or areas of lower-cost housing with higher transport costs, are a product of the built environment. The built environment is also the primary influence on the length of trips and choice of transport mode (Ewing & Cervero, 2001). All else being equal, residents of neighbourhoods with higher levels of density, land-use mix, public transport accessibility and pedestrian friendliness tend to drive less and report higher rates of walking and cycling than residents of low-density, single-use neighbourhoods where connections to effective public transport are lacking (Handy et al., 2002; Handy, Cao, & Mokhtarian, 2005; Saelens, Sallis, Black, & Chen, 2003).

The measure of affordability used in this essay includes both housing and transport costs to capture how households are affected after residential location decisions have been made. Mattingly and Morrissey's (2013) study of Auckland suggests that once commuting costs are incorporated into measures, outlying areas become relatively less affordable, while those close to employment centres become relatively more affordable. This essay contributes by focusing on the location and transport cost associated with the location. This is not to recommend where to purchase, rather the aim is to identify the location that might require policy attention due a lack of housing affordability.

Population growth in outer regions may also lead to the consolidation of groups of low-income earners, in which households are effectively trapped by their limited opportunities to move (Hulse, Burke, Ralston, & Stone, 2010). If neighbourhoods with similar socio-economic characteristics are created or developed at the same time, changes in economic conditions that affect one household are likely to affect other households in the same location. Similarities in household type and housing histories may make an area vulnerable to changing economic circumstances. Changes in economic conditions will impact areas that are mostly made up of low-income earners or are classified as affordable suburbs (Knight & Cottet, 2011). These suburbs are the least able to adapt to changing conditions, as they lack the needed resources that other areas possess. The impact of many households that are in stress being in proximity has wider implications. It may reflect a lack of job opportunities, transport infrastructure or supply of housing. In an Australian context, Kelly, Weidmann, and Walsh (2011) highlight the importance of location to housing. Their work involves a survey of how individual decisions about housing were made,

given constraints of current housing costs and incomes. Once such constraints are considered, the location of housing continues to play an important role for those surveyed.

The built environment of Australian cities cannot be changed easily (Page, 2006). This may impact on the nation's ability to cope with population growth, provide affordable and functional housing, cost-effectively maintain and extend infrastructure, and avoid pollution externalities (Troy, 1995). The most dynamic imbalance arises from the simultaneous over-centralization of employment, civic opportunity and public investment, and the continuing haphazard dispersal of housing, commercial activity and motorized travel. With transport systems that are highly centralized, Australian cities lack the ability to provide cross-metropolitan travel for employment- and non-employment-related trips (Gleeson, Dodson, & Spiller, 2010). As early as the mid-1960s, Neutze (1965) observed that while location in a major city could provide firms with valuable economies of scale and agglomeration, city growth also imposed substantial costs in the form of traffic congestion, lengthening journeys to work, pollution, and rising housing costs. Newman (1992) argues that continual urban sprawl is not a viable long-term option and creates a drag on economic growth. Urban sprawl continues, without being matched by investment in transport infrastructure, and is now likely to play a key role in predicting whether a household will be in affordability stress.

3 Methodology

The model introduced in this essay is based on the trade-off that households make between location and housing costs, which is influenced by the built environment and transport costs. The built environment and transport costs will change depending on the household's location within a particular State. The key measure and variables that will be used to address the research question will be introduced in this section to provide an understanding of how they will be incorporated within the final results. The key elements are the built environment, transport costs, geography and the measure of housing stress that will be applied. Analysis of the built environment will extend to the origins and development of Melbourne and Sydney. The geography (or location) of housing stress will be influenced by the built environment and how it has evolved over time. This is a major focus of the empirical model.

3.1 A residual expenditure model with regional differences and transport costs

The *Residual expenditure with transport costs* model incorporates spatial aspects, with the inclusion of the distance variables that were not considered in Essay One. It examines that location of household within a State and runs the model only on households within the same State. Six Waves, Waves 5 to 10 of the HILDA data set, are used, Wave 5 was collected 2005 then annually with Wave 10 collected 2010. In the data there is an observation for each individual, but variables such as housing costs and disposable income are from the household that the individual lives in. This individual is a representative individual and only one individual per household is kept, which is in line with the ABS selection of reference person within a household. The level of detail in the data set allows analysis at the individual level. HILDA provides information about housing costs, postcode, and travel time that is vital for the model. Henman (1999) is the second data source for the budget standards. Key elements may be removed from this data set if required. In this case, the transport and housing elements are removed in constructing the measure of housing affordability.

The model is run on each of the Waves in which there is data on transport costs for Victoria and New South Wales, 2005-2010. The level of detail in regard to location allows for adjustments to be made within a city. The dependant variable is also altered to consider transport costs within the measure of housing affordability. The two components that are now considered fixed in the short term are housing and transport costs.

The *Residual expenditure with transport costs* model may be expressed in the following:

$$y_i * = \boldsymbol{x}_i \boldsymbol{\beta} + \epsilon_i \qquad \epsilon_i \sim N(0,1), \forall i = 1, \dots, N. \qquad (1)$$

Where:

$\boldsymbol{x}$ - vector of independent variables;

β - vector of coefficients;

ϵ - Is assumed to be normally distributed across observations

y^* - is unobserved, what is observed is:

$$y = \begin{cases} 0 & \text{if } y^* \leqslant 0 \\ 1 & \text{if } 0 < y^* \leqslant \mu_1 \\ 2 & \text{if } \mu_1 < y^* \leqslant \mu_2 \end{cases} \quad (2)$$

Where:

μ – are unknown parameters to be estimated with β

The Ordered Probit technique uses an observation *y*, an observed ordinal variable, the value of which is determined by the continuous, unmeasured variable *y** (housing stress), to fit the parameter vector β in (1). In the model, residual stress (*y**) is the latent variable; the observed variable (*y*) depends on whether a particular threshold parameter is crossed, to predict if a household is, may be, or is not in residual stress. The threshold points are derived by the coefficients within the model.

x - [AGE, EDUC, GOV, DISTANCE, MOVE, HOUSEHOLD TYPE]

Equation above has four key independent groupings:

a) the basic characteristics of the individuals. These include education levels, age and the percentage of income that is obtained from government transfers. These elements are included to capture variation in the basic characteristics and to isolate the predictive impact of the distance variables.

b) the different household types. This controls for differences that result from household types.

c) whether the household has moved in the past twelve months. While this is not directly related to distance, it captures those households that are often in unstable housing situations.

d) the group of location variables that have been produced from the postcode variable and refers to the distance from the city centre.

Table 2.1

Variables used to create the measure of Housing affordability with transport costs

Variable name	Variable label	Explanation or HILDA variable names
Tnchild	Total number of dependent children	Made up from hhd0_4, hhd5_9, hhd1014, hhd1524
hhd0_4	Number of dependent children aged 0 to 4	
Htype	The ten different household types	Requires tnchild, hhtype, hgsex, hgage
Hhtype	General household types	
Hgsex	The gender of the individual	
Hgage	The age of the individual	
State	The State the household lives in	Taken from hhstate
LCT	Low cost budget standard without transport cost	Benchmark depending on the htype and year
MT	Moderate budget standard without transport cost	Benchmark depending on the htype and year
WHC	Weekly housing costs	Requires hsmg and hsrnt depending on the type of housing costs
Hsmg	Mortgage usual repayments $ per month	

Hsrnt	Rent usual payment $ per month	
WDI	Weekly disposable income	Requires hifdip
WTC	Weekly transport cost	Requires Hxymvfic Hxymvri hxypubt
Hxymvfic	Household annual motor vehicle fuel	
Hxymvri	Household annual repair and maintenance	
Hxypubt	Household annual public transport and taxis	
RI	Residual income	(*WDI – (WHC +WTC*))

Source: Melbourne Institute (2001-2010).

Table 2.2

Variables in the Residual Expenditure model with transport costs

Variable name	Variable label	Explanation or HILDA variable names	Values
Dependant variable			
Y	Housing affordability with transport costs		y = 0 if y* ⩽ LCT y = 1 if y* > LCT & y* ⩽MT y = 2 if y* > MT
Independent variables			

AGE	Age of individual	Taken from hgage for recoding	15 to 34 35 -54 55+
EDUC1	Post-high school education	Taken from edhigh for recoding	Degree or higher (EDUC1)=1 All else = 0
GOV	Percentage of income from Government	Made from hifapti and hifefp	-*GOV0* = zero - *GOV1* = zero < x <50% - *GOV2* = x<50%
DISTANCE	Distance from City Centre		0 -10Km 11-20Km 21-40Km 41+Km Other Urban Rural
MOVE	Moved in the past year	From mhli	Move = 1 Everyone else = 0
HOUSEHOLD TYPE	Household types taken from matching budgets.	Grouped from htype	*SINGLE UNDER 65* *SINGLE OVER 65* *COUPLE OVER 65* *COUPLE UNDER 65* *PARENT* *SINGLE PARENT*

Source: As for Table 2.1.

The dependant variable in the empirical model is the measure of housing affordability. The most commonly used measure of affordability, the ratio approach, is based on the percentage of household income spent on housing. If this exceeds 30 per cent, a household is considered to be stressed. However, if other elements, such as transport costs are included in the measure, naturally more households will be classified as in ratio stress. The approach taken here is to include transport costs and treat them as fixed costs for a household. The residual measure, which uses the budget

standards, may be adjusted to include different elements. This is done by subtracting fixed costs, for both disposable income and the budget standards. In this case housing and transport costs would be subtracted from disposable income to produce a residual income. This is then compared to a budget standard for that particular household type that has these elements removed. The residual income will be recoded depending on how it compares to the two budget standards. These budget standards will also be adjusted depending on which State the household is residing in.

The following procedure provides the residual income for a household:

$DI - (HC + TC) = RI$

The Budget standard used is:

$BS_{ah^{(xtp)(LC)}} - LCT$

$BS_{ah^{(xtp)(M)}} - MT$

RI - residual income

DI - Disposable Income

HC - Housing costs

TC - Transport costs

BS - Budget standard

x - Household type

t - the transport component, highlighting that transport is removed from benchmark

p - the particular time period.

ah - budgets for after housing costs comparisons.

Thus the dependant variable compares the residual income against a budget standard for that time period and household type. The following is an outline of how the benchmarks are produced, which makes the dependant variables in the ordered probit:

$DI - (HC + TC) < BS_{ah^{(xtp)(LC),}}$ then household is assigned 0.

$DI - (HC + TC) > BS_{ah^{(xtp)(LC)}}$ & $DI - (HC + TC) < BS_{ah^{(xtp)(M)}}$, then household is assigned 1.

$DI - (HC + TC) > BS_{ah^{(xtp)(M),}}$ then household is assigned 2.

Location is measured by the distance between the GPO at the City Centre for the State of interest and the geographical centre of the postcode that a household lives, as determined by Google Maps. This is to reflect the experience of distance for households; distances that would have to be travelled by road to get to the City Centre were obtained using Google Maps. The resulting distances are then grouped together. Households that are located outside of metropolitan area are classified as either 'other urban' or 'rural', depending on the density of population at their location. The distance variable to the City Centre is only applied to those that live in a major urban area. Outside of this the household is grouped by the density of their location.

The key focus of the analysis is to determine whether the built environment is a predictor of the location of residual stress, when housing and transport costs, which are considered to be fixed, are included in the measure of stress. To understand if this is the case the built environment of two capital cities is explored. Predictions about the nature of the built environment and interpretations from the model cannot be made without reference to a historical perspective on the current time period. This will include the evolution of transport infrastructure and usage, housing density, the geography of the housing stock, and location of household types and general characteristics of suburbs. The development of a city's transport and growth corridors will impact on levels of private transport usage and whether suburbs are physically grouped by similar characteristics. The location and level of new housing supply will influence housing and transport costs. Once the built environment is explored the results from the *Residual expenditure with transport costs* model will be discussed.

3.2 The built environment of Melbourne and Sydney

Melbourne and Sydney were founded for different purposes, which affected the original placement of their ports and town centres. Sydney was founded in 1788 as a convict settlement and laid out for ease of defence; Melbourne was founded in 1836 by free settlers for commercial purposes.

Sydney began as a rough camp, located at a confined site at Sydney Cove where fresh water was available from a stream close by (Karskens, 2009). Melbourne was more decentralized, with its port and town centre at separate locations, due to the absence of potable water at the mouth of the Yarra River. Sydney was largely unplanned and its hilly terrain made the construction of regular streets difficult. Melbourne's town grid of wide streets was laid out by Surveyor Robert Hoddle, who also planned new suburbs such as Carlton, St Kilda and Emerald Hill (South Melbourne) in the 1850s.

Nineteenth-century Sydney had a similar income level to Melbourne, but because of planning and institutional constraints its suburbs were slow to develop (Frost, 1991). A lack of available space meant that Sydney's first railway, opened in 1855, terminated at Redfern, about 4km from Sydney Cove. Country interests dominated the New South Wales Parliament, which resulted in underinvestment in urban infrastructure. Narrow, crooked streets were ill-suited to trams. Inconvenient road and rail links retarded suburban development to Sydney's south and west. Ferries ran from Sydney Cove to the north side of the Harbour, but rugged terrain and poor roads raised the costs of suburban development. The contrast between nineteenth-century Sydney and Melbourne is evidenced by differences in their physical extent, and levels of population density close to their centres. In 1891, Melbourne's population was 18 per cent higher than that of Sydney, but its built-up area was seven times greater (Frost, 1991, p. 27).

Investment in transport infrastructure in Melbourne slowed after the depression of the 1890s (Frost, 2013). By World War I the efficiency of the system was being improved by electrification of the rail and tram network, and the duplication of tracks and removal of level crossings from busy rail lines. The extent of the rail network was so great that at the end of World War II, Melbourne still had large areas of vacant, potential suburban land within reach of fast commuter trains (Frost, 2001). In the early twentieth century, Sydney began to develop its transport infrastructure. The suburban train and tram network was electrified and extended at the end of the 1890s and Central Station was opened in 1906. The population of the old core of Sydney grew by 16 per cent from 1911-21, but growing suburbs such as Canterbury to the west, Hurstville to the south, Randwick to the east and Willoughby to the north increased their population by 313 per cent, and their share of the metropolitan population from 28 to 58 per cent (Frost, 1998, p. 68). The underground rail loop, which began operating in 1926, and the Harbour Bridge, completed in

1932, helped to link the suburban lines with the city centre thus increasing the supply of suburban land that was available to those working in the city. Population growth and aspirations for suburban living triggered a suburban building boom in the 1920s (Spearritt, 2000). Eventually, Sydney sprawled to a size similar to that of Melbourne.

After World War II the two cities diverged again, with greater investment in transport infrastructure taking place in Sydney than in Melbourne. The decentralised nature of Melbourne encouraged further car usage that continues today. Between 1986 and 2006, investment in Sydney rail services declined, with the State Government opting for a large program of motorway building. The growth in public transport usage ceased and substantial declines were only prevented by the city's historical strengths of an extensive rail system, high population densities and relatively high employment in suburban centres with rail access (Mees, O'Connell, & Stone, 2008).

A built environment that encourages car usage imposes fixed costs on households rather that the government (Glaeser, 2008). Cars have high fixed costs for consumers, but the fixed costs of public transport are by the transport provider (i.e. taxpayers). Differences in the type of transport usage between locations may drive the results in this model. Households in or near city centres may be expected to use public transport or other forms of transport more often that those who live further out. Peripheral suburbs may be expected to have higher car usage, and thus face higher transport costs.

Randolph (2002) and Randolph and Freestone (2012) use the concept of three belts of suburbs to categorise the built environment of Sydney. The 'first suburb' is a global arc, defined as international Sydney, and includes the central area, high-density inner suburbs such as Glebe and Potts Point, and high-amenity beachside suburbs such as Bondi and Double Bay. This is equivalent to the old central core that housed almost all of Sydney's population in 1891. It also includes the airport and major concentrations of producer services. The 'second suburb' is an outer arc of mainly new housing developments. Examples include Blacktown, Kenthurst and Campbelltown. Households here have high rates of homeownership (or are paying off mortgages), low unemployment, higher education levels, car dependence and single family dwellings. The 'third suburb' is the middle arc of older suburbs mainly western and south western Sydney, including Bankstown, Auburn, Parramatta, Holroyd, Fairfield, and Kogarah, where there is a predominance of working class and ethnic communities that face issues of high unemployment

and crime (Randolph & Freestone, 2012). The middle ring suburbs are predominantly low to moderate income suburbs that grew rapidly during the interwar years and the post-World War II housing boom.

This middle ring has fallen behind both the inner city, which is now largely gentrified, and newer outer fringe in terms of disproportionately high levels of social polarisation and disadvantage. The third suburbs are characterised by low levels of investment and development in housing, jobs and infrastructure, which have seen them attract households who have low levels of assets and skills. Unemployment and crime levels are higher than the metropolitan average, reinforcing the region's lack of desirability for new investment and reducing the returns from homeownership due to slow appreciation of prices. Between 1986 and 1996, Sydney expanded its boundaries, with most metropolitan growth taking place at the periphery. However, between 1996 and 2006 Sydney largely engaged in infill development, using vacant land almost equally in all three rings and redeveloping to increase densities (Flood & Baker, 2010). All areas of Sydney are growing, but the type of investment and the resources of households vary according to location in the three suburban belts.

Melbourne's 'third suburbs', such as Essendon, Coburg, Heidelberg, Box Hill and Oakleigh were first subdivided in the 1880s , but not fully developed by World War II. Others, such as Moorabbin, Mordialloc, Nunawading, Dandenong and Preston grew very slowly and were not developed extensively until after the War (Ward, 1984). The residential population of the 'first suburb', the City of Melbourne and its ring of inner suburbs, such as Richmond and Fitzroy, experienced population decline from 1947 to 1991, due to job losses in local manufacturing (Dingle, 1995). However, the City of Melbourne's residential population rose from 35,000 in 1991 to 86,000 in 2011, with the construction of high-rise apartments at Southbank and Docklands, and the conversion of industrial buildings into housing space (City of Melbourne, 2013; Dingle & O'Hanlon, 2009). The second, outer arc fringe is epitomised by Casey-Cardinia, Hume, Melton and Wyndham. Growth in Melbourne's outer suburbs has been more substantial than in Sydney. The outcome of this household creation in the inner and outer suburbs is something of a doughnut effect, with the middle ring of suburbs developing more slowly than elsewhere, mainly due to resistance to infilling, which restricts housing options (Flood & Baker, 2010). Areas of high residual income in Melbourne are in established middle ring suburbs, such as Brighton and Kew.

