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*Housing affordability and mental health:  
Do definitions matter?*

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## **Abstract**

Housing affordability is an increasingly discussed political and economic issue. Recent research finds a negative relationship between housing affordability and mental health. Much of the prior research uses a ratio measurement for housing affordability. Using alternative measures of housing affordability, I re-examine the relationship between housing affordability and mental health. A fixed effects approach using a residual income measure of housing affordability does not find a significant relationship between housing affordability and mental health. Interestingly, the results are significant for females, when the regressions are run separately for males and females, but not for males. A large and significant relationship with mental health is found from questions on household's ability to pay either housing costs or household bills. The results suggest that conventional measures of housing affordability may not identify a large portion of the population who have troubles paying for either housing costs or major bills and therefore underestimate the prevalence of mental health issues related to housing affordability.

This paper 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 Australian Government Department of Social Services (DSS) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the author and should not be attributed to either DSS or the Melbourne Institute.

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# 1. Introduction

Housing has long been recognised as a social and economic determinant of health (Krieger & Higgins 2002). As housing is a major component of every individual's life, it affects health in a variety of ways. Some of the mechanisms through which this occur involve poor housing quality leading to poor physical health outcomes (Pevalin et al. 2006). Another is the impact that housing expenditure can have on the financial position and decisions of household, since for many households, housing costs are a significant source of spending for most of their lives (ABS 2017a).

In many developed countries, and particularly Australia, housing affordability is becoming a more pronounced issue. Trends in home ownership in Australia have been declining in recent times with an opposing rise in those renting in the private rental market (ABS 2017a). The precise causes of this change are frequently debated, yet a consistent issue emerges; housing affordability. This trend is not unique to Australia, with most developed countries, and major cities seeing worsening housing affordability according to a variety of metrics (Demographia 2017). This leads to both economic concerns from more financial resources devoted to housing, along with health concerns from the increasing cost of housing (Bentley et al. 2016).

Recent research has focussed on the relationship between housing affordability and mental health finding a negative relationship between housing affordability and mental health (Mason et al. 2013). Prior studies have generally found a more pronounced effect in low-income households as they have a limited ability to absorb difficult financial situations for prolonged periods of time (Bentley et al. 2011). In this paper, I seek to contribute to the research on housing affordability and mental health through a re-examination of housing affordability measurement, and how this may then impact the relationship with mental health.

I build on the literature through a critical quantitative approach to the definition of housing affordability. Much of the prior research on the relationship between housing affordability and mental health has focussed on a simple ratio measurement of housing affordability, which treats all types of households with the same ratio constraint to household budgets. I re-examine the data using alternative measures, including the residual income method, which tailor's budgets for specific household types. Few studies have examined the residual income method, leaving a significant gap in the housing affordability literature on analysing this measure.

Using different measures of housing affordability, I re-examine the data to see how this may influence the results. The aim of the paper is to address a gap in the literature on housing affordability and mental health by comparing how the definition of housing affordability affects the results.

This paper is structured as follows. First, I present a literature review of housing affordability, particularly focussed on Australia. This includes discussion of the major measures of housing affordability. I then discuss the literature on housing affordability and mental health, along with other findings from housing affordability studies. Following the literature review, I present the research questions of the paper. I then present the data sources used in the paper to address these questions. Following the data section, I explain the empirical method to analyse the relationship between housing affordability and mental health. I then present the results, followed by a discussion and conclusion.

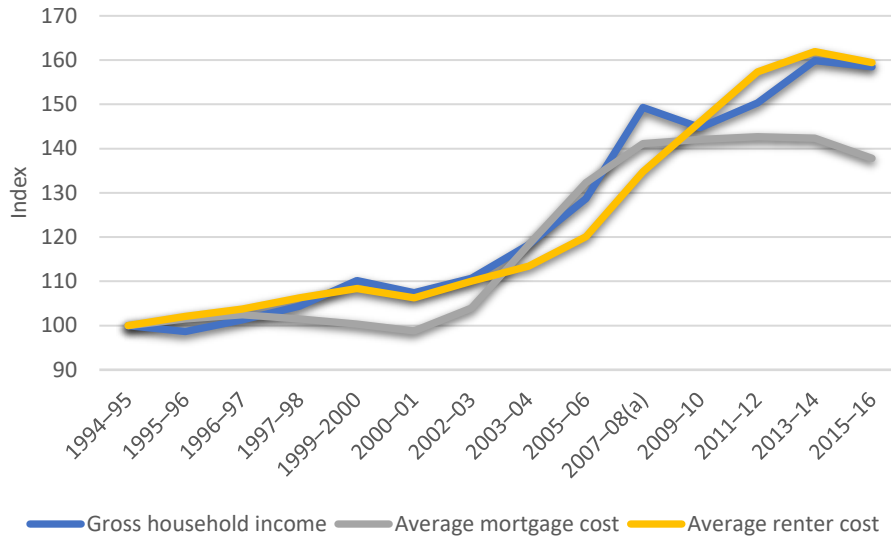
## **1.1 Literature Review**

### **1.1.2 Housing Affordability in Australia**

Housing affordability refers to a household's capacity to pay for the cost of housing while also being able to meet other regular costs such as food, clothing and transport costs. (Stone et al. 2011). This is a broader term than affordable or unaffordable housing, which refer to distinct positions of households based on analysis of the costs of housing and income (ibid). Affordable and unaffordable housing are commonly measured by analysing income and housing costs. I discuss the commonly used measures below.

Over the last twenty years, Australia has seen rising incomes, along with rising housing costs. Figure 1 shows this trend, where average gross household income has risen slightly more than average mortgage costs or average rental costs. However, gross household income tends to be more skewed than housing costs. Figure 1 also shows that in recent years, renter costs have risen significantly faster than mortgage costs.

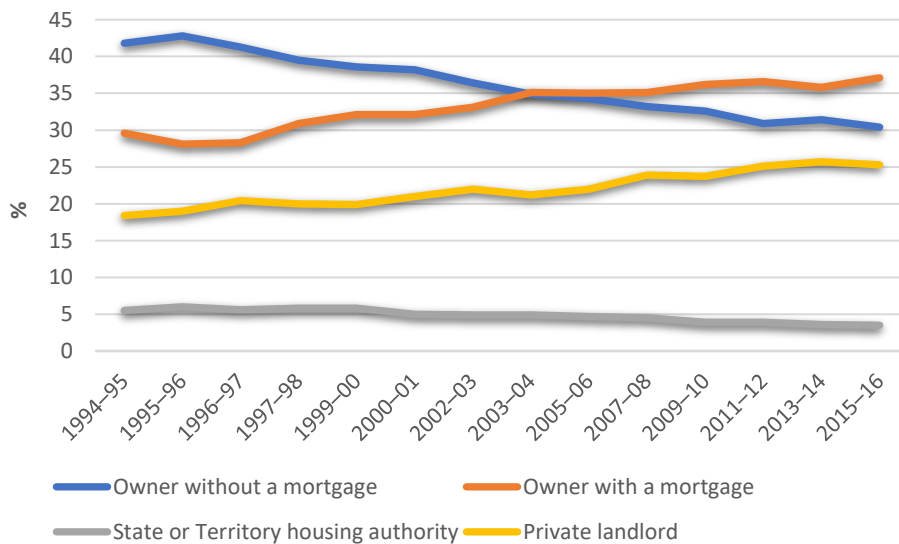
**Figure 1: Income and housing costs price changes in Australia since 1994-95**



94-95 set as base year. Prices in real terms as at 2015-16. Source; ABS 2017a, ABS 2017b.

During this same period, there has also been a change in household composition and tenure type. Figure 2 highlights the steady rise in the proportion of renters and owners with a mortgage, while owners without a mortgage are continuing to decrease.

**Figure 2: Tenure Type of Housing in Australia, 1994-95 to 2016-16**



Source: ABS 2017b. Prices in real terms as at 2015-16.

While figure 1 suggests a similar trend in the growth rates of income and housing costs, it misses a few issues. The first is that mean income is distributed far differently to housing costs, with the very high end of the income distribution inflating mean incomes. Appendix 1 shows that median disposable incomes in Australia are substantially lower than mean disposables incomes in Australia. Second, figure 2 highlights the tenure trends occurring. The combination of more renters and a lack of supply in the low-income private renter market has left lower income households with more affordability problems (Ong et al. 2017). Additionally, demographic changes have led to more households with only one income earner (ABS 2015).