New households tend to have a lower residual income, and be located in peripheral growth areas. Sydney's City Centre, where transport costs are lower due to high public transport usage and walking, has a higher residual income than all other parts of the metropolitan area. It is also the location of those with higher incomes and no children, which is the reverse of households located further out.

Table 2.3 shows that the distribution of Melbourne's population between the three types of suburbs changed between 1986 and 2006, with the outer suburbs increasing their share (from 21.9 per cent to 30.8 per cent) at the expense of the inner and middle ones. In Sydney, population growth was spread more evenly across the metropolitan region, with the middle suburbs maintaining their share and the outer suburban share increasing slightly (from 23.3 per cent to 27.6 per cent) at the expense of the inner suburbs, which declined from 30.2 per cent to 26.7 per cent). The growth in new households in Sydney's 'third suburbs' is an outcome of infilling, while Melbourne's doughnut effect is the result of families moving to the outer and inner rings. There is also a different in the absolute growth rate of Sydney compared to Melbourne (10.4 vs 15.6), and in the period 2001-11 Melbourne grew by 636,300 compared to Sydney 477,600 (Australian Federal Goverment, 2013). Those already in the middle ring would be expected to have a good level of residual income. Melbourne's outer growth areas, which are proportionately larger and growing more rapidly than those in Sydney, may be expected to have lower residual income, due to high transport costs associated with heavy dependence on cars at the fringe of the city (Australian Federal Goverment, 2013).

Table 2.3

Share of households and growth rate within Sydney and Melbourne rings

	Share (per cent)						Growth rate (per cent) of number of households			
	1986		1996		2006		1986-96		1996-2006	
	Syd	Mel	Syd	Mel	Syd	Mel	Syd	Mel	Syd	Mel
City	21.8	18.4	20.5	17.7	19.9	18	16.2	17.9	10.4	15.6
Inner 'first'	30.2	28.8	27.3	26	26.7	24.9	5.1	6.4	8	10.7
Middle 'third'	46.5	49.3	45.7	47.1	45.7	44.4	14.4	12.7	10.4	8.8
Outer 'second'	23.3	21.9	26.9	26.9	27.6	30.8	34.3	44.6	12.9	32.3

Source: Flood & Baker (2010).

Note: Data on regional shares for Sydney and Melbourne metro areas relate to Australia as a whole; data within these regions relate to shares of the metropolitan population.

Randolph and Tice (2013) separate their sample of households into factor groups. They define *Economically engaged* as households made up of singles or with dual incomes drawn from well-paying occupations, generally young or early-middle aged with no dependent children. *Battlers* are typically low-income families, with dependent children and lower skills and incomes. *Achieving education* is made up of typically young students, with low incomes and renting in lone-person or grouped housing. *Residentially retired* are often 'empty nesters' that no longer have dependent children. They may have low current incomes but higher rates of outright homeownership. The *Apartment elite* is a high-income group with preferences for proximity to urban amenities. They generally share characteristics with either the economically engaged or residentially retired.

The decentralised nature of Melbourne means that high-density living does not exert a dominant influence on where these household groups live. Randolph and Tice (2013) analyse the composition of different areas of Melbourne and Sydney in terms of household types in high-density accommodation. Table 2.4 reveals no strong patterns for Melbourne, except for the *Residentially retired* to be located predominantly in the outer ring of suburbs. Sydney has stronger patterns, with most of the inner city having household types that have higher than average incomes and no children. Such groups also have lower than average non-housing consumption needs, which would put them ahead of households with similar incomes but with children, due to the latter's higher non-housing consumption needs. The total percentage of factor groups varies for the different cities. The largest household group for Sydney's sample is *Battlers*, at 38 per cent. The same group in Melbourne accounts for only 10 per cent of the city's entire sample for high density households (Randolph & Tice, 2013). *Battlers* account for 59 per cent of Sydney's middle ring sample, compared to 15 per cent in Melbourne's. The largest group in Melbourne is *Achieving education* (30 per cent) and *Residentially retired* (25 per cent); the same groups in Sydney are at 6 and 10 per cent respectively, thus the samples capture very different household types in high-density housing. *Apartment elite* make up 52 per cent of the inner Sydney sample, but only 22 per cent of the inner Melbourne sample (Randolph & Tice, 2013).

Table 2.4

High-density housing: Distribution of factor groups by urban location: Sydney and Melbourne, 2006 (percentages)

	Inner		Middle		Outer	
	Sydney	Melbourne	Sydney	Melbourne	Sydney	Melbourne
Battlers	9	1	59	15	39	36
Economically engaged	25	29	10	10	34	0
Apartment elite	52	22	13	0	3	3
Residentially retired	6	15	13	36	24	64
Achieving education	8	33	5	36	0	0
Total	100	100	100	100	100	100

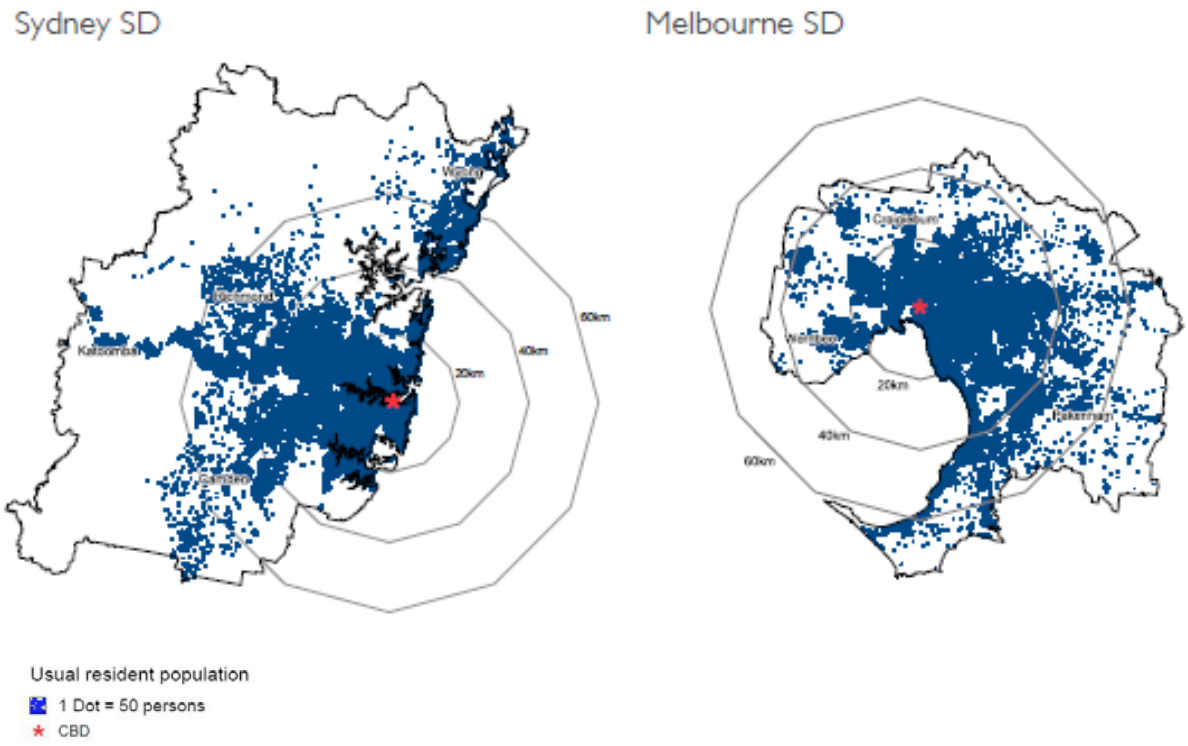
Source: Randolph and Tice (2013).

Table 2.4 shows that *Apartment elite* are dominant in inner Sydney, and beyond this zone the most common household type is *Battler*. There is very little high-density housing in the outer suburbs of Melbourne, with most of it occupied by *Residentially retired* and *Battlers*. In this zone, *Economically engaged* would most likely consume a single-family home. This is consistent with the results from the model run in this essay, in which inner Sydney is better off in terms of residual income compared to other areas. This is driven by the higher incomes and lower transport costs of *Apartment elite*, due to a greater share of the population taking public transport or walking, and lower non-housing consumption needs. Inner Melbourne is a mixture of all household types except *Battlers*, who are pushed to peripheral estates. In Melbourne, *Battlers* make up 36 per cent of households in the outer region, but only 10 per cent of the total population in high-density housing (Randolph & Tice, 2013).

Figure 2.1 shows the role that geography plays in the development of the two cities. Melbourne is located on Port Phillip Bay, with ample flat land available for suburban development. Its suburbs have developed outwardly in almost all directions. The development of Sydney has been more constrained by geography, due to the Harbour and the surrounding areas that are not as flat as Melbourne. This has restricted development, creating more transport bottlenecks, which would increase the cost of distance and accounts for Sydney being more densely populated. The scale for both cities is the same, with the edge of the third ring at 60Km from the City Centre.

Figure 2.1

Dot density map of population distribution within Sydney and Melbourne Statistical Divisions, 2011



Source: Australian Government (2013).

The level of population density in an area is dependent on housing density, average household size and the amount of non-residential land in an area. Sydney is Australia's most densely populated city, and the most densely populated Statistical Local Areas (SLA) are concentrated in Sydney. In both Sydney and Melbourne, density gains were recorded in established

inner and middle suburbs between 2001 and 2011, with inner city Melbourne recording some of the largest gains (Australian Government, 2013). The most densely populated SLA in Australia is Melbourne Inner, which averages almost 9,000 persons per square kilometre: the Sydney East SLA is not far behind. However, Sydney contains five of the seven Australian SLAs with population densities of more than 6,000 persons per square kilometre (Australian Government, 2013). Thus while Melbourne has the SLA with the highest population density, Sydney has a much greater number of SLAs that are characterised by high-density living. As a result, Sydney is more densely populated on average than Melbourne.

Most of the new housing stock in Melbourne is built on the urban fringe, due to the availability of Greenfield sites and the cost of infilling (Kelly et al., 2011). Supply-side constraints in the housing market, due to complex planning processes and a shift towards user funding of infrastructure, have increased the private cost of development. Hsieh, Norman, and Orsmond (2012) estimate that in 2010 government charges (excluding GST) levied on developers amounted to around $60,000 per greenfield housing site in Sydney, but only $20-30,000 in other Australian capital cities. If differences in charges are applicable to all developments in the two cities, this can help explain part of the divergence between the numbers of building completions per thousand in New South Wales and Victoria. Public attitudes towards infill developments also restrict supply (Hsieh et al., 2012).

The cost of fringe land was about 10 per cent of the median house price in Sydney in the first half of the 1950s, and this rose to 30 per cent in the second half of the 1960s (Stapledon, 2012). The trend then changed with a sharp rise in the first half of the 2000s, taking the figure to over 40 per cent of the median house price in the second half of the 2000s. Changes in the availability of transport and the infrastructure lowered the cost of travel from the suburban fringe and hence expanded the potential supply of urban lands. As motor vehicle usage grew and outpaced road capacity, increased congestion from the late 1960s began to reverse those gains and lift the cost of travel (Stapledon, 2012).

In terms of real housing costs there has been an upward trend for many years. The longer term trend in real median house prices for Sydney and Melbourne to rose marginally from 1880 to the mid-1950s. The real price of housing was relatively stable over this period. Thereafter, house price and rents trended upwards. Taking 1955 as the approximate turning point, the median house

price for Sydney rose by seven times or about 3.5 per cent per annum in real terms, while Melbourne prices rose by five times or about 3 per cent per annum over the period to 2011 (Stapledon, 2012).

4 Data

In this essay, unit record data from the HILDA Survey is used. The HILDA Project was initiated and is funded by the Commonwealth Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA), and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this essay, however, are those of the author and should not be attributed to either FaHCSIA or the Melbourne Institute.

5 Results

Empirical results from the model for both of the States are examined, before combining the results with an analysis of the capital cities' built environment. The results will be in three different formats. The first is descriptive in nature and will help to outline the situation that the model is applied to. Secondly, results from the model are derived at the coefficient level when looking at the States separately. Thirdly, the results at the marginal level are explored to ascertain differences between the States in relation to the predictive power of distance.

5.1 The impact of distance in Melbourne

How did the situation regarding housing stress in Melbourne changes between 2005 and 2010? Table 2.5 shows the percentage of the sample that is in each of the groups. The first Wave is compared to the others, with a t-test of the means being conducted. The Waves are all significantly different at the mean from Wave 5 except for the final Wave 10. Wave 10 does not have sufficient evidence at the mean to determine that it was different to Wave 5. Thus on average, the problem worsened over time until Wave 10 was reached.

Table 2.5

Percentage of households in affordability Stress in Victoria from 2005 to 2010

Melbourne	Wave 5	Wave 6*	Wave 7**	Wave 8**	Wave 9**	Wave 10
Residual stress	0.07	0.09	0.10	0.09	0.12	0.08
May be in residual stress	0.09	0.09	0.10	0.10	0.05	0.06
Non-residual stress	0.84	0.82	0.80	0.81	0.83	0.86

Source: Author's calculations using Hilda data from Melbourne Institute (2001-2013).

Note: ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

The measure of housing affordability for Table 2.5 includes actual transportation costs for the households of interest. Does the result change when using different measures of transport costs? The alternative is to use the transport costs from the budget standards themselves. Table 2.6 takes the percentage in each group when using the budget transport costs, subtracting it by the percentage from the actual transport costs. If the figure is positive, the budget transport allowance is greater than when using actual costs. The two measures are statistically different. *Residual stress* has a very small change; the greatest movement is between *may be in residual stress* and *non-residual stress*. It appears that households have been able to move from *may be in residual stress* to *non-residual stress* by reducing their transportation costs to levels lower than what is budgeted for them. Those that remain in stress have not been able to reduce their costs below what is budgeted for them. The percentage of households in *residual stress* is very similar for either measure, demonstrating a lack of ability on the part of households to reduce or change actual costs. The lower the disposable income, the more constrained a household is in its decision making.

Table 2.6

Difference between Budge standards and Hilda Housing and Transport affordability stress for Victoria

Melbourne	Wave 5***	Wave 7***	Wave 10***
Residual stress	0.013	0.007	0.004
May be in residual stress	0.045	0.039	0.045
Non-residual stress	-0.058	-0.047	-0.049

Source: As for Table 2.5.

Note: ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

The inclusion of a *Move in the past year* variable within the model is intended to capture changes in the housing situation of households from the preceding year. This separates the effect of location from the effect of households that have moved recently. For those households that have not moved in the preceding year, their current location is classed as not temporary. This is particularly important with housing being the major reason for households moving. The issue of households that do move is a potential area of future research. Table 2.7 shows that 12-18 per cent of households that move do so involuntarily. These households would experience moving in a different way to those who move voluntarily. A household moving into a new house for work reasons or to be closer to family will be able to plan the move and look for appropriate accommodation. If a household is forced to move there may be little time to plan for the move and finding alternative housing will be more difficult.

Table 2.7

Reason for moving housing for those in Victoria

Reason for moving (per cent)	Work	Housing	Forced	Personal
Wave 5	11	42	12	35
Wave 8	7	36	18	36
Wave 10	7	39	14	39

Source: As for Table 2.5.

Note: Percentages may not sum to 100 due to rounding.

The variable in the model for *Moved in the past year* is shown in Table 2.8. Waves 5, 6, 7 are significant in the model, showing how moving changes the likelihood of Victorian households being in different groups of stress. Those that have moved in the preceding year have an increased likelihood of being in *residual stress* and *maybe in residual stress*, and a decreased likelihood of being in *non-residual stress*. The increased likelihood of not being in *non-residual stress* is of the magnitude of 6-10 per cent. The act of a household moving reflects the unstable nature of a household housing situation.

Table 2.8

The marginal effect of moving in the past year compared to those who have not.

Move	Residual stress	Maybe in residual stress	Non-residual stress
Victoria Wave 5	0.031	0.040	-0.071
Victoria Wave 6	0.051	0.046	-0.097
Victoria Wave 7	0.035	0.030	-0.065
NSW Wave 8	0.039	0.030	-0.068
NSW Wave 10	0.041	0.026	-0.066

Source: As for Table 2.5.

This section refers to Table A2.1; the model is applied to six Waves with the same variables and with little change in the individual in the sample. The individuals included are those whose responses match the budget standards and live in the correct location. Between Waves, individuals may move out of the State, hence dropping out of the sample or move into a household type that is not captured by the budget standards. Most, but not all of the individuals are the same between Waves.

The basic variables, *EDUC1*, *AGE* and *GOV*, are included to capture variations in household characteristics. *EDUC1* plays a significant role in only half of the year and is positive. As would be expected, household members that have a degree or higher qualification have better residual incomes compared to those who do not. The *AGE* dummies are only positive in the first wave and not significant after that. *GOV* behaves in the way expected, showing lower residual income than those not receiving income from the government. The *MOVE* variable is negative and has already been covered. These variables have captured the basic characteristics of a household and those new to a location.

The household types are all positive, and are thus predicted to have lower levels of residual stress than singles. It is positive for almost all Waves for those over 65. Younger couples are predicted to be better in every survey, which is not surprising as the amount of housing required is the same for couple as singles, but the former often benefit from two incomes. PARENTS are positive in four of the Waves but *SINGLE PARENTS* only in one. Given single and single parents have the highest occurrences of stress thus it was expected that there would not be significant differences between them. The element remaining is that of distance.

All household locations are compared to those that are located *0-10 km* from the City Centre. If the coefficient is positive, the model predicts that those located a distance from the city are better off than those close to the City. The distance variables for those in an urban setting are not always significant but when they are, they are positive. Thus when transport costs are included, the model predicts that those who live further from the City Centre will have a better residual income than those who live close to the Centre. *Other urban* predicts a higher residual income. The household focus can be away from the City Centre in provincial towns such as Ballarat and Bendigo, which are large enough to provide jobs from which substantial disposable incomes may be drawn. At the same time, distance from the City Centre is not as important to *other urban* households, as they are more likely to travel to regional town centre as part of their daily commute. The only distance variable that is negative is *Rural*. Once households move beyond an urban environment, affordability stress is likely to be an outcome of a lack of job opportunities to earn a comparable disposable income or greater transport costs.

The model is used to examine the predictive abilities of distance, which include housing and transport costs, on levels of residual stress. It includes basic characteristics of a household and those who recently moved. Once these elements are included there are still significant results for the distance variables. The Victorian results show only one city result that is significant, thus distance is not a good predictor within Melbourne once controlled for household characteristics. For a person living in a provincial city, the model predicts a better residual income than for those in the City Centre. Outside the urban environment, it predicts a lower residual income level.