Within the literature and policy on housing affordability, there is no single accepted measure, with alternative measurements which reflect different views of affordability (Tang 2012). This is for a variety of reasons; One, housing markets and policies towards housing differ substantially between countries. The second reason is that it is rather subjective. What one-person views as unaffordable another may see as reasonable. Third, there are a variety of ways to analyse the topic. Some affordability measures are calculated as comparisons between what households pay and earn. Other measures focus on purchase affordability, looking at relationships between house prices and incomes, or mortgage deposit requirements and income. The focus of this paper is on measurements related to what households are spending on housing compared to their income, as I examine the impact of living in affordable compared to unaffordable housing. In this domain of housing affordability, there are a few measurement approaches which I now discuss.

### 1.1.3 The ratio approach

The ratio approach refers to a ratio of housing costs to income. The dominant ratio measurement is the 30% rule, which defines unaffordable housing as housing costs exceeding 30% of household income (AIHW 2017). This is mostly calculated using gross income, however, sometimes is calculated using disposable income (Stone et al. 2011). The calculation is simple, and directly comparable between countries, given it is on a gross income basis. However, as tax rates and social support vary between countries, it is not necessarily an appropriate comparison between countries.

An alteration to the 30% measurement is the 30/40 rule. This refers to those households spending more than 30% of gross income on housing and in the bottom 40% of the income distribution. Generally, the bottom 40% is calculated using equivalised household income to adjust for household composition and size. The measure is also mostly calculated using gross income,



however, households are sorted into income groups using equivalised household disposable income. The 30/40 rule is often used in research and policy due to the evidence that housing affordability issues tend to affect lower income households more significantly (Bentley et al. 2011).

There are a few issues associated with a ratio approach. The first is the use of 30% as the appropriate threshold. While studies have found it to be an appropriate indicator, this has been built on moderate historical evidence with no change in recent times (Stone 2006). This is backed up by Rowley and Ong (2012) who find no statistically significant relationship between the 30/40 measure of housing affordability, and a household paying rent or mortgage on time.

Another issue is that all households budget restraints are treated in the same manner. A single person household with the same income as a single parent household has the same affordability constraint. At the same time, it also implies that lower income households have lower requirements once housing costs are considered (Stone 2006).

There is also inconsistency in the use of gross or disposable income (Stone et al. 2011). Generally gross income is used, however, there is no real justification for this, apart from the data issues often limiting calculation of disposable income. It is disposable income that faces pressure from housing costs and necessary non-housing consumption, not gross income (Stone 2006).

The Australian Bureau of Statistics highlight some additional measurement issues with the ratio approach, as rental subsidies are added to income rather than deducted from the cost of housing (ABS 2015). In this regard, the ratio measurement treats a gain in income as different to a reduction in the cost of housing, given gains in income are added to the denominator, while reductions in housing costs are taken out of the numerator. Rental subsidies form a significant portion of housing affordability policy for private renters in Australia, as relative to other developed countries, there is a lower portion of social and public housing (AIHW 2017). This means a rental subsidy is treated differently than a deduction in rent.

#### 1.1.4 The residual income method

More recently, the residual income method has been developed as an alternative to the ratio method. This method defines a minimum budget for different household types, after the cost of housing is accounted for. If after housing costs, a household's remaining income is below the

defined budget, then the household is in unaffordable housing. This has generally been examined in two ways; through a poverty-line, or a budget standard (Stone 2006). The key rationale behind this method is that a household would not spend on housing at an amount that would place them below the required amount they need for essential consumption (Borrowman et al. 2017).

To estimate the residual income method, a budget or standard is required for different households. In Australia, extensive budget standards were developed in 1998 (Saunders et al. 1998). The standards were developed to reflect what a household needs in dollar terms for a certain standard of living (ibid). While budget standards are developed for analysing the sufficiency of welfare payments and minimum wages (Saunders & Bedford 2017), they have also proven useful in analysing housing affordability. In 1998, the authors developed two budget standards; low cost, and Modest-but-Adequate (MBA). To use these budget standards, studies have inflated (or deflated) the estimates forward to current times for use.