5.2 The impact of distance in Sydney

Tables 2.9 and 2.10 cover the same variables as those for Melbourne. While the results obtained are similar in some respects, those relating to distance are very different. Stress over time for Sydney, in terms of how stress changes across each wave is not significantly different from Wave 5, except Wave 6 at the 10 per cent level. The percentage of the sample in residual stress remains similar across time. Table 2.10 represents the differences between the two measures for transportation costs. The percentage of households that are able to reduce their actual transport costs below the budgeted levels is greater for New South Wales than it is in Victoria. Wave 5 and Wave 7, 2 per cent more of the sample is able to leave the lower groups. This can represent a greater ability to reduce actual transportation costs below the budget transport costs for those in New South Wales.

Table 2.9

Percentage of household in Affordability Stress in New South Wales 2005 to 2010.

Sydney	Wave 5	Wave 6*	Wave 7	Wave 8	Wave 9	Wave 10
Residual stress	0.09	0.12	0.10	0.10	0.09	0.09
May be in residual stress	0.11	0.10	0.10	0.09	0.07	0.07
Non-residual stress	0.80	0.78	0.80	0.81	0.85	0.84

Source: As for Table 2.5

Note: ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

Table 2.10

Difference between Budge standards and Hilda Housing and Transport affordability stress for New South Wales.

Sydney	Wave 5***	Wave 7***	Wave 10***
Residual stress	0.027	0.023	0.008
May be in residual stress	0.060	0.049	0.042
Non-residual stress	-0.087	-0.072	-0.050

Source: As for Table 2.5.

Note: ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively.

The result from the reasons for moving in Table 2.7 and Table 2.11 are very similar. The search for appropriate housing remains one of the major reasons for moving, but is not the dominant reason, with personal reasons being most common in some Waves. The variable *move,* only increases the likelihood of stress by 6 per cent and is only significant in two of the Waves available.

Table 2.11

Reason for moving housing for households in New South Wales

Reason for moving	Work	Housing	Forced	Personal
Wave 5	8	36	14	41
Wave 8	9	32	17	42
Wave 10	6	45	10	36

Source: As for Table 2.5.

Note: Percentages may not sum to 100 due to rounding.

The variables included in the model (see Appendix D) are the same for each wave and the same as for the Victorian model. The dependant variable, the residual approach to measuring housing affordability with transport costs, is the same as in the Victorian model, in which housing and transport costs are considered fixed, with the budget standards adjusted for the State. Thus the only difference between the two models is the location of the households. The households included in the model are those that responded by stating that they lived in New South Wales.

The model for Sydney has the same variables as Victoria. *EDUC1* is only significant once, in contrast with Victoria, in which half of the Waves are significant. The *AGE* variables, however, play a greater role with the middle age group (34-55) having five significant results when compared to the younger age group plus the older grouping four times. This was something that only occurred once for both age groups in Victoria. The role of *GOV* is very similar in both of the models but does play less of a role for those on low levels of support. *Moved in the past year* predicts negative association with housing stress.

The household type is very similar to Victoria except over 65 have more positive results and only four significant results were recorded for *COUPLE UNDER 65*. They are all positive when significant. Half of parent and single parent are significantly positive. The only variable remaining is that of distance from the City Centre for those in New South Wales.

For those who live within a major urban area in New South Wales, there is a predicted negative relationship when compared to those that live in the City Centre. Every location when compared to the City Centre of Sydney is negative. The model predicts that a household's residual income level will be less than that of households that live close to the city. In the New South Wales model there are more distance variables that are significant than in Victoria. Distance has a greater predictive ability, which may be driven by transport costs rising more quickly than the drop in housing costs, or housing costs not changing much over distances. There may also be differences in disposable incomes that are occurring in different locations. The drivers of this will be explored more fully in the next section.

5.3 Marginal effects for Victoria and New South Wales

The results presented in Tables 2.12 and 2.13 are the marginal likelihood of the distance variables for each group. The key feature of Table 2.12 is the difference in results for the capital city (*major urban*) between the two States. The *other urban* distances can be found in Table 2.14. Only results that are significant are included in the tables. Both States are included so that differences between results may be observed.

Table 2.12 shows that the marginal effects of distance are reversed in Melbourne and Sydney. Households that are located outside the City Centre in Melbourne have a higher predicted

value for residual income grouping. This is demonstrated by the positive value for *non-residual stress*, which shows the increased in likelihood of this type of household being in this group. The reverse is the case for Sydney, where positive values are recorded for *residual stress* and *May be in residual stress*. This represents the increased likelihood of a household location *11-40Km* from the City Centre being associated with *residual stress*. This is consistent the finding of Randolph and Tice (2013) that high-density housing in inner city Sydney, with *Battlers* dispersed to middle and outer areas. In Melbourne, less grouping of household types by location in high-density living is evident (Randolph & Tice, 2013), which helps to explain the lack of significance by distance in the model. Inner city households tend to be smaller in size and less likely to use cars than other forms of transport. Distance from the City Centre does not change the direction of the values. The predictive influence that distance has on residual stress is larger for Sydney than Melbourne. These outcomes hold for every result for distance in an urban environment. In both cities, the proportion of childless couples in inner cities grew around three times as fast as other household types. The inner ring is increasingly the province of childless couples, with single parents increasingly excluded economically, and pushed to the outer areas (Flood & Baker, 2010).

Table 2.12

Key marginal results for distance when comparing those in a location against the base case for major urban area.

	Residual stress	Maybe in residual stress	Non-residual stress
11-20Km			
Melbourne Wave 10	-0.032	-0.021	0.053
Sydney Wave 8	0.129	0.075	-0.203
Sydney Wave 10	0.059	0.035	-0.094
21- 40Km			
Sydney Wave 8	0.085	0.057	-0.142
Sydney Wave 9	0.066	0.042	-0.107
Sydney Wave 10	0.041	0.026	-0.067

Source: As for Table 2.5.

Table 2.13 shows outcomes for households located beyond metropolitan areas. The two models predict very similar outcomes for the rural environment of the two States in terms of residual income levels. The size of the likelihood of being in stress and the direction of movement

from *rural* are the same. *Other urban* has a positive outcome for Victoria, suggesting that households in provincial towns are able to live close to their workplaces, and hence incur lower transport costs. However, this result does not hold for New South Wales. These differences between *other urban* in the two States could be explored in further research. In the next section, the built environment as it relates to distance will be examined to explain the differences in the marginal results for Melbourne and Sydney.

Table 2.13

Key marginal results for distance when comparing those in a location against the base case for rural and other urban area.

	Residual stress	Maybe in residual stress	Non-residual stress
Rural			
Melbourne Wave 6	0.047	0.043	-0.090
Melbourne Wave 8	0.043	0.038	-0.081
Sydney Wave 8	0.046	0.034	-0.080
Sydney Wave 9	0.049	0.033	-0.082
Other urban			
Melbourne Wave 5	-0.020	-0.031	0.052
Melbourne Wave 9	-0.036	-0.019	0.054
Sydney Wave 8	0.039	0.031	-0.069
Sydney Wave 9	0.037	0.027	-0.064

Source: As for Table 2.5.

5.4 Impact of the built environment and distance

In Sydney, the residual income of all household characteristic groups, except the youngest, declines the further away from the City Centre a household is located. Growth rates of incomes are higher in the inner city, in line with the steepening house price curve. Since the 1970s, inner city gentrification in Sydney and Melbourne has been spearheaded by young two-income professional childless couples (DINKS – double or dual income, no kids). The highest average household income group in Sydney and Melbourne is inner-city 25–44-year-old couples without

children, while the highest income growth rates are recorded among couples over 45 without children (Flood & Baker, 2010). Within both cities, income gradients continue to steepen in line with steepening house price gradients. In Sydney, a slight flattening of incomes in the middle ring is evident (Flood & Baker, 2010).

In recent decades, higher-density multiunit apartments have accounted for a larger proportion of new residential development in both cities. *Battlers* account for 38 per cent of the Randolph and Tice (2013) sample for the Sydney apartment market, but only 10 per cent of the same housing market in Melbourne. The low-income group is predominantly a middle suburban market in Sydney, but an outer suburban market for Melbourne. Sydney's higher-income middle age groups live in the inner area and its *Battlers* in the middle and outer areas (Randolph & Tice, 2013). Thus distance in Sydney is more significant than in Melbourne, with the location of different household types being concentrated in the former and more evenly spread in the latter. Inter-city differences between who lives in the city centre and levels of public transport and walking influences transport costs as distance increases.

Sydney has higher levels of mortgage and oil vulnerability in areas beyond 20km from the City Centre to the north, south and particularly the west. This is assessed though the use of the Vulnerability Assessment for Mortgage, Petrol and Inflation Risks and Expenditure (VAMPIRE) index, which is a composite mortgage vulnerability index constructed from a range of variables (Dodson & Sipe, 2008). VAMPIRE records the average vulnerability of households within the collection district in terms of car dependence, income and mortgages, rather than indicating the specific vulnerability of particular households. Melbourne's middle zone between the inner city and the outer suburbs show considerable VAMPIRE variation. Income and tenure effects also play a role, but it is notable that effective public transport systems appear to be contributing to higher mortgage and oil resilience in some better serviced areas, thus highlighting the importance of transport costs and viable alternatives. Many outer suburban households in Australia are more exposed to these price pressures because of their combined mortgage exposure, modest incomes and car dependence (Dodson & Sipe, 2008).

Per capita use of Melbourne's transit system declined rapidly after 1950 and stagnated for 25 years after 1980. Patronage has grown since 2006, but this may be attributed to increased employment in the City Centre and rising petrol prices (Stone, 2009). From 1976 to 2006,

Melbourne experienced the largest proportional decline in public transport usage of any Australian capital city and the biggest increase in driving for journey to work purposes. Public transport mode share for work trips fell from 24 per cent in 1976 to 14 per cent in 2006 (Stone, 2009). The peak of car use in Melbourne was in 2006. Sydney is the only Australian city in which the public transport share of travel declined and car driving rose in 2001-2006. Even so, Sydney still had the highest rate of public transport use and the lowest rate of car use in 2006. The main reasons for this recent improvement in public transport performance is increased employment in the centre of Australian cities, since these are the destinations with the highest public transport mode shares (Mees et al., 2008). Between 2001 and 2011, the private vehicle mode share of commuter travel fell by 4 per cent in Melbourne and 0.8 per cent in Sydney. However, outer suburban Sydney residents increased their rate of private vehicle use. Sydney has by far the highest overall mode share for public transport at 21 per cent, compared to 14 per cent for Melbourne (Xu, Milthorpe, & Tsang, 2011). Outer suburban Sydney households have higher residual stress levels those at the City Centre. By contrast, Melbourne's more established middle sector has lower residual stress levels than its City Centre.

Active transport (walking and cycling) shares are higher in Sydney than in any other major Australian city. Sydney has a slightly higher public transport mode share for inner sector residents (34 per cent) than Melbourne (30 per cent) (Australian Government, 2013). Most use of active transport is attributable to inner city residences; Sydney has the greatest share of active transport and public transport usage for inner city residence. As a result, the use of private vehicles is low for inner city Sydney residents. The car gradually becomes a more important mode of access as residents locate at increasing distances from the City Centre (Xu, Milthorpe, & Tsang, 2011). The high density environment that was a characteristic of early Sydney has endured, with low levels of car dependence continuing to characterise inner city locations.

In 2006, more households used non-car transport in Sydney than Melbourne, with over 30 per cent using transport other than cars. However, the change in oil and mortgage costs that are key variables in the VAMPIRE index means that vulnerability is growing in Sydney. From 2001-2006 the increase in vulnerability for Sydney (46 per cent of households) was larger than in Melbourne (42 per cent). A consequence is that the reduction in vulnerability in Melbourne (24.6 per cent) has been greater than that in Sydney (18 per cent) (Australian Government, 2010). While

Sydney is the only Australian city in which the public transport share of travel declined and car driving rose in 2001-2006, it remained the highest user of public transport and the lowest user of the car in 2006. In terms of the balance between public and private transport usage, Melbourne is the worst performer of any Australian city (Mees et al., 2008).

From 1996-2004 there was an increasingly steep decline in Melbourne house prices with distances from the City Centre (Wood et al., 2008). The variable of distance is important in understanding the affordability situation for households. The driver of increasing housing costs is that of land costs and in particular, urban land costs. This is reflected by increases in the level of land prices in a specific location and in land price gradients in the major capitals (Yates, 2011). These may cause residential sorting, which accelerates spatial income inequality by making it unaffordable for lower-income household to gain a foot on the property ladder, or compete in the private rental market in inner-city locations. Increasingly, housing choice for lower-income families is being restricted to locations at greater distances from the inner city (Wood et al., 2008). These price gradients within urban areas is consistent with urban economic theory, which suggests that higher residential land values in central locations arise from an increase in access costs from the periphery, such as transport costs and commuting time (Yates, 2011).

In Melbourne suburbs within 10km of the City Centre, the car accounts for around half of all trips to work, with public transport making up 25 per cent and other forms of transport the remainder. As distance increases, public transport use declines as more households rely on cars for commuting. Other forms of transport usage do not decline greatly as distance increases. In Sydney, the change as distance increases is more significant. Other forms of transport decline from around 40 per cent of trips to work to 20 per cent as distance increases. Public transport use varies from 30 per cent for the inner area to around 10 per cent in the outer suburbs. The major difference between the inner and outer suburbs is the use of cars to get to work – from around 30 per cent in the former to 70 per in the latter. This accounts for the large difference in transport costs depending on the location of the household. Those in the City Centre use public or other forms of transport; those further out most use cars, which have higher transport costs.

Table 2.14, derived from the HILDA data set, shows housing and transport costs and disposable and residual income levels by distance groupings. The results are based on comparisons of differences in median values and do not take into consideration the different household types.

If positive, the variables are above the median for the entire sample. Housing costs for Victoria react in the manner expected, with the highest costs in the centre of Melbourne and cheaper housing in rural areas. Transport costs are very similar across the different distances, except for rural households. Effective public transport is often lacking in rural areas, with residents tending to rely on cars for journeys often made over long distances. The highest disposable income is for households closest to the City Centre. Residual income levels in raw median values decrease with increased distance from the City. These results are not a by household type, which is required to determine if a household is in stress. The model in Table A2.1 has key characteristics and isolates the predictive power of distance. It is important to consider other factors and look beyond the raw figures. Family composition will determine the level of consumption required for each family type. To be effective the residual income has to be compared to a benchmark – in this case the budget standards. Without this benchmark the data could show a household having higher residual income, when in fact it would be in more stress than the median due to its household type. That particular composition might have a higher residual income requirement.

Table 2.14
Difference from median values for entire State, Wave 8

Distance	Housing costs		transport costs		disposable income		residual income		Difference	
	Mel	Syd	Mel	Syd	Mel	Syd	Mel	Syd	Mel	Syd
0-10Km	86	113	-3	-1	238	425	106	275		
11-20Km	-25	-16	0	-5	156	-6	92	-94	-14	-369
21-40Km	6	88	-1	14	73	267	38	140	-68	-135
41+Km	26	19	-3	-1	-124	46	-56	71	-162	-204
Other Urban	-32	-25	-7	-5	-273	-200	-226	-157	-332	-432
Rural	-63	-97	16	11	13	-77	21	-13	-85	-288

Source: As for Table 2.5.

The results for New South Wales are more extreme than those for Victoria. The spatial distribution of housing costs shows two different peaks. In the middle (11-20km) band of suburbs, housing costs are lower than in the City (0-10km) and outer suburbs (21-40km). This is similar for different waves, and 11-20km also has lower transport costs. The 21-40km band has transport costs that are above the Sydney average. Housing costs and disposable incomes in the 0-10 and 21-40km

bands are peaks, although transport costs are higher for those living further from the City. The difference in residual income is negative for all distances when compared to the City. All the distances are significant in predicting lower residual income in the model, once other key variables are included except 41+km. The additional transport costs are consistent with greater use of car as the primary mode of transport for those located on the urban fringe, which is the finding from the census data in the Appendix (Australian Government, 2013).

The impact of distance differs between the two States. Households in Melbourne's middle suburban band have either a positive predicted residual income level compared to those in the City Centre, or no significant result. Housing costs appear to be lower, with little increase in transport costs. Outside Melbourne, the level of population density has a major influence on whether a household is better off. More remote, low-density *rural* areas have residual incomes that are well below the State average. Large provincial Victorian towns, located in the *other urban* zone, are better off. For Sydney the results show a negative relationship with distance. Households immediately outside of the City Centre have negative predicted residual income levels, and these appear to be concentrated on households within the same location.

The distance variable became more significant in wave 8 onward (2008). Growth in taxable incomes in the poorest postcodes was sluggish in both Sydney and Melbourne (Wood et al., 2008). Isolation from amenities and opportunities, which is pronounced in the New South Wales model, exacerbates housing stress levels further.

Effective public transport networks and proximity to jobs raise land values and make redevelopment viable. When communities are established in Greenfield areas they tend to lack these qualities. Land use is predominantly residential and public transport is likely to be sparing. Due to the low-density nature of these developments, it is likely to take time for public transport investment to be feasible. Even with private transport the distances from amenities and low-density nature of the housing stock makes infrastructure expensive. Between 2006--2011, the population of metropolitan peripheral estates in Australia increased two-and-a-half times faster than elsewhere (Kelly et al., 2012). The consolidation of quality jobs in the metropolitan core is not being complemented by transport linkages to growth areas (SGS Economics & Planning, 2009).

The middle ring or second suburb of the two cities is very different. In Sydney there has been a greater level of infilling, and while this tends to be patchwork in nature, with some investment in high quality housing, these suburbs have lower household income levels overall. The highest income growth rates were recorded among couples aged over 45 without children. In Melbourne, these groups tend to be located in the more established middle suburban rings. A measure that incorporates the costs of transport is important in developing an understanding of the situation for these households, given their trade-offs. Growth on the urban fringe with ineffective transport links is likely to increase the affordability gap between communities. Households with low incomes and less choice in their consumption either live near the city in small dwellings, or move to larger, cheaper housing on the fringe.

Sydney and Melbourne have been shaped by their past development, with different built environments that may be traced to initial conditions. Path dependency is an exogenous variable that influences distance and transportation costs for the waves in the model. Higher densities prevail close to the centre of Sydney, which is a desired place to live, as shown by the concentration of the A*partment elite* there (Randolph & Tice, 2013). High numbers of households continue to walk to work in this area, which reflects the legacy of the city's nineteenth-century development. Melbourne was more decentralized by 1890 and remains highly dependent on the car. New suburbs were created in Melbourne before existing ones were developed fully. Suburbs were in filled later and land beyond walking distance of public transport was not developed until cars became widely available. Location plays a bigger role in determining the predominant mode of transport in Sydney. These differences go part of the way to explaining the difference in results that occurred in the models, in which distance have opposing values in the two States.

6 Policy implications

The focus of the essay is the distance variable within Victoria and New South Wales. The model predicts the location of households that are in stress, using a measure that includes transport and housing. Given the decentralised nature of Melbourne, transport costs do not increase greatly with distance, and housing costs typically fall as distance increases. Households that move to Melbourne's fringe may not have better residual stress levels than those that chose to live in or near the City Centre. Households make purposive choices and consider available options in order

to maximise their utility subject to their budget constraints. In Melbourne, these choices result in no significant difference between the two suburban locations in terms of residual stress levels.

The predictive power of distance is stronger for households in Sydney, with distance predicting a negative result for residual stress levels. Households that are in locations other than the City Centre, record a negative predicted residual stress level. The finding in this essay has a range of potential policy implications and which is the most appropriate depends on factors beyond the remit of this thesis. They could include increasing public transport capacity, creating new fixed lines and public transport bus routes on the one hand, and programs to increase labour market opportunities in most outer areas so that the journey to work is shorter on the other hand (Burke et al 2014). For locations that have high concentrations of residual stress levels, a coordinated response is required to tackle housing and transport issues, while also promoting stability in housing situations.

The policy implications of this work are based on a measure of housing affordability that includes transportation costs. The aim was to consider the differences in housing affordability that can result from the location of a household. Housing and transport are substantial costs that are in most cases fixed in the short term for households. The measure of housing affordability reveals a worsening of the situation for all Waves when compared to 2005. For the last wave, there is insufficient evidence to conclude that it was different. This research introduces a measure of housing affordability that can include other elements, while still maintaining results that are consistent with reality. The residual income is compared to budget standards that are appropriate for the situation. In terms of policy issues, a broader perspective is required when considering the housing market and when classifying if a household is in housing stress or not. The use of a measure that does not take location into consideration may be misleading. This could result in policy failure, with households becoming worse off than before due to changes in their locations. Building on the fringes of cities may make houses seem affordable when only housing costs are considered, whereas in reality households are required to spend more of their budget constraint on travel, incurring greater levels of costs than other areas as a result.

7 Conclusion

In two models, one for each of Victoria and New South Wales, the impact of distance on the predicted level of residual income differs in each State. In Melbourne, distance has a weak positive effect, predicting a better residual income level at the metropolitan periphery in relation to that of the inner city. The reverse is the case for Sydney, with the inner ring of suburbs having higher levels of residual income than the second and third rings. The major driver of these differences is variations in the built environment. The predictive power of distance improves over the time period of the survey, with the more recent waves having more significance. The results from the model appear to be driven by the difference in growth levels in Melbourne and for Sydney, and the difference between inner city transport usages compared to the rest of the city. The built environment is highly sensitive to initial conditions, which have persisted in a path-dependent way. The continuing influence of the built environment on housing affordability demonstrates how resistant the former is to change.

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9 Appendices

Table A2.1
Housing affordability entire sample Victoria

Housing Affordability Total - for all Budget Standards with Transport						
Victoria	2005	2006	2007	2008	2009	2010
Degree or higher	0.022	***0.235****	***0.305****	0.079	***0.376*****	-0.028
	(-0.130)	(***-0.120***)	(***-0.130***)	(-0.120)	(***-0.140***)	(-0.120)
35-54 age	***0.348*****	0.092	-0.113	0.096	0.094	0.209
	(***-0.130***)	(-0.140)	(-0.130)	(-0.130)	(-0.140)	(-0.140)
55+ age	***0.338****	-0.176	0.057	0.101	0.161	0.239
	(***-0.180***)	(-0.170)	(-0.170)	(-0.170)	(-0.180)	(-0.170)
Income from gov less than 50%	***-0.523*****	***-0.343****	***-0.236****	***-0.533*****	***1.070*****	***-0.382*****
	(***-0.160***)	(***-0.140***)	(***-0.140***)	(***-0.140***)	(***-0.190***)	(***-0.140***)
More than 50% from gov	***-1.667*****	***-1.470*****	***-1.370*****	***-1.561*****	***-0.461****	***-1.184*****
	(***-0.190***)	(***-0.150***)	(***-0.160***)	(***-0.160***)	(***-0.200***)	(***-0.150***)
11-20 from city	0.226	0.035	0.002	0.143	0.234	***0.315****
	(-0.170)	(-0.170)	(-0.160)	(-0.170)	(-0.180)	(***-0.170***)
21-40 from city	0.159	-0.017	0.044	-0.196	0.105	0.211
	(-0.180)	(-0.180)	(-0.160)	(-0.170)	(-0.170)	(-0.160)
41+ from city	0.044	0.113	-0.009	0.014	0.168	0.135
	(-0.170)	(-0.180)	(-0.170)	(-0.180)	(-0.170)	(-0.160)
Other urban	***0.291****	0.061	0.075	0.094	***0.304****	0.149
	(***-0.160***)	(-0.170)	(-0.160)	(-0.180)	(***-0.170***)	(-0.160)
Rural	-0.025	***-0.358****	***-0.261****	***-0.314****	-0.076	-0.222
	(-0.170)	(***-0.170***)	(***-0.160***)	(***-0.170***)	(-0.170)	(-0.160)
moved since last survey	***-0.316****	***-0.380*****	***-0.241****	-0.206	0.096	-0.007
	(***-0.130***)	(***-0.140***)	(***-0.130***)	(-0.150)	(-0.170)	(-0.160)
SINGLE OVER 65	***0.522****	***0.612*****	***0.336****	***0.454****	0.290	***0.438****
	(***-0.220***)	(***-0.190***)	(***-0.190***)	(***-0.210***)	(-0.220)	(***-0.200***)
COUPLE OVER 65	***0.609****	***0.645*****	***0.747*****	***0.614*****	0.124	0.332
	(***-0.250***)	(***-0.200***)	(***-0.210***)	(***-0.220***)	(-0.210)	(-0.210)
COUPLE UNDER 65	***0.482*****	***0.301****	***0.379****	***0.543*****	***0.293****	***0.430*****
	(***-0.170***)	(***-0.160***)	(***-0.150***)	(***-0.170***)	(***-0.170***)	(***-0.160***)
PARENT	***0.510*****	0.212	***0.284****	***0.440*****	0.129	***0.541*****
	(***-0.160***)	(-0.160)	(***-0.150***)	(***-0.150***)	(-0.160)	(***-0.170***)
SINGLE PARENT	***0.475****	-0.063	0.346	0.317	0.350	0.109
	(***-0.200***)	(-0.200)	(-0.220)	(-0.210)	(-0.220)	(-0.210)
cut1	-1.556***	-1.828***	-1.592***	-1.658***	-0.278	-1.306***
Constant	(-0.200)	(-0.190)	(-0.190)	(-0.210)	(-0.240)	(-0.190)
cut2	-0.956***	-1.290***	-1.053***	-1.122***	0.019	-0.964***
Constant	(-0.180)	(-0.190)	(-0.180)	(-0.200)	(-0.240)	(-0.190)
N	1063	1075	1090	1114	1147	1173

Source: Author's calculations using Hilda from Melbourne Institute (2001-2013)

Notes: Standard errors in parentheses. ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively. Significant results in italics.

Table A2.2

Housing affordability entire sample New South Wales

Housing Affordability Total - for all Budget Standards with Transport New South Wales	2005	2006	2007	2008	2009	2010
Degree or higher	***0.318*** (***-0.120***)	0.158 (-0.110***)***	0.119 (-0.120***)***	0.097 (-0.110***)***	0.124 (-0.120***)***	0.126 (-0.110***)***
35-54 age	***0.245**** (***-0.110***)	***0.331***** (***-0.110***)	***0.232**** (***-0.110***)	***0.411***** (***-0.120***)	0.204 (-0.130***)***	***0.221**** (***-0.130***)
55+ age	***0.387**** (***-0.150***)	***0.258**** (***-0.140***)	***0.274**** (***-0.150***)	***0.247**** (***-0.150***)	0.144 (-0.150***)***	-0.047 (-0.140***)***
Income from gov less than 50%	-0.192 (-0.130***)***	-0.145 (-0.130***)***	***-0.449***** (***-0.140***)	***-0.451***** (***-0.130***)	***0.542***** (***-0.190***)	-0.093 (-0.130***)***
More than 50% from gov	***-1.517***** (***-0.140***)	***-1.444***** (***-0.140***)	***-1.539***** (***-0.140***)	***-1.461***** (***-0.140***)	***-0.701***** (***-0.210***)	***-1.075***** (***-0.140***)
11-20 from city	-0.103 (-0.180***)***	-0.170 (-0.200***)***	-0.131 (-0.190***)***	***-0.679***** (***-0.180***)	-0.203 (-0.180***)***	***-0.376**** (***-0.170***)
21-40 from city	-0.089 (-0.160***)***	-0.017 (-0.150***)***	-0.251 (-0.160***)***	***-0.514***** (***-0.150***)	***-0.457***** (***-0.170***)	***-0.284**** (***-0.160***)
41+ from city	-0.103 (-0.100***)***	0.012 (-0.100***)***	-0.119 (-0.090***)***	-0.156 (-0.100***)***	-0.160 (-0.100***)***	-0.067 (-0.100***)***
Other urban	-0.067 (-0.110***)***	***-0.179**** (***-0.110***)	-0.035 (-0.110***)***	***-0.280**** (***-0.110***)	***-0.304***** (***-0.110***)	0.061 (-0.120***)***
Rural	-0.165 (-0.130***)***	-0.171 (-0.130***)***	-0.189 (-0.130***)***	***-0.305**** (***-0.130***)	***-0.360***** (***-0.140***)	-0.108 (-0.140***)***
Moved since last survey	***-0.191**** (***-0.110***)	-0.152 (-0.120***)***	-0.106 (-0.110***)***	***-0.266**** (***-0.120***)	-0.131 (-0.130***)***	***-0.281**** (***-0.120***)
SINGLE OVER 65	***0.868***** (***-0.170***)	***0.611***** (***-0.170***)	***0.685***** (***-0.170***)	***0.604***** (***-0.170***)	***0.351**** (***-0.170***)	***0.454***** (***-0.160***)
COUPLE OVER 65	***0.884***** (***-0.220***)	***0.672***** (***-0.200***)	***0.809***** (***-0.190***)	***0.671***** (***-0.190***)	***0.741***** (***-0.190***)	***0.499***** (***-0.170***)
COUPLE UNDER 65	***0.500***** (***-0.140***)	***0.245**** (***-0.130***)	0.187 (-0.130***)***	***0.299**** (***-0.140***)	0.150 (-0.140***)***	***0.221**** (***-0.130***)
PARENT	***0.477***** (***-0.140***)	-0.007 (-0.140***)***	***0.402***** (***-0.150***)	***0.332**** (***-0.140***)	0.190 (-0.140***)***	0.024 (-0.150***)***
SINGLE PARENT	***0.635***** (***-0.170***)	-0.112 (-0.170***)***	0.043 (-0.180***)***	***0.321**** (***-0.190***)	***0.324**** (***-0.180***)	-0.072 (-0.200***)***
cut1 Constant	-1.381*** (-0.2***)***	-1.477*** (-0.2***)***	-1.663*** (-0.2***)***	-1.759*** (-0.2***)***	-1.321*** (-0.2***)***	-1.694*** (-0.2***)***
cut2 Constant	-0.774*** (-0.2***)***	-0.994*** (-0.2***)***	-1.104*** (-0.2***)***	-1.276*** (-0.2***)***	-0.913*** (-0.2***)***	-1.292*** (-0.2***)***
N	1273.0	1306.0	1360.0	1386.0	1400.0	1428.0

Source and notes: As for Table A2.1

Essay Three: How long do households remain in housing affordability stress?

1 Introduction

A family home is considered a necessity for individuals but unlike many other types of necessities it is a durable good. Clothing and food is consumed within a short period of time but individuals may remain in the same house for many years, especially if they are homeowners. Thus housing is a large component of expenditure for most households that will not change quickly with time. The longer a household is in stress, the more likely it is that its members may experience mental health issues (Bentley, Baker, & Mason, 2011). This potentially reduces the quality of human capital and rates of labour force participation. Labour market outcomes are an important element in the reduction of housing stress (Burke et al., 2007). Households who are in chronic housing stress may be unable to own their own homes, thus excluding them from the potential benefits of housing stability, security and the ability to grow equity in the long term. These issues raise an important question: do households who are forced into stress due to housing costs remain there for a long period of time?

Much of the information about individuals and their level of stress are based on cross-sectional surveys. This provides information about levels of stress at a particular point in time. Individual may fall into stress in the short term for a number of reasons, such as changing jobs or having a child. Thus information about the length of time is required to distinguish between households who are short-term stress and those that require more time or support to leave stress. Cross-sectional surveys are effective at providing a snapshot of the population at a particular time, but can overestimate the size of the problem if most individuals escape in the next period, without requiring further help. Longitudinal results present a different understanding of the situation, through the use of panel data, which allows tracking of individuals over time and thus uncovers the length of time in stress, rather than just who is in stress at a particular time of observation. The panel data cohort remains the same over time and such data should be used with caution when generalising for the general population for that period of time.

In this essay, the length of time that a household may be expected to remain in residual stress will be assessed to better uncover the household characteristics that predict lengthy periods of stress. The aim is to capture a clear picture of how individuals experience their financial situation as affected by housing costs. Research into the duration of housing stress

using any measure of housing affordability is scarce. The issue has important implications for policy makers, as the longer a household is in stress, the greater is its need for support.

The residual measure of housing affordability includes an income component, so that the likelihood of a household falling into residual stress is reduced as household income rises. The ratio measure in most cases does not include an income component and is simply used to assess if an individual spends more than a certain percentage of income on housing. The focus of this study is solely on those who are genuinely in stress and struggling to buy basic necessities. The longer a household is in stress the lower its reserves, both financial and mental, will be. This leads to members of a household focussing on short term, essential needs. The immediacy of these problems makes it less likely that households are able to plan for longer-term projects, such as investment in education, health, and community activities. The situation calls for targeted policies that can assist such households in moving out of stress and planning more effectively for the future.

The household characteristics that determine the length of time that a household will spend in a particular financial status will be specified. The essay will also identify the life events that are associated with an individual falling into residual stress, providing a better understanding of the impact that life events have upon individual residual income levels. The research question that will be addressed is:

What household characteristics affect the experience and duration of housing stress?

To uncover the experience of housing affordability the percentage of individuals from the sample who are in stress has to be determined. The magnitude of the problem for each year is demonstrated through a count of how many households experience stress. The data is transformed into a survival data format so that the duration of status can be examined in the *Living in stress* model. The model will be first introduced in the general form, with a focus on the duration of stress and the factors that explain this duration. This model has three approaches within its application. The first is non-parametric and uses the Kaplan-Meier estimator. No variables or distribution are selected for the function, allowing the situation to be shown without any restrictions placed on the data. The second is a semi-parametric analysis that applies a Cox Proportional discrete hazard approach, with variables introduced to see if they predict different durations of stress. This does not restrict the distribution of the data in a functional form. The variables are compared to the base case selected, but there are no restrictions applied to this base case. The last approach will impose the parametric distribution

that best fits the hazard function in the data; in this case this is the Weibull distribution. This will restrict the function both by the introduction of variables to explain the duration of stress, and the application of a distribution that assumes the functional form of the data.

The *Living in stress* model will apply the Kaplan-Meier estimator to produce survival tables that examine the length of time that households remain in a particular affordability status (Cleves, Gould, Gutierrez, & Marchenko, 2010). These will be produced for individuals during the first period of observation in a particular status, then sub-groups based on their housing situation (renters, owners) and household type (single, parents)

The second and third elements of the *Living in stress* model will be run on the entire sample that experiences stress. Each of the variables that are significant will be used to predict if a household is more or less likely to experience an income situation for longer than the base case. With the inclusion of all the significant variables within the one model, more of the variation between groups can be explained. The Cox Proportional discrete hazard approach will be used to examine the characteristics of households that predict the length of time in different states. Through this procedure, applied to ten waves of data, an attempt will be made, to capture all significant variables. To complement this element three different distribution of parametric are applied to the data, hence variables and functional distribution is fitted to the data. OLS and probit models are used for robustness checks.

Examining the life events (such as separation from a spouse, retirement or having moved house) of those who fall into stress involves separating observations into two groups: those who fall into stress in the past year, and those who do not. This is to determine if those falling into stress experience particular life events at a greater rate than the rest of the sample. Life events that occur when an individual moves from one financial status to another will be examined by comparing them against those who do not change their status, through the application of a t-test.

The contribution of the essay lies in revealing the length of time that a household experiences a particular status of residual income, and provides greater understanding of how different groups of households experience the duration of housing stress through the application of the *Living in stress* model. It uncovers what type of individuals fall into stress and the length of time they may be expected to remain there; it uses three different elements of survival analysis and applies it to a residual measure of housing affordability using income and housing data. To complement this, the life events that occur at the same time that a household falls into stress are considered and compared to the rest of the sample. This helps to identify

the particular life events that occur when the household reference person changes his or her income status.

The results demonstrate that for most individuals the length of time in stress is short, but there is a group of individuals that remains in stress for longer periods. Those who can escape stress do so, leaving only a core group that does not move from one status to another. The majority of those who are identified as in stress using cross-sectional data do not require new policies to escape stress. Attention is more appropriately focused on those who remain in stress for prolonged periods. This is influenced by education, household type and housing situation (renting versus home-ownership). The housing supply needs to adapt to cater for households with the characteristics of singles aged under 65, which remain in stress for the longest time. Renters are more likely than homeowners to remain in stress. This occurs even though renters can move more freely to try to avoid stress than homeowners can.

The essay structure is as follows. Section 2 provides a review of research into the duration of housing stress, the affordability measures used previously, and the current housing problem. This is followed by a methodology section (Section 3), which will introduce the main model, *Living in Stress* and each of its elements that are used to uncover the length of stress, the non-parametric approach Kaplan-Meier estimator, semi parametric Cox Proportional discrete hazard model and parametric approaches. The measure, variables, and data required for survival analysis are explained. The source of the data is set out in Section 4. The results section (Section 5) will describe the results relating to the duration in stress and life events. The policy implications are covered in Section 6, which is followed by the conclusion.