In late 2017, updates to the budget standards were released. The new budget standards were developed using large retail outlets that have a large concentration across most markets in Australia, meaning the budgets have been designed to best reflect an average across Australia (Saunders & Bedford 2017). Like the older standards, two budget standards were developed; one for unemployed families, and one for low-income families. In these standards, five family types were covered; lone person, couples, couples with one child, couples with two children, and single parents with one child (ibid). In the 2017 standards, the budgets assume the first child is a 6-year-old girl, and the second child a 10 year old boy (ibid). Adults are assumed to be between 35-40.

The 2017 standards have been updated using a more comprehensive qualitative and quantitative approach than before (Saunders & Bedford 2017). Through the literature review, I could find no study that had used these measures on housing affordability, which is not surprising given they have only been released in late 2017.

Stone et al. (2011) examined the residual income method using the 1998 budget standards. The standards were produced to reflect that non-housing costs for smaller households are on average less than large households, both in aggregate and percentage. Thus, larger households can likely afford to spend less on housing than smaller households.

Yates and Gabriel (2011) compared residual method using the low cost standard and the 30/40 measure finding that 44% of all lower income (bottom 40% of equivalised income) households were in unaffordable housing according to the residual income measure compared to 28% using the 30/40 rule. This indicates, that overall for low income households, the 30% threshold may underestimate the prevalence of those in unaffordable housing.

Also using the residual income method on Australian households, Borrowman et al. (2016) find that for most types of households, housing affordability issues tend to be temporary and last less than one year. Of the sample, approximately one third fell into unaffordable housing at some point during a ten-year sample (ibid). And of those, approximately one quarter had this occur for more than one time. This suggests that while short-term affordability problems are far more common, long term issues still occur.

#### 1.1.5 Issues with housing affordability measurement

When determining which housing affordability measure is appropriate, there is an issue of ‘conceptual rigour vs practical policy implications’ (Stone et al 2011 p:2.). The ratio measure is far simpler to calculate, and easier to base policy around. For example, calculations for rental assistance payments are simpler if based on ratio measurements than budget standards specific to many different household types. The residual income method requires far more data, and for setting housing policy, would also involve changes as households change in size or composition. The budget standards are designed for specific family types, including ages, so at times must be generalised if applying to large data sets.

There are additional issues related to housing affordability measurement that affect most measurements of housing affordability. One issue with regards to tenure is whether the principal payment in mortgages is a cost of housing, or an investment (ABS 2015). As a majority of owner-occupier mortgages in Australia involve principal payments (ibid), this can make a comparison to renting slightly misleading, as a portion of the mortgage payment is an equity investment in the property. Statistics from 2015 show that the average mortgage payment in 2011-12 was comprised of 80% interest and 20% principal (ibid).

Another issue is the definition of housing cost. While a mortgage or rent is likely to make up most of total housing costs, other items, such as bills, and housing insurance can also contribute

significantly to the cost of housing (Henman & Jones 2012). Transport costs can significantly add to household budgets and may be missed by measures of housing affordability. If households move further away from city or job areas, at the expense of higher transport costs, this would not show up in measures of housing affordability. Recent research found a negative relationship between housing affordability and transport costs in Melbourne, showing that as households reduced their cost of housing, this may have been offset by higher transport costs (Saberri et al. 2017). All these issues combined highlight the challenge in producing a single measure that reflects housing affordability for all household types.

## **1.2 Housing affordability and Mental Health**

There is growing evidence of the relationship between housing and health. This can be both physical health (Meltzer & Schwartz 2015) and mental health (Bentley et al. 2011). Housing, and in particular, housing affordability is significant regarding mental health for two main reasons. One is that we spend so much time in our house, meaning it is a crucial feature of life (ibid). Two, for many households, it is the largest expenditure item and generally paid for before many other expenses are considered (ABS 2017a).

Recent research in Australia has found a negative association between housing affordability and mental health (Bentley et al. 2011). The authors find a small decrease in self-reported mental health of low to moderate income households when they change from affordable to unaffordable housing. However, while the individual effects are small, the results suggest the impact is on a substantial portion of the population (ibid), given the prevalence of households in unaffordable housing.