2 Housing concepts: the longitudinal perspective

The *Living in stress* model examines the length of time in which individuals are in stress. This section will discuss other research on tracking individuals over time from a housing perspective. A decision has to be made about when an individual is considered to be in stress. This is dependent upon the measure that is used to assess these individuals. The approach taken here focuses mostly on those who are in stress, but also adopts a wider perspective to understand the situation that this model is applied to. This is important when interpreting the results produced in the model and the policy implications.

There are three key elements in this section. Previous research using panel datasets and duration models is examined in Section 2.1. In Section 2.2 a discussion of the type of measure

used in previous work and its effectiveness is provided. An understating of the current state of the problem is essential to the interpretation of the results, and this is explained in Section 2.3.

2.1 Duration of stress

The key research in the area of duration and housing affordability is by Wood and Ong (2009), who identify causal factors associated with movement into and out of housing stress for the years 2001-2006. Drawing on the HILDA data set, they use a range of variables to determine the odds of a person either escaping or continuing to be in stress. 'The odds' in this context refer to the transformation of the variables; the coefficients are transformed by the equation p/(1-p). These include the number of years in stress, the year of entering the stress situation, if the household was a renter or owner, had recently moved house, the region that the dwelling was located in, and the education and working status of the household reference person. The ratio measure of affordability was used, with the 30 per cent of expenditure on housing threshold, and households exceeding this level were considered to be in stress. There was no income component in the measure used.

Marks and Sedgwick (2008) examine the persistence of housing stress using the ratio approach and the same data set, to determine how many years a household remained in stress when looking at the general sample. Their longitudinal analysis did not include an income component in the affordability measure. Persistence was found to be low, but the study missed a critical point in that while the proportion of the sample that escaped stress in the first year is large, in subsequent years it is small and stress persisted. Of those in stress in the first year, 45.8 per cent were still in stress in the following year. Thus more than half of the sample left stress within one year, which is a large drop off. At the five-year point 32.1 per cent remained in stress, thus for those still in stress after one year, 70 per cent were still in stress at the five-year mark (32.1/45.8 = .70). The focus was on persistence according to whether the household was renter or homeowner, but sub-groups relating to other household characteristics and location may be explored further.

Waite, Henman, Banks, and Curtis (2010) use the residual measure to assess the duration of housing stress for Queensland households that are in receipt of a government transfer or payment. Using data from Centrelink (the division of the Commonwealth Department of Human Services that administers health, social and welfare payments and services), the authors examine the third year of a person's receipt of government transfers. This focuses on one of the key element of the residual measure, the inclusion of an income

component, and is better able to target low-income earners. Different household types and income support benefits are associated with different housing affordability issues over time. This supports the development of more finely-tuned targeting of short- and long-term government housing assistance.

The HILDA data set is based on a general sample of the population, while different sub-sections of the sample may be examined to uncover the experience of those in housing stress. It is important to examine households' life events beyond their housing situation. The characteristics of households that take longer to escape stress are also important. The experience of housing is not isolated to ownership, or lack of it, but is tied to broader factors, including the ability to find work and individual well-being.

2.2 Measures of housing affordability: the duration aspect

In previous studies of housing affordability, duration models are based on the ratio approach. This prompts a discussion about the effectiveness of the ratio measure and the alternative approach that is used in this essay. The choice of measure is crucial if households are in housing stress, but not in other types of stress, in which case households may simply be identified by their preference to spend more on housing.

A measure based on a ratio approach is most commonly used for assessing if a household is in housing stress. If a household is found to be in housing affordability stress then it is more likely that it is experiencing general financial problems. Rowley and Ong (2012) find that there is no statistically significant relationship at the 1 or 5 per cent level between a movement out of housing stress and an improvement in financial wellbeing. This casts doubt on the use of the ratio approach in making judgments about the financial position of a household. There appears to be a trend towards a willingness of households to spend an increased greater share of income on housing, with those who do so not considering themselves to be in stress. The apparent decline in affordability over the long term may partly result from the collective decision of households to spend a greater share of their income on larger and better-equipped housing (Productivity Commission, 2004).

The key issue is whether the ratio method identifies those who are in stress due to circumstances beyond their control, or households who move into that state by choice. Rowley, Ong, and McMurray (2011) examine this question through an analysis of the financial health of households in HILDA surveys and their level of expenditure on housing over the same time period, concluding that households chose to incur greater costs. Levels of stress as measured

using the ratio approach increased, while measures of financial wellbeing showed improvement. The analysis suggests that the traditional housing stress measure is not an accurate reflection of how well households cope financially. The use of multivariate analysis also failed to establish a statistical relationship between housing and financial stress based on the ratio approach (Yates, 2007).

2.3 Housing market in Australia

House prices have continued to increase during the past decade in Australia, with a sharp increase occurring in the first half of the 2000s (Stapledon, 2012). The ratio measure reveals increasing levels of housing affordability stress, but households continue to buy because they are willing and able to spend more than this set percentage, without feeling stressed. The residual measure may be used to explain this situation:

> Low-moderate income home purchasers are still able to buy housing that looks increasingly unaffordable if they are single people or couples without dependents to support. Households with children are being squeezed out of the market because of their greater non-housing expenditures. A single person or couples with no children who are willing to live on the Modest but Adequate budget standard can afford to borrow much more than a household whose non-housing expenditures reduce their ability to take on a larger mortgage (Hulse, Burke, Ralston, & Stone, 2010, pp70-71).

This explains why households are still able to move into homeownership, but does not address what is happening once they are in residual stress. In this essay, various household characteristics are examined separately to determine which of them are associated with the experience of long periods of stress. Household compositions with lower non-housing expenditure and the same income as other households are less likely to be in residual stress.

Local house prices naturally affect the housing costs of Australian households. Globally, a widespread increase in real house prices has been driven by demand fundamentals underpinned by supply constraints; a situation that underpins increased demand for public housing (Yates, 2011; Rowley, Ong, & Mahendran, 2010). The Australian housing market has experienced a sustained period of relatively low and stable interest rates, a less regulated banking system, population growth and strong employment levels. Dual income families are becoming the norm (Phillips, 2011). On the supply side there is a shortage of new and existing

houses. Using a measure of incomes in relation to house prices, with five times one's annual income being considered an affordable house price, it will take nearly nine years for housing to reach this affordability level if median prices remain the same and income continues to grow at trend (Phillips, 2011).

Better understanding of the experience of low-income groups will allow appropriate policies to be designed to help those most in need. Policies that promote secure, stable and affordable housing enrich society by adding to overall wellbeing, while policies that precipitate house price escalation and excessive risk-taking may make some individuals and institutions rich, while beggaring society as a whole (Beer, Baker, Wood, & Raftery, 2011). If the current housing stock does not match the changing nature of demand, housing may not be a good match for the choices and trade-offs that households would make given their current constraints (Kelly, Weidmann, & Walsh, 2011). This mismatch would lead to households having to pay greater housing costs than is warranted by the composition of their family.

By international standards, Australians are on the whole highly mobile, moving house more often than is the case in most other countries. This mobility is driven by renters and younger Australians, with owner-occupiers being much less likely to move (Sánchez & Andrews, 2011). Indeed, the difference in mobility between owners and renters in Australia is the highest in OECD. Australia has one of the highest levels of transactions costs associated with moving house in the OECD (Sánchez & Andrews, 2011). Renters are moving more often and those that do manage to purchase may live in stress for many years due to a lack of housing choice (Burke et al., 2007).

The situation for different types of housing tenure – renting and paying a mortgage – needs further examination using the residual method to determine how long households remain in residual stress. How are low-income earners affected by these market forces? What is the length of time that one could expect them to remain in stress, using the residual approach, and what are the key characteristics that determine this duration? The current situation is characterised by increasing house prices that will flow through to housing costs in the form of either repayment or rents. What is the experience for these low-income earners in regard to those changes in the market?

3 Methodology

In this essay, housing affordability is tracked between the time periods in which a change in residual income status takes place. This involves comparing the household residual income against the budget standard for that household in a particular year. The characteristics of a household may change over time, and thus the budget standards that will be applied may also change. This approach differs from that of other duration models that are based on the ratio measure. The residual affordability measure has two values, one or zero. 'One' applies if the household reference person has a residual income that is greater than the low cost budget standard. 'Zero' applies if the residual income is less than the low-cost budget standard. The measure will follow the representative individual over time and this will allow changes to be observed.

Research by Wood and Ong (2009) is extended here through the application of the residual approach instead of the ratio one, and by using data from a longer time period of time, 2001 to 2010. A household with a high percentage of income spent on housing may have more than adequate remaining income for non-housing necessities. The ratio measure only captures those who spend over a certain percentage of income on housing costs. The residual approach involves a comparison of the amount of income remaining after expenditure on housing, which is the residual income, to a budget standard (without the housing costs) for particular types of household characteristics. A household that is in residual stress will have a residual income that is lower than budget standard for all households with the same characteristics. The measure therefore better reflects non-housing consumption needs. Low residual income reflects a lack of discretionary spending power. Intuitively, a household that remains in stress may find it difficult to cope with the situation or raise financial resources over time, given its lack of residual income.

The experience of households with housing affordability is related to the duration of time they may be expected to remain in their current residual income group. The longer a household remains in residual stress, the more unpleasant the experience is likely to become, as reserves of emotional and financial resources are exhausted. Intuitively, household characteristics would affect this duration. Knowing the predicted results from these characteristics is important to the development of effective policies to reduce household's experience of residual stress. Identification of the life event(s) that cause households to enter stress will uncover triggers for changes in affordability states.

3.1 General form for duration of stress

The general form of the *Living in stress* model will be applied in three different approaches. The model is used to explain the duration of a household experience of stress. Hence:

The duration = function form (x_i)

The duration of housing stress aspect of the research question will be reported in two different formats, either a survival function as shown in equation (2) (specified on page 156), or as a hazard function, *h(t),* also known as the conditional failure rate. The non-parametric analysis will report the survival function without restricting the function form or any variables. The semi-parametric analysis will include a range of x_i to understand the characteristics that explain the duration but without restricting the distribution of the hazard function. The parametric analysis has the greatest level of restrictions on the data through the selection of the function form and x_i to explain the duration of time that households will live in stress for.

Table 3.1 lists the key variables that will be used to run the model. The variable name specifies the formal term that will be treated in the model. The explanation gives further insight into the derivation of the variables in the HILDA dataset. Age, gender, highest education achieved, origins and labour force status variables are included to facilitate understanding of the characteristics of the household reference person, who will be followed through time. Information about the household, such as housing situation (homeowner or renter) and location (State) is included.

Table 3.1

Variables in Living in stress model

Variable name	Variable label	Explanation or HILDA variable names	
Dependant variable			
HAT	Housing affordability Total – for all budget standards	HAT = 0 if resin <= LCBS HAT = 1 if resin > LCBS	
Independent variables			
EDUC1	Post-high school education	Taken from edhigh for recoding	*EDUC1*=1 for those with Degree or higher *EDUC1* = 0 all else
ORIGIN	Place of birth	Taken from anbcob	Non-native = 1 Australian born = 0
AGE	Age of individual	Taken from hgage for recoding	Less than 41 41 to 50 51+
HHTENDER	Household situation	Taken from hstenur & hstenr	*SINGLE UNDER 65* *COUPLE UNDER 65* *NON-PARENT OVER 65* *PARENT*

			SINGLE PAREN
LFSCP2	Those not working	Taken from esbrd	Not working = 1 Working = 0
STATE	The State the household lives in	Taken from hhstate	NSW Vic All others
Health	If the individual has a long term health condition based on show card K2, as in appendix F	Taken from helth	Have a long term health problem = 1 Does not = 0

Source: Melbourne Institute (2001-2010).

Household disposable income, together with housing costs, produces the representative individual's residual income. Housing costs in this case refer to either mortgage repayments or rent. Other costs, such as utilities, are not included as data on them are not available for all the Waves of interest. Ideally these costs should be included as they are fixed in the short term, with any real changes to the provision of utilities, such as new and more efficient equipment, taking time to implement.

Residual incomes are compared to the budget standards for that household type, adapted from Henman (2001). Inclusion of the family type variable is required to match with the budget standards. The budget standards have ten combinations. The family composition specifies if the representative individual is in a relationship or has children, but not the number of dependent children, which is also required to make the affordability measure. This is a more complex procedure than that involving the use of the ratio approach. The more advanced ratio approaches also require the number and age of children in order to work out the equivalent income levels. The measures that better reflect the situation and may be adapted for different households require more detailed data. All the data comes from HILDA except for the low cost budget standard (LCB), which has been updated from the original budget standards (See Section 4).

Table 3.2

Variables used to create measure of housing affordability.

Variable name	Variable label	Explanation and HILDA variable used without alteration
tnchild	Total number of dependent children	Made up from hhd0_4, hhd5_9, hhd1014, hhd1524
hhd0_4	Number of dependent children aged 0 to 4	
htype	The ten different household types	Requires tnchild, hhtype, hgsex, hgage
hhtype	General household types	
hgsex	The gender of the individual	
hgage	The age of the individual	
LCBS	Low cost budget standard	Benchmark depending on the htype and year
housec	Weekly housing costs	Requires hsmg and hsrnt depending on the type of housing costs.
hsmg	Mortgage usual repayments $ per month	
hsrnt	Rent usual payment $ per month	
WDI	Weekly disposable income	Requires hifdip
resin	Residual income	(WDI – housec)

Source: As for Table 3.1.

There are limitations of the number of individuals that can be included in the sample. Firstly, the measure of affordability currently does not match all household characteristics with a budget standard. Secondly, the attrition rate is the number of individuals that continue to respond to the survey over time. Often individuals choose not to continue taking part in the survey and drop out. This will reduce the sample size as new information is no longer available for these individuals. Thirdly, missing values may result, due to individuals refusing to answer or not knowing information about a certain question. If missing values remain after attempts are made to fill them, the individual concerned is omitted from the sample.

For the duration models, problems may arise as individuals move from dependant to independent status, and then return to dependant status. Such a sequence would result in the individual entering the survey in their own right but then leaving it to become a dependant again, thus causing them to drop out of the more detailed part of the survey. Given the difficulty in matching these individuals and them in effect leaving the survey, these individuals will not be included in the sample. Wood and Ong (2009) impute a rent level for those who had no housing costs, either due to owning their property outright or living rent free. If a person has no housing costs, he or she cannot be considered in stress when using the ratio measure, which requires the use of imputed rent. The residual approach does not have this problem and the analysis will include these individuals as their income can still be compared. Their income levels might in fact be too low to avoid residual stress even without any housing costs. This could be the case if a person receives free housing as part of their job, but given family characteristics they receive insufficient income to cover non-housing expenditure. Those who have a negative or zero income will be dropped, as this is often the result of tax minimization or temporary losses incurred by self-employed individuals, which does not reflect their true housing affordability state.

The *Living in stress* model applies three approaches to the general form, which are used to capture the nature of the situation for a particular household. Non-parametric analysis will create survival tables using the Kaplan-Meier estimator; this will measure the length of time that households stay in residual stress at their residual income level without any restriction of the data. Semi-parametric and parametric models of the duration in stress will be developed to assess which variables impact the duration. The difference between the two parametric models is the level of restriction, with the parametric also applying a function form. This will be complemented by the identification of life events that occur at the same time that individuals move into residual stress, using panel data that tracks the individual over time. The approach used here differs from previous literature, in that households are tracked over time by taking

advantage of the type of data available, thus uncovering when a household changes state. This does not generate a snapshot of the situation, but rather tracks how households consume housing over time and the duration of the residual stress that they experience. This is complemented by non-survival analysis of the likelihood of an individual being in stress at a point in time, rather than the duration of stress.

3.2 Survival table for those in stress

The analysis of households is based on whether they are in residual stress, and how long they continue to exist in that group. Non-parametric analysis will be used to produce life tables, while not restrictive the form of the data. The scenario that will be examined is for individuals that are experiencing stress and how long they remain in that state. The Kaplan-Meier estimator is a non-parametric estimate of the survivor function, which is the probability of survival past time *t*.

Probability of surviving current time period = $\left(\frac{n_j - d_j}{n_j}\right)$ (1)

Survivor function $\hat{S}(t) = \prod_{j|t_j \leq t}\left(\frac{n_j - d_j}{n_j}\right)$ (2)

Where n_j is the number of individuals at risk at time t_j and d_j is the number of failures at time t_j, failure is when the event occurs, thus indicating a change in residual income status. The survivor function is the product for all observed failure time periods that are $\leq t$ (Cleves et al., 2010).

The time presented in these tables is not the date but the length of time in a particular state. A value of one in a given time period means that the individual has been in stress for one year; the time period is presented in years as individuals are observed once a year. The number of individuals of interest is recorded in the life table. This group changes depending on the next two elements, hence everyone of interest is in the first time period, after which they may either change group, are 'censored', or remain in the sample. Censored refers to a situation in which there is no new information about the individual, often due to the data set finishing. As a result, we do not know if or when the event occurs. The next group is the number of individuals that moved out of the group of interest; if examining the duration of stress, this would mean that in the previous recorded period the individual was in residual stress, and in the next period was in non-stress. The event, in this case moving into non-residual stress, results in the person leaving the grouping of interest and no more information about them is collected.

The term ‘censored individuals’ refers to cases where no new information about an individual is collected because the data has ended. There is no new information after 2010, so one does not know if the individual concerned remained or escaped from the group of interest, and they are thus regarded as censored. The next year for the interest group is the previous wave, minus those who escaped or were censored.

The probability value shows the number of individuals in the group at the start of the time period, minus those that escape the group, divided by the number of households in the group of interest at the start of the wave. As shown in equation (1), this probability may change, depending on which wave in stress is being observed. It represents the likelihood of remaining in the selected group for each time period. The survivor function is derived from the probability values and follows equation (2). The probability value is a conditional probability of survival beyond the current time period, given that the individual has so far survived in the group. The unconditional probability of survival beyond the current time period is the survival function, which is the product of the probability value of all time periods prior to the current time period. The probability can be any value between 0 and 1. The survivor function reports the probability of surviving beyond time *t*. It is the probability that there is no failure event prior to *t*. The function is equal to one at t=0 and decreases towards zero as t goes to infinity. The survivor function is a monotone, non-increasing function of time (Cleves et al., 2010).

The focus of survival tables is not on whether a representative individual experiences residual stress, but how long the situation of the first spell in residual stress lasts. The first spell may occur in any of the ten Waves, then for as long as there is information and they remain in residual stress, individuals will remain in the table. A general picture is obtained of how households in a particular residual income group experience their first spell in residual stress. The situation may be broken down further through the selection of key characteristics, based on the housing situation (renters, homeowners) and household characteristics (single, couple, couple with children). This categorisation allows greater understanding of the factors that may increase the duration of stress and how this differs between these characteristics. Different households experience residual stress in different ways. The characteristics of the household may change over time. In this analysis it is the characteristics at the start of the spell that are of interest. The household type at the start of the first period of stress is assigned to the individual for the duration of that period. This determines which sub-group they are assigned to, even if the characteristics change after the first period in residual stress.

With ten waves available it is possible for a person to escape and re-enter residual stress multiple times. Hence the number of times that individuals re-enter residual stress is shown.

The mean number of waves experienced is ascertained to assess the lack of permanence for those escaping residual stress. The number of households that manage to enter non-residual stress but are not able to remain in this state may be specified. Some individuals move between the groups and this table will help to show the percentage of the sample that does this.

3.3 Duration of stress: characteristics

In the model, when a household escapes affordability stress, the change in status constitutes an 'event'. The independent variables inform if the event is more likely to happen within a time period compared to a base case. The first Cox Proportional discrete hazard model will examine the length of time that an individual can expect to remain in residual stress, based on information about the individual before the event occurs. The sample includes any individuals who experience a period of residual stress. The model allows identification of the variables that have a significant relationship with the different lengths of time that individuals spend in residual stress. The direction and scale of the predicted values will improve the effectiveness of policy making through identification of the characteristics that increase the likelihood that the duration of an event for a particular type of individual will be longer or shorter.

The value reported is the hazard function and representative variable of interest, which gives information about the duration of stress. The hazard function, *h(t),* or conditional failure rate, is the limited probability that the failure event occurs in a given interval, conditional upon the subject having 'survived' (i.e. remained in a given status) to the beginning of that interval, divided by the width of the interval (Cleves et al., 2010). The width in this case is one observation, as there is only one observation per year, hence it is the probability of the failure event occurring in a given year, conditional upon the household having survived to the beginning of the year, in its current group.

The Cox Proportional discrete hazard model assumes that the covariates multiplication shift the baseline hazard function. The the hazard rate for the *j*th subject in the data is:

$$h(t|x_j) = h_0(t)exp(x_j\beta_x) \quad (3)$$

The baseline hazard $h_0(t)$is given no particular parameterization and may be left un-estimated (Cleves et al., 2010). The model makes no assumptions about the shape of the hazard function over time. It assumes that whatever the general shape it is the same for everyone and hence no assumption is made about the shape of the distribution. One subject's hazard is a multiplicative replica of another's; comparing subject *j* to subject *m*, the model states that:

$$\frac{h(t|x_j)}{h(t|x_m)} = \frac{exp(x_j\beta_x)}{exp(x_m\beta_x)}$$

This is constant, assuming the covariates x_j and x_m do not change over time. Thus the coefficients compare the hazard rate to the baseline hazard. If the coefficients are negative, the model estimates that the individual will face a hazard rate that is less than the baseline hazard faced by the baseline subject. When looking at those in stress a positive number would represent characteristics that are associated with ability to escape residual stress.

The Cox Proportional discrete hazard model assumes that the covariates multiplication shift the baseline hazard function. This might not always be the case. The model also does not make assumptions about the distribution of the hazard function. Parametric distributions are also applied to the data, with the one that best fits the hazard function being used.

The hazard function can be estimated by imposing a parametric functional form, thus applying a restriction of the data and assuming a functional form. The models can be estimated, assuming various shapes of the baseline hazard corresponding to the distributions followed by the hazard function. The choice of distributions and corresponding functional form from equation (3) for the Proportional Hazard models is as follows:

Exponential: $h(t|x_j) = h_0(t)exp(\beta_0 + x_j\beta_x)$

Weibull: $h(t|x_j) = pt^{p-1}exp(\beta_0 + x_j\beta_x)$

Gompertz: $h(t|x_j) = exp(\gamma t)\ exp(\beta_0 + x_j\beta_x)$

The distribution that results in the best fit, as shown in Table A3.4, will be included in the results. This model will have a distribution that best fits the cumulative hazard function.

Two further robustness tests are conducted. These models do not use the survival approach. Firstly, an OLS model is applied with time intercept dummy variables. The dependant variable is the probability that an individual will be in stress. For each observation in stress, a zero is recorded; one is recorded for those not in stresses. This is summed for all observations and is divided by the number of observations to obtain a value between 0 and 1. The higher the value of the dependant variable reflects more observations of the individual in non-stress, the greater the probability that this individual is not in stress.

The second approach uses a probit model applied to the panel data. The dependant variable is the stress variable that was created to examine duration of stress. If residual income is below the low cost budget a zero is assigned and a one for those above the budget standards. Thus each observation has a zero or one and it is this variable that is the dependant variable.

3.4 Incidence of change/ life events

Data regarding life events for individuals when they move from non-stress into residual stress is provided, and contrasted with all other individuals. There are two groups: (1) the household was not in stress in (*t*-1) but was in stress in period (*t*); and (2) the rest of the sample. An individual could thus be in both groups, but at different time periods. If a person is in non-stress for wave 1 and 2, but falls into stress in the wave 3, then the individual will be included in the rest of the sample group for wave 1 and 2 as still not in stress, but will be in the group of interest for wave 3. This is because in *t*-1 the person was not in residual stress, but was for period *t*. The focus is on the difference between the two groups, and whether there is an incidence of those falling into residual stress compared to everyone else that occurs more often. This will go some of the way to explaining the shift between groups. The two groups are then compared through a *t-test* to assess if life events are more likely to occur for the group falling into stress in the past year when compared to the rest of the sample.

Negative life events such as death, injury or violence for the individual or family members are likely to be associated with a household falling into stress. Other outcomes that create uncertainty may be due to voluntary or involuntary factors. For example, when an individual moves house, this may be positive if the decision is made by choice, but could also reflect being forced to move, due to a landlord requesting that the premises be vacated, or an inability to bear the burden of homeownership. The choices of major life events will be guided by the approach taken by Rowley and Ong (2012). They use the ratio measure and thus the make-up of their groups may be very different to the ones here, given the different income levels that the ratio can capture.

Table 3.3

Life events that occurred in the past year

Variable name	Variable label	Explanation or HILDA variable names
Lebth	Birth/adoption of new child	Same as HILDA
Ledrl	death of close relative/ family member	Same as HILDA
Ledsc	Death of spouse or child	Same as HILDA
Lefnw	Major worsening in finances	Same as HILDA
Lefrd	Fired or made redundant	Same as HILDA
Leinf	Serious injury/ illness to family member	Same as HILDA
Leins	Serious personal injury/illness	Same as HILDA
Lertr	Retired from the workforce	Same as HILDA
Lesep	Separated from spouse	Same as HILDA
Lemvd	Changed residence	Same as HILDA

Source: As for Table 3.1.

4 Data

This essay uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Project was initiated and is funded by the Commonwealth Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) and is managed by the Melbourne Institute of Applied Economic and Social

Research (Melbourne Institute).[6] The data used was extracted using the Add-On package PanelWhiz for Stata®.[7]

The HILDA data set follows a representative individual over the first ten waves, but the information will be examined at the household level, as it is household income and characteristics that are of interest, with only one individual per household. Detailed information such as that relating to age, employment status, and housing situation is vital for the model and the survey provides this information.

Participants may drop out of the survey over time, and once they have done so no new information is available on them. Such individuals are excluded from duration analysis, due to the lack of information about when their stress ends. When the HILDA data set started it included 11,693 individuals; this declined over time as individuals dropped out or became part of other, existing households. In households made up of multiple individuals, only the representative individual is retained. Nevertheless, a very large sample is available for duration analysis, with 5,138 individuals having been interviewed for all ten Waves. If there are multiple individuals in a household only one is used for that year and he or she becomes the representative individual. Excluded individuals may be included in later time periods if they leave the household and form a household independently of the representative individual already being used. The representative individual is the first listed person within a household.

The second data source is for the budget standards (Henman, 1999). These have key elements that may be removed if required. In this case the housing cost element is removed in constructing the measure of housing affordability. The budget standard used here has ten household combinations. They are single male aged under 65, single female under 65, single over 65, couple under 65, couple over 65, couple with one dependent child, couple with two children, couple with three children, single parent with one child and single parent with two children. It is the age of the representative individual that is being tracked to allow for matching with the correct budget standard. These household combinations are matched to those in the HILDA data set. Households that do not match one of these household combinations are set equal to one. These households are included so that one year's lack of a match does not mean

[6] The findings and views reported in this paper are those of the author and should not be attributed to FaHCSIA or the Melbourne Institute.

[7] PanelWhiz (http://www.PanelWhiz.eu) was written by Dr. John P. Haisken-DeNew ([redacted]); see Hahn and Haisken-DeNew (2013); Haisken-DeNew and Hahn (2010) for details. The Panel Whiz-generated DO file to retrieve the data used here is available from the author upon request. Any data or computational errors in this paper are my own.

that the household is lost to the analysis. Given the high rate of matching between household types in the HILDA dataset with a budget standard this is not a process that is likely to distort the final result.

5 Results

The results come in four different formats:

1. A descriptive account of the situation, through results such as the percentage of the sample that is in stress for each of the years of interest and the breakdown of stress by age groups.
2. Non-parametric analysis using the Kaplan-Meier estimator. This is done for all ten compositions that have experienced stress.
3. Semi-parametric and parametric models: Cox Proportional discrete hazard model and other distributions of the hazard function.
4. Robustness checks in the form of OLS and probit model

Points 2 and 3 involve different techniques to those that have been applied to the *Living in stress* model. The techniques differ in their variation of parametric form.

5.1 Descriptive statistics

The information here is provided for either all of the sample or by age groups, before the data is transformed for survival analysis. Table 3.4 shows that most waves recorded around 5-10 per cent of the sample as being classified as in residual stress. Hence in any individual year the percentage of the sample that is in stress is not great and the problem is relatively stable after the first year. Each of the observations represents a household, to preclude double counting. The sample increases as individuals that are not the representative individual leave their household and form a new household thus become a representative individual.

Table 3.4

Number and percentage of total sample in stress

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Residual stress	232	452	460	482	434	445	454	471	439	380
%	5.6	10.4	10.2	10.4	9.1	9.2	9.2	9.4	8.7	7.4
Total	4,149	4,327	4,507	4,637	4,750	4,835	4,927	4,997	5,069	5,138

Source: Author's calculations using confidentialised unit record files of the HILDA Survey Waves 1–10 from HILDA data set (Henman, 2001; Melbourne Institute, 2001-2013).

Table A3.1 and 3.5 show the percentage of those in stress based on age. The key result is that the percentage of individuals in stress from the older age group is greater than average for all years. The other age groups tend to be below the average. One of the shortcomings when using panel data is that fewer individual remain in the younger age group by the end of the time period. This is as expected, as over ten years most respondents will be aged over 30 and all age-related variables will have increased by 10 years over the course of the survey.

Table 3.5

Summary of percentage and number in stress by age brackets, 2001, 2006, 2010

Age brackets	>31	31-40	41-50	51+	Average
2001					
Percentage	5.8	3.2	4.5	7.6	5.6
Number	36	31	43	122	232
Total	620	965	961	1603	4149
2006					
Percentage	11.5	7.2	6.6	10.7	9.2
Number	74	65	75	231	445
Total	642	901	1,142	2,150	4,835
2010					
Percentage	7	7.9	5.1	8.2	7.4
Number	35	66	57	222	380
Total	500	831	1,111	2,696	5,138

Source: As for Table 3.4.

5.2 Survival in stress

Only those who experience residual stress are included in the analysis. The number of individuals in stress in any one period is not high, but the survey story is different for those who experience stress over the time period of the survey. Of the 5,138 individuals that are in the sample over the ten years, 1,633 (almost 32 per cent) experienced residual stresses in at least one time period. While the percentage in stress in any given wave is small, the total percentage of individuals that experience stress at some stage is not.

Table 3.6 is a survival table that includes everyone who experienced stress. It allows examination of how individuals are able to escape from residual stress. The shorter the time in stress, the better the outcome for individuals who have fallen into that situation. The second column shows the total number of individuals that experienced at least one wave of residual stress. The first column shows the length of time in that state; '1' represents those that have

had one observation in stress. As there is only one observation a year this represents an individual who is in stress for one year. The '2' means that there are two observations in a row that has the individual as being in stress. The *Out of stress in next period* column shows the number of individuals who are recorded as in non-residual stress in the next observation. The figures show the number of households in the sample who are in stress for one year, but moved out of stress the following year. The *Attrition from sample* column refers to when individuals are censored. In other words, there is no new information about the individual as the data does not extend beyond wave ten. The *Probability of in stress in next period* column represents the probability of surviving beyond that time period, which is based on equation (1). The survivor function is created from equation (2) and hence is the product of *p*. In the first time period the values of *p* and *survivor function* will be equal.

Table 3.6

Total sample in residual stress, survival tables

Beg. Time	Total in stress	Out of stress in next period	Attrition from sample	Probability of in stress in next period	Survivor Function	Std Error	[95%	Conf.Int.]
1	1633	1085	21	0.34	0.34	0.01	0.3128	0.3585
2	527	251	14	0.52	0.18	0.01	0.1575	0.1948
3	262	84	7	0.68	0.12	0.01	0.1039	0.1361
4	171	43	2	0.75	0.09	0.01	0.0757	0.1044
5	126	34	5	0.73	0.07	0.01	0.0535	0.0786
6	87	12	4	0.86	0.06	0.01	0.0452	0.0689
7	71	21	6	0.70	0.04	0.01	0.0303	0.0508
8	44	13	17	0.70	0.03	0.00	0.0199	0.038
9	14	4	10	0.71	0.02	0.00	0.0122	0.0308

Source: As for Table 3.4.

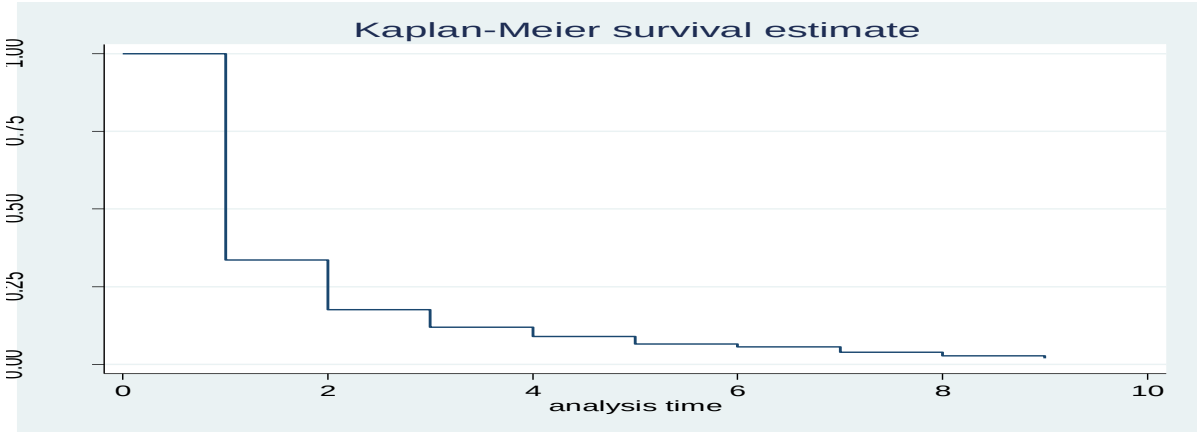
Table 3.6 shows that most individuals escape from residual stress in the first period. There is only a 34 per cent probability of surviving in residual stress beyond the first time period. If a person remains in stress for a second year then there is only a 52 per cent chance of progressing beyond the second year. This refers to the probability of an individual who is in stress for a second year continuing to be in stress after that year. The longer an individual is in stress, the higher is the probability that he or she will not escape stress. This is shown by the *Probability of in stress in next period* value increasing to 68 per cent after the third year. If a person cannot escape residual stress in the first three years, the probability of doing so within the sample period decreases dramatically. This suggests that three years marks a threshold,

beyond which a person enters a condition of chronic housing stress. The *survivor function* shows that 88 per cent of individuals remain in stress for less than three years. For most individuals, residual stress is a state of transition that lasts only for a short period, but for one in ten households, escaping stress takes much longer. By the end of the sample there are few individuals for whom we have data on, indicating that most escape stress eventually. The experience of those in the *Attrition from sample* column is unknown, as the dataset ends before they escaped stress.

Figure 3.1 shows the survival estimates for the total sample. There is a big drop in those remaining in the sample; this then flattens out as the longer one is in stress the more difficult it is to escape.

Figure 3.1

All individual experience of stress, chance of surviving in stress



Source: As for Table 3.4.

Note: Vertical axis is the probability of surviving in stress/ the survival function from equation (2). Analysis time is in years.

Table 3.7 contains information about all of the individuals who experience stress at some time during the sample period. It shows how many times an individual falls into stress during the 10-year time period. Of those that fall into stress, 73 per cent will do so once. Either they escape stress permanently, remain in chronic stress, or the data finishes. Those households for which the data finishes are shown in the *Attrition from sample* column (Table 3.6). The number of individuals in the net loss column is small, fewer than 100. The number that did not escape stress by the end of the period is 14 but is really 44, as the second last wave is the one that should be used, because it is not possible for these individuals to leave stress and re-enter stress in fewer than three waves. The important point to note from Table 3.7 is that 27 per cent

of the sample falls into residual stress more than once in the 10-year period. This is a high figure given that a minimum of three observations within the ten Waves is required for an individual to fall into stress multiple times.

Table 3.7

Number of times representative individual enters stress over ten years

Number of times individual falls into stress	Number of representative individual	Percentage
1	1,191	73
2	355	22
3	78	05
4	9	01
Total	1,633	100
Average number of waves	1.33	

Source: As for Table 3.4.

Note: Percentage does not sum to 100 due to rounding.

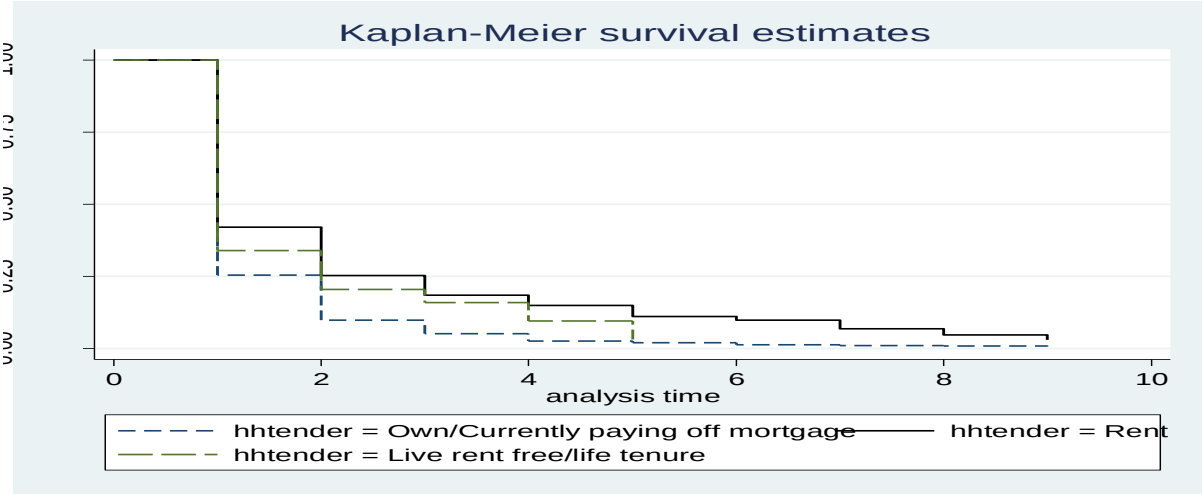
The attrition rate in HILDA is comparable with other panel data sets used internationally. The biggest drop in responses is between the first and second wave. A *t-test* was run to check the impact on the stress measure caused by those dropping out. It tested those who are in the second wave against those who dropped out to see if the stress levels are different. The result is that there is no statistical significant difference in the stress level between the two groups.

There appear to be two types of individuals that should be the focus of future government assistance. This first is those who are not able to escape residual stress in a timely manner. This may reflect uncertainties in their housing, employment or health situations. A further breakdown of the sample is made in an attempt to uncover these effects. The second is the 27 per cent of the sample that falls back into stress on multiple occasions.

The entire sample of those who are in residual stress is separated into sub-groups, to determine whether sub-groups react differently to the experience of residual stress. The two sub-groups that will be examined are housing composition (parent or not) and housing situation (renting or owning).

Figure 3.2

Residual stress by housing situation



Source: As for Table 3.4.

Note: Vertical axis is the probability of surviving in stress. Analysis time is in years.

Appendix A3.2 and Figure 3.2 capture only those who are in residual stress, not all homeowners and renters. The speed with which homeowners are able to escape stress is surprising, given that they not able to move quickly to lower-cost housing due to the transactions costs associated with buying and selling. After three years the survivor function for homeowners is 18 per cent; there is a 12 per cent chance of still being in stress for the entire sample and only 5 per cent for homeowners. The case for substantial government support for homebuyers is therefore not strong, as few of them that get into stress will remain there beyond a couple of years. Those who are renting tend to stay in stress for longer, the reason for this is not known but is an area that further research should be done. There is a 42 per cent chance of a tenant still being in stress after one year, compared to 34 per cent for the general sample. Given the ease with which tenants are able to move house, this suggests a lack of supply of affordable rental properties for low-income earners. There is an 18.5 per cent chance of tenants remaining in stress longer than three years, compared to 12 per cent for the general sample and 5 per cent for homeowners. Renters make up 88.6 per cent of those in the sample who remain in stress after eight years, despite them making up only 47 per cent of those who experience residual stress, however few of those who enter stress are still in stress after eight years.

Table 3.8

Duration of stress by Household type, survival table

Beg. Time	Total in stress	Out of stress in next period	Attrition from sample	Probability of in stress in next period	Survivor Function	Std Error	[95%	Conf.Int.]
SINGLE UNDER 65								
1	572	319	6	0.44	0.44	0.02	0.4013	0.4825
3	147	41	2	0.72	0.20	0.02	0.1632	0.2289
9	10	3	7	0.70	0.03	0.01	0.018	0.0564
COUPLE UNDER 65								
1	288	198	4	0.31	0.31	0.03	0.2598	0.3665
3	30	13	2	0.57	0.07	0.02	0.0433	0.1052
9	1	0	1	1.00	0.02	0.01	0.0095	0.0534
OVER 65								
1	321	243	6	0.24	0.24	0.02	0.1976	0.2911
3	34	9	0	0.74	0.09	0.02	0.0643	0.1311
9	3	1	2	0.67	0.02	0.01	0.0053	0.0493
PARENT								
1	296	223	4	0.25	0.25	0.03	0.1991	0.2969
3	27	11	2	0.59	0.06	0.01	0.0357	0.0913
6	1	1	0	0.00	0.00	.	.	.
SINGLE PARENT								
1	156	102	1	0.35	0.35	0.04	0.2725	0.4208
3	24	10	1	0.58	0.10	0.02	0.0551	0.1485
8	1	0	1	1.00	0.01	0.01	0.001	0.0488

Source: As for Table 3.4.

Identification of the household type that is most vulnerable to stress will influence the appropriate policy response. Do households with children escape stress more slowly than those without children? How do those aged over 65 experience stress? In Tables A3.3 and 3.8 the different household characteristics are included. *SINGLE UNDER 65* escapes stress the slowest; the survivor function is higher than for any other type of household, with 20 per cent still in

residual stress after three years. For *PARENTS* there is little evidence that residual stress lasts longer than a couple of observations, with only a 6 per cent chance of surviving in stress longer than three years and 11 per cent for longer than two years. *SINGLE PARENT* outcomes show a high survival rate in year one but this drops quickly in subsequent observations. To summarise, family composition does predict different durations of stress. *PARENTS* do not remain in residual stress for long. Older non-parents have a higher than average probability of escaping residual stress, but if they are in stress for longer than two years, they will struggle to escape. This may reflect their reduction in earning potential. *SINGLE UNDER 65* remains in stress for longer than other household types.

5.3 Characteristics of those trying to escape stress

The Cox Proportional model does not limit the base case or assume any shape to the data. Thus the results may be compared to the baseline case. The coefficients are in relation to this baseline case hazard ratio; positive coefficients mean that the variables predict a higher hazard ratio compared to the baseline case. The hazard ratio is the rate at which individuals escape their current state, and shows how many events of residual stress a household could expect to occur in the time period.

The baseline case for the model in Tables A3.5 and 3.9, which all the results are compared to, is an individual aged 31-40 who is working, has no university qualification and does not have a long-term health problem. The age variables in the model are not significant, but the employment variable is. Those not working have a hazard ratio that is 21.5 per cent lower than those working. This is an indicator that when household's reference person is unemployed they do not have the capacity to escape residual stress as quickly as others. The other household characteristics are significant in predicting the length of time in stress; all of them are significant and positive in direction, meaning that every type of household escapes at a quicker rate than *SINGLE UNDER 65*. The largest coefficient is for non-parents over 65, who as expected have one of the lowest survival functions in Table A3.5.

Table 3.9

Summary of results from parametric and semi-parametric approaches

Cox	Weibull
	(41 to 50)
	(51+)
	Degree
	(Long term health)
(LFSCP2)	*(LFSCP2)*
	(New South Wales)
COUPLE UNDER 65	*COUPLE UNDER 65*
NON-PARENT OVER 65	*NON-PARENT OVER 65*
PARENTS	*PARENTS*
SINGLE PARENT	*SINGLE PARENT*

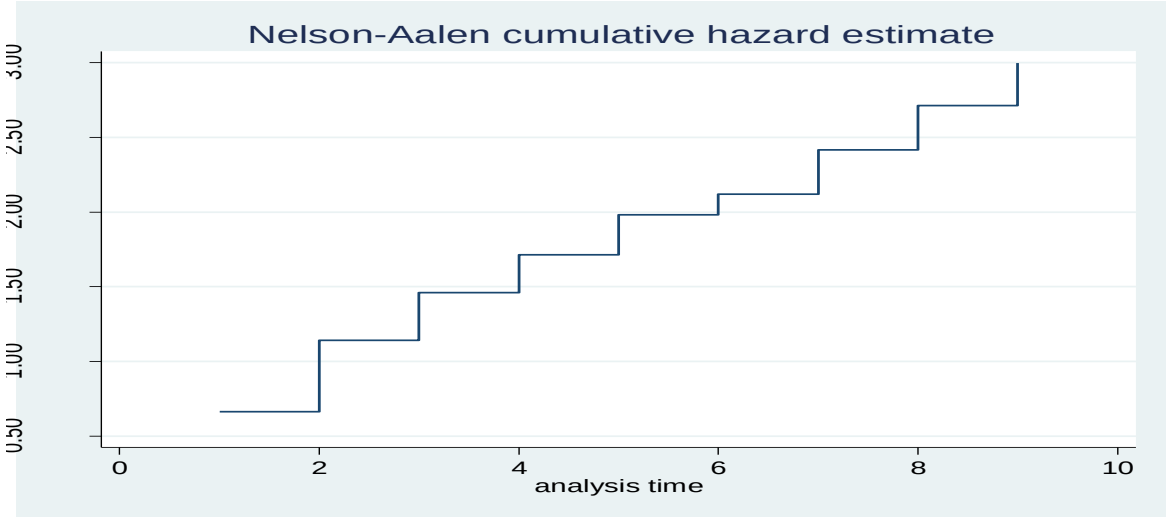
Source: As for Table 3.4.

Note: Negative values are in parentheses.

The Weibull distribution is the parametric model that provides the best fit for the hazard function found in the data. This is shown by the lowest AIC or BIC values in Table A3.4. This distribution also has the most positive log likelihood. The accumulative hazard function before the model is shown in Figure 3.3, which is a positively sloped hazard estimate. Figure 3.4 has the predicted cumulative hazard function that the Weibull predicts. The direction and slope of the two distributions are very similar, making the Weibull distribution a good fit for the shape of the hazard function.

Figure 3.3

Cumulative hazard estimate of the 'event' of leaving stress, using non-parametric techniques

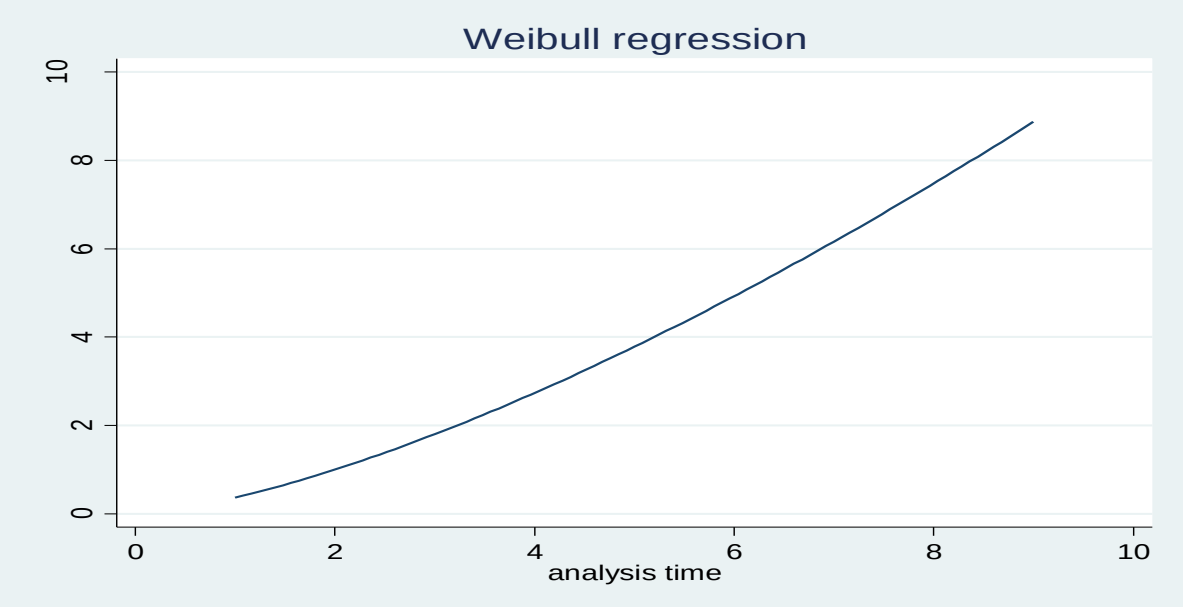


Source: As for Table 3.4.

Note: Vertical axis is the Cumulative Hazard estimate. Analysis time is in years.

Figure 3.4

Cumulative Hazard assumed by the Weibull distribution



Source and *Note*: As for Table 3.3.

The *Weibull* approach has other significant results for age, health, education and *NSW*, which have the same direction and significances as the Cox model. Except for *EDUC1*, these are all negative in direction, predicting longer periods in stress. The older age groups are negative. Thus after household composition is taken into consideration, age and other characteristics should be examined for positive or negative effects. Health problems slow one's ability to escape residual stress. Higher housing costs in New South Wales make it harder to escape stress when compared to other locations.

Both of these models only include those that are in stress and for as long as they remain in stress. Once households leave stress no further information is recorded. Thus the models try to predict when the event of moving out of stress occurs, based on household characteristics. This is different to the next two models, in which all observations are included, but the length of time in stress is not. For the OLS, the probability of being in stress is based on the occurrence of stress, with the total number of times in stress being divided by the number of total observations. The probit model uses a stress variable that records zero or one.

In the Weibull distribution the older age groups had a longer period in stress compared to the younger age group. The results from OLS and probit are both positive, they predict a lower occurrence of stress for older age groupings. Victoria's positive coefficient predicts lower levels of stress but is only weakly significant. *Health, working status* and *origins* are all negative in directions, predicting greater levels of stress as expected. *EDUC1* is positive, predicting much lower levels of stress. All of the household types are positive as expected, except for *SINGLE PARENTS*; these results are compared to singles under 65. The duration in stress is predicted to be shorter for *SINGLE PARENTS* compared to singles but they are more likely to experience more observations of stress, thus highlighting the difference between occurrence and duration.

Table 3.10

Summary of results from robustness checks using non survival approaches

OLS	Xtprobit
41 to 50	*41 to 50*
51+	*51+*
Degree	*Degree*
(Long term health)	*(Long term health)*
(LFSCP2)	*(LFSCP2)*
(Non-Native Australians)	*(Non-Native Australians)*
Victoria	
COUPLE UNDER 65	*COUPLE UNDER 65*
NON-PARENT OVER 65	*NON-PARENT OVER 65*
PARENTS	*PARENTS*
(SINGLE PARENT)	*(SINGLE PARENT)*

Source: As for Table 3.4.

Note: Negative values are in parentheses.

5.4 Life events

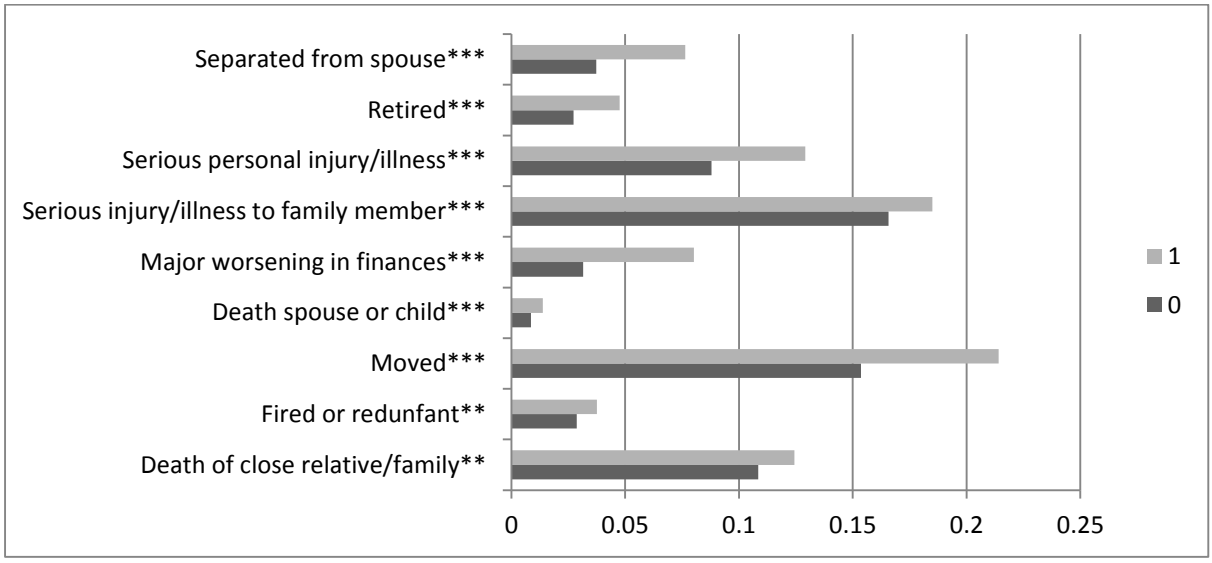
In the previous section, the focus was on the length of time that individuals spend in residual stress. Section 5.4 looks at those individuals who are entering residual stress. The sample is separated into two groups. The first comprises those who were in stress during a given period, but were not in the previous period. The second is the remainder of the sample. The objective is to determine if there is a difference between the two groups due to the occurrence of certain life events, such as relationship breakdown, birth of a child, or moving house.

In Figure 3.5 the two groups were compared to identify possible differences in terms of life events. All of the life events were different between the two groups to at least a 5 per cent level of significance. The first variables of interest are those of *separation* and *retirement*,

which represent changes to family composition or ability to work. A separation represents a disruption to a person's living situation and requires a readjustment to a new living situation. Retirement usually affects individual budget lines due to reduced hours of work. *Personal injury* and *worsening finances* react in the ways expected, with their impact resulting in household moving into residual stress. The standout life event is having *Moved* in the past year, which affects a quarter of households falling into stress in that time. This may reflect the temporary nature of the housing situation of such households, with them having been forced to move.

Figure 3.5

Life events associated with changes in housing status



Source: As for Table 3.5.

Notes: *significant at 10% level **significant at 5% level ***significant at 1% level. 1 is in stress this period and not in previous observation; 0 is the remainder of the sample (i.e not having entered stress in the past year).

6 Policy implications

The results have long-term policy implications. The focus of the analysis is on the duration that a household spends in residual stress. This looks beyond the issue of who is in stress, to consider how long the individuals concerned remain in that state. Over a 10-year time period, 32 per cent of the sample experienced stress, but few remained in stress for more than three years. For most the duration of stress is short, which is not to say that this presents no problem for these household. Rather, it suggests that the policy focus should be on those in

chronic housing stress, with lower levels of human capital, higher rates of unemployment and greater incidence of long-term renting. Renters make up the sub-sample for which the duration of stress is the longest. There is a 15 per cent chance of renters remaining in stress beyond three years, compared to 5 per cent for homeowners. The life event that occurs most often when an individual enters residual stress is that they have moved house in the previous year. This finding here highlights the importance of a robust economy that creates jobs and provides effective health care. Both of these issues are key predictors for falling into housing affordability stress or remaining in that in that state. The lower the level of unemployment, the less likely it is that an individual will be in housing affordability stress. Households reference persons with long-term health problems are more likely to fall into stress, which signals that they require a greater level of support than is currently given. The analysis should remind policy makers that housing and other factors in the economy do not operate in isolation. Housing affordability is closely related to the availability of jobs, education and healthcare, improvements in which will not be confined to those markets but flow into the housing market.

The household type that is most likely to fall into stress and remain there is singles under 65. This suggests that a change in the type of housing that is available is required. The percentage of sole person households is growing, with individuals marrying later, hence remaining single longer. An increasing proportion of the population is elderly and may live alone. The type of housing required is changing and while there is a lack of appropriate housing for these household types more households will continue to be in and remain in residual stress.

There are broad forms of housing interventions that could be considered in responding to the problem revealed by the data. Some of the assistance that could be considered is:

1. A housing payment or allowance to households to reduce their housing cost to a more affordable level such as expended but target rent assistance schemes (Melhuish, King, Taylor, 2002)
2. Give assistance to other agencies, investors, builders and developers, to provide affordable and adequate rental housing. This can be achieved through low interest loans, taxation provision, grant or planning controls e.g. inclusionary Zoning (Hulse, Reynolds & Yates 2014; Milligan, Phibbs, Fagan, & Gurran, 2004 ; Beer & Faulkner 2009; Dalton, Hurley, Gharaie, Wakefield & Horne 2013)

3. Government to provide funds directly to not-for-profit housing, thus increasing affordable housing such as public or community housing (Hulse, Reynolds and Yates 2014; Beer et al 2009
4. Regulate the market to enable that affordability is maintained through tenancy (Hulse, Reynolds & Yates 2014; Milligan et al, 2004)

This is a non-exhaustive list of the options that are available for policy makers, however the data is too broad to suggest which is the most applicable but within each option there is a diversity rang of methods of implementation. This research adds to the understanding of the problem and the type of individuals that require help. This is important as very different policy requirements are required depending on the individual. The housing affordability stress issues goes beyond just housing and is also related to employment, health, and age.

7Conclusion

The duration of household experience of residual stress has been analysed in this essay. This is not possible when using cross-sectional surveys, which provide information on households for only one time period. There are ten waves of information for the households within this survey, which enables households to be tracked over time. This raises the question of whether households with particular characteristics are likely to remain in stress for that particular time period only, or whether they are in need of long term support. In most cases, households that are in stress will escape it in a short period of time – generally within a year – and do not need assistance over longer periods. However, those that do remain in stress are likely to need support to be able to escape.

Using the residual approach reduces the likelihood that an individual with a high income could be considered to be in stress. This misleading outcome might be the case using the ratio approach, as in previous studies that do not consider residual income or the place of households in the income distribution. Thus the result here includes those individuals who do not have the ability to purchase a basic level of necessities after housing costs have been considered.

The sample was separated into sub-groups to give a better understanding of the situation. Renters are likely to remain in stress for a longer period of time than homeowners. *SINGLE UNDER 65* takes longer to escape stress than other household types. The health, education and employment status of an individual plays an important role in predicting if the household will fall into and remain in stress. These are the key characteristics that can affect the length of time

that individuals experience stress. The essay has applied the residual housing affordability approach to a panel data set to examine the experience of different household in residual and non-residual stress over time. The life events that occur when households fall into stress have also been identified, highlighting the importance of housing stability. The results show that the issue of housing affordability is multi-dimensional extending to issues of education, employment, health, age, housing situation and type.

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9 Appendices

Table A3.1

Stress by Age over time

Percentage in stress	Year of Wave									
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
>31										
%	5.8	14.2	14.6	14.1	12.6	11.5	10.3	9.2	7.8	7
Number in stress	36	94	103	97	85	74	61	51	41	35
Total	620	663	706	689	677	642	595	553	529	500
31-40										
%	3.2	8.4	8.4	6.9	5.7	7.2	7.2	7.3	4.6	7.9
Number in stress	31	81	79	64	51	65	66	67	40	66
Total	965	969	943	928	897	901	923	914	868	831
41-50										
%	4.5	7.9	7.1	8.8	7.4	6.6	7.7	7.4	5.5	5.1
Number in stress	43	79	76	98	85	75	87	83	62	57
Total	961	1004	1074	1118	1147	1142	1136	1126	1135	1111
51+										
%	7.6	11.7	11.3	11.7	10.5	10.7	10.6	11.2	11.7	8.2
Number in stress	122	198	202	223	213	231	240	270	296	222
Total	1603	1691	1784	1902	2029	2150	2273	2404	2537	2696
Average										
%	5.6	10.4	10.2	10.4	9.1	9.2	9.2	9.4	8.7	7.4
Number in stress	232	452	460	482	434	445	454	471	439	380
Total	4149	4327	4507	4637	4750	4835	4927	4997	5069	5138

Source: As for Table 3.4.

Table A3.2

Duration of stress by Housing Situation

Beg. Time	Total in stress	Out of stress in next period	Attrition from sample	Probability of in stress in next period	Survivor Function	Std Error	[95%	Conf.Int.]
Homeowner								
1	814	607	17	0.25	0.2543	0.0153	0.2249	0.2846
2	190	117	6	0.38	0.0977	0.0107	0.078	0.12
3	67	32	4	0.52	0.051	0.0082	0.0366	0.0688
4	31	15	0	0.52	0.0263	0.0062	0.0161	0.0407
5	16	4	1	0.75	0.0198	0.0055	0.011	0.0328
6	11	4	1	0.64	0.0126	0.0045	0.0059	0.0241
7	6	1	0	0.83	0.0105	0.0042	0.0044	0.0216
8	5	1	1	0.80	0.0084	0.0039	0.0031	0.0191
9	3	0	3	1.00	0.0084	0.0039	0.0031	0.0191
Renter								
1	772	447	3	0.42	0.421	0.0178	0.386	0.4555
2	322	128	8	0.60	0.2536	0.0157	0.2234	0.2849
3	186	50	1	0.73	0.1855	0.0141	0.1586	0.2139
4	135	26	2	0.81	0.1497	0.013	0.1253	0.1763
5	107	28	3	0.74	0.1106	0.0115	0.0892	0.1344
6	76	8	3	0.89	0.0989	0.011	0.0787	0.1219
7	65	20	6	0.69	0.0685	0.0095	0.0514	0.0887
8	39	12	16	0.69	0.0474	0.0083	0.033	0.0656
9	11	4	7	0.64	0.0302	0.0087	0.0164	0.0508

Source: As for Table 3.4.

Table A3.3

Duration of stress by Household type

Beg. Time	Total in stress	Out of stress in next period	Attrition from sample	Probability of in stress in next period	Survivor Function	Std Error	[95%	Conf.Int.]
SINGLE UNDER 65								
1	572	319	6	0.44	0.44	0.02	0.4013	0.4825
2	247	96	4	0.61	0.27	0.02	0.2344	0.3075
3	147	41	2	0.72	0.20	0.02	0.1632	0.2289
4	104	22	1	0.79	0.15	0.02	0.1251	0.1852
5	81	19	2	0.77	0.12	0.01	0.0923	0.1464
6	60	5	3	0.92	0.11	0.01	0.0835	0.1357
7	52	18	3	0.65	0.07	0.01	0.0506	0.0947
8	31	10	11	0.68	0.05	0.01	0.0313	0.0693
9	10	3	7	0.70	0.03	0.01	0.018	0.0564
COUPLE UNDER 65								
1	288	198	4	0.31	0.31	0.03	0.2598	0.3665
2	86	52	4	0.40	0.12	0.02	0.0882	0.1652
3	30	13	2	0.57	0.07	0.02	0.0433	0.1052
4	15	3	0	0.80	0.06	0.01	0.0321	0.0893
5	12	2	1	0.83	0.05	0.01	0.025	0.0784
6	9	3	0	0.67	0.03	0.01	0.0138	0.0602
7	6	0	1	1.00	0.03	0.01	0.0138	0.0602
8	5	1	3	0.80	0.02	0.01	0.0095	0.0534
9	1	0	1	1.00	0.02	0.01	0.0095	0.0534
Over 65								
1	321	243	6	0.24	0.24	0.02	0.1976	0.2911
2	72	34	4	0.53	0.13	0.02	0.0938	0.1683
3	34	9	0	0.74	0.09	0.02	0.0643	0.1311
4	25	5	0	0.80	0.08	0.02	0.0487	0.1098
5	20	6	1	0.70	0.05	0.01	0.0307	0.0834
6	13	0	1	1.00	0.05	0.01	0.0307	0.0834
7	12	3	2	0.75	0.04	0.01	0.0206	0.0682

8	7	2	2	0.71	0.03	0.01	0.0122	0.0559
9	3	1	2	0.67	0.02	0.01	0.0053	0.0493
PARENT								
1	296	223	4	0.25	0.25	0.03	0.1991	0.2969
2	69	41	1	0.41	0.10	0.02	0.0687	0.1382
3	27	11	2	0.59	0.06	0.01	0.0357	0.0913
4	14	8	0	0.43	0.03	0.01	0.0109	0.0507
5	6	5	0	0.17	0.00	0.00	0.0004	0.0218
6	1	1	0	0.00	0.00	.	.	.
SINGLE PARENT								
1	156	102	1	0.35	0.35	0.04	0.2725	0.4208
2	53	28	1	0.47	0.16	0.03	0.11	0.2258
3	24	10	1	0.58	0.10	0.02	0.0551	0.1485
4	13	5	1	0.62	0.06	0.02	0.0281	0.105
5	7	2	1	0.71	0.04	0.02	0.0168	0.0852
6	4	3	0	0.25	0.01	0.01	0.001	0.0488
8	1	0	1	1.00	0.01	0.01	0.001	0.0488

Source: As for Table 3.4.

Table A3.4

Assessments of best fit by Model distribution.

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
model_exp	1633	-2058.9	-1993.76	12	4011.524	4076.303
model_web	1633	-1957.56	-1819.25	13	3664.499	3734.676
model_gom	1633	-2058.9	-1985.9	13	3997.808	4067.984

Source: As for Table 3.4.

Table A3.5

Survival model by semi-parametric and parametric distributions

Variables	Cox	Weibull
41 to 50	-0.0846	-0.153**
	(0.08)	(0.08)
51+	-0.118	-0.276***
	(0.08)	(0.08)
Degree	0.0714	0.167**
	(0.08)	(0.08)
Long term health	-0.0851	-0.152**
	(0.06)	(0.06)
LFSCP2	-0.215***	-0.453***
	(0.06)	(0.06)
Non-native Australians	0.0256	0.0517
	(0.06)	(0.06)
NSW	-0.0485	-0.144**
	(0.06)	(0.06)
Victoria	-0.0281	-0.0688
	(0.06)	(0.07)
COUPLE UNDER 65	0.260***	0.569***
	(0.08)	(0.08)
NON-PARENT OVER 65	0.406***	0.805***
	(0.09)	(0.09)
PARENTS	0.264***	0.595***
	(0.08)	(0.08)
SINGLE PARENTS	0.215**	0.463***
	(0.10)	(0.10)
Constant		-0.922***
		(0.07)
ln_p		
Constant		0.372***
		(0.02)
N	1633	1633
log likelihood	-10627.4	-1819.25

Source: As for Table 3.4.

Notes: Standard errors in parentheses. ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively. Significant results in italics.

Table A3.6

Robustness checks.

Variables	OLS	OLS	Xtprobit	Xtprobit
41 to 50	0.0203***	0.0201***	0.196***	0.193***
	(0.00)	(0.00)	(0.04)	(0.04)
51+	0.0250***	0.0247***	0.222***	0.225***
	(0.00)	(0.00)	(0.05)	(0.05)
Degree	0.0274***	0.0273***	0.465***	0.463***
	(0.00)	(0.00)	(0.05)	(0.05)
Long term health	-0.0502***	-0.0504***	-0.162***	-0.162***
	(0.00)	(0.00)	(0.03)	(0.03)
LFSCP2	-0.0862***	-0.0860***	-0.674***	-0.667***
	(0.00)	(0.00)	(0.03)	(0.03)
Non-native Australians	-0.0140***	-0.0139***	-0.130***	-0.129***
	(0.00)	(0.00)	(0.05)	(0.05)
NSW	0.00254	0.00262	0.0540	0.0537
	(0.00)	(0.00)	(0.04)	(0.04)
Victoria	0.00327*	0.00332*	0.0715	0.0716
	(0.00)	(0.00)	(0.05)	(0.05)
COUPLE UNDER 65	0.0461***	0.0461***	0.186***	0.187***
	(0.00)	(0.00)	(0.04)	(0.04)
NON-PARENT OVER 65	0.0562***	0.0559***	0.182***	0.181***
	(0.00)	(0.00)	(0.05)	(0.05)
PARENTS	0.0516***	0.0515***	0.271***	0.271***
	(0.00)	(0.00)	(0.04)	(0.04)
SINGLE PARENTS	-0.0153***	-0.0153***	-0.448***	-0.441***
	(0.00)	(0.00)	(0.06)	(0.06)
Constant	0.909***	0.905***	2.298***	1.936***
	(0.00)	(0.00)	(0.06)	(0.05)
With time intercepts	yes	no	yes	no
N	47336	47336	47336	47336
r2	0.109	0.109		
Log Likelihood			-11183.1	-11250.8

Source: As for Table 3.4.

Notes: Standard errors in parentheses. ***, *** and * denote statistical significance at the 1%, 5% and 10% levels respectively. Significant results in italics.

Conclusion

In this thesis, the issue of housing affordability is examined through the application of the residual approach to different models. The key contribution is the development of four new models that extend previous research on housing affordability. The first essay develops *Residual expenditure* and *Depth of housing stress* models. The *Residual Expenditure* model provides understanding of the characteristics that predict different levels of residual stress and builds on the work of Stone et al. (2011). The *Depth of housing stress* model captures the size of the group that is in stress, and does so more effectively than the traditional simple head count. This model builds on previous work that incorporates a poverty perspective to the housing measure (Chaplin et al., 1999). The *Residual expenditure with transport costs* model developed in the second essay builds on these by incorporating locational factors, through the inclusion of distance and transport costs in the model as suggested by Burke et al. (2014) and Mattingly et al. (2013). In the third essay, a *Living in stress* model was developed to examine the length of time a household could expect to remain in stress, extending the work of Wood et al. (2009).

The direction of the variables in the *Residual Expenditure* model show that lifecycle is an important factor in housing affordability stress, especially for households of older ages, which appear to be in a better situation than other age groups. *EDUC1* has a positive impact for most of the surveys; university education holds its value across most years of interest. *Employment status, Percentage from government* and *Level of previous financial year's disposable income* all behave in ways that would be expected of them, which help show that the outputs from the ordered probit models are logical. Housing in South Australia and Tasmania has remained affordable and is associated with higher residual income. This may be due to housing costs being restricted by lower population growth and generally smaller populations. The results regarding household origins and locations warrant further research to gain a clear picture of the situation for better policy design.

EDUC2 does not hold its significance in the sub-samples, but this does not imply that post-school, non-university education is not of any value. The model measures the relationship between education and residual income, but education can play other roles. A relationship between university education and higher levels of residual income remains. A closer examination of education and its links to different levels of residual income is needed, given society's level of investment in education.

The *Depth of housing stress* model was used to measure and compare the housing affordability situation for different household types. It was expanded to look at different housing situations, from home owners and different renting types. The model highlights that sole person households have the greatest depth of housing stress. Public housing is captured in this measure, and the results show that future formulae for setting rents could be adjusted effectively. There is stress among homeowners in the short run when compared to renters. The results show that the situation for public housing tenants and homeowners is not as favourable as expected, suggesting that policies could be directed at these housing situations.

The *Residual expenditure with transport costs* model is applied to capital cities in Victoria and New South Wales. The impact of distance on the predicted level of residual income differed in each State. In Melbourne, distance had a weak positive effect, predicting a better residual income level at the metropolitan periphery in relation to that of the inner city. The reverse was the case for Sydney, with the inner ring of suburbs having higher levels of residual income than the second and third rings. The major driver of these differences is variations in the built environment, which have evolved historically. The predictive power of distance improves over the time period of the survey, with more recent Waves having more significance. The results from the model appear to be driven by the differences in growth levels in Melbourne and Sydney, and between inner city transport usages compared to the rest of the city. The built environment is highly sensitive to initial conditions, which persist in a path-dependent way. The continuing influence of the built environment on housing affordability demonstrates how resistant the former is to change.

The *Living in stress* model finds that in most cases, households that are in stress will escape it in a short period of time – generally within a year – and do not need assistance for longer periods. However, those that do remain in stress are likely to need support to be able to escape from it. The sample was separated into sub-groups to give a better understanding of the situation. Renters are more likely to remain in stress for a longer period of time. Singles under 65 take longer to escape stress. The health, education and employment status of an individual plays an important role in predicting if the household is going to fall into and remain in stress. The results show that the issue of housing affordability is multi-dimensional, which extends to issues of education, employment, health, age, housing situation and type.

This thesis has a core thread running through it. What is housing affordability, who does it effect, where are these households and for how long would they experience housing

stress for? There is extensive discussion in Essay One about the different measures of housing affordability. The residual approach was selected as the measure that would reveal the most accurate picture of the situation. It is especially useful in that it focusses on low-income earners. The models in Essay One, *Depth of housing stress* and *Residual expenditure*, both aim to identify the household characteristics that predict residual stress and have a greater depth of housing stress. Essay Two incorporates a transport and location perspective in the measure, to understand the location of those in stress. The inclusion of the built environment of Australia's two largest cities provides a context to locational variables within the model. Essay Three tests a model of the length of time that households remain in stress. The results show that particular characteristics and types of households are disproportionately subject to long periods of affordability stress. In addressing the research questions posed, the thesis offers comprehensive coverage of the situation through the application of the residual approach.