Probing further into the relationship, Bentley et al. (2016a) compare housing affordability and mental health in Australia and the United Kingdom, focussing on tenure. Using a fixed effects approach, and an interaction term between housing affordability and tenure type, they find a negative relationship between housing affordability and mental health only found for private renters (ibid). However, other evidence from Australia has highlighted that this effect may be driven from other characteristics of the households which differ between renters and owners (Baker et al. 2013).

There may be a variety of reasons why tenure may impact the relationship between housing affordability and mental health. Security of home ownership may reduce the impact of any

financial difficulties that are occurring (Baker et al. 2013). Second, home ownership in Australia, and in the major cities, has been extremely profitable since the start of the century, with significant increases in house prices. A second, and less obvious point is that renting and mortgage payments may not be a like for like comparison. Unless a mortgagee enters into an interest only contract, some part of the mortgage payment is principal, and is an investment in the house. This has been raised by the Australian Bureau of Statistics (ABS 2015), however, it is not addressed in any of the literature discussed in this paper.

Using New Zealand data, Pierse et al. (2016) find large effects between household crowding and housing affordability and psychological distress when using cross-sectional models. However, using fixed-effects models, the authors find that the results mostly disappear.

A key challenge in all the studies is the identification of any casual mechanism. Bentley et al. (2016b) find that those in less secure employment face some negative effect of unaffordable housing, while those in secure employment do not. Their results suggest that the impacts of housing affordability on mental health may be more severe for those who are in insecurely employed households (ibid). This is an interesting dynamic that was previously not controlled for in many prior analysis and is estimated by the authors through an interaction term between housing affordability and employment security.

Bentley et al. (2011) analyse a different perspective, looking at the effect of cumulative exposure to housing affordability. Most of the effect is found in the first year of housing affordability, with little evidence found of a cumulative effect (ibid).

Household wealth has also been found to be related to overall well-being. Using wealth data, Brown & Gray (2016) find that net wealth is positively related with life satisfaction. The authors note this issue is particularly relevant in Australia, given the high level of household debt in Australia compared to most other countries. Windsor et al. (2013) find a link between house prices and household spending. The authors suggest this is through expanded credit constraints due to increasing house prices leading to households with a mortgage being able to borrow more. This is a possible explanation for why households with a mortgage may be less susceptible to mental health issues than renters, given some use the mortgage to finance other consumption.

Analysis of Swedish survey and register data provided a different approach to the issue, looking at financial strain and mental health (Dackehag et al. 2016). This paper differs from the other literature as it examined both subjective and objective measures of mental health. The authors find a strong negative relationship between payment difficulties and self-reported health, but smaller effects with later psychiatric drug use. The focus of the paper was not specifically on housing affordability, but on financial strain, and the impact of debt. Interestingly, the authors find the effect may be from the individual's view of their financial situation (ibid). This had not been examined in the earlier research on Australian data.

A bi-directional relationship may also exist, as highlighted by both Dackehag et al. (2016) and Baker et al. (2014). These papers highlight the challenge in identifying a casual mechanism for the relationship between housing affordability and mental health, particularly, whether it is housing affordability the causes mental health. Rather, there may be an issue of mental health issues leading to housing affordability problems. This is not explored in the other papers and has very distinct policy implications since it may indicate policies targeted towards mental health rather than housing affordability. Using an average of self-assessed mental health for the prior three years, Baker et al. (2013) find an association with poor housing affordability, while Dackehag et al. (2016) use a lag of one year finding that objective measures indicating mental health issues precede financial strain.

Baker et al. (2016) find that dwelling quality is becoming an issue in Australia, even with its high share of new housing stock. The study finds those in poor-derelect condition housing do self-report worse general health, however, the finding is small for mental health, and there is only a difference between those in poor-derelect and those in excellent. Dwelling condition may be related to housing affordability, as those in low income households are more likely to live in lower quality or overcrowded housing (AIHW 2017).

There is also some evidence from qualitative studies. Using a survey of General Practitioners in England, Shelter (2017) found that housing was a significant factor in patient's mental health, particularly anxiety and depression. While the key issue identified was the condition of the property, housing affordability and insecure tenancy were also found to be significant.

From this literature, there is significant evidence of a negative relationship between housing affordability and mental health. However, the exact causal mechanism of this has yet to be fully

established. Few papers have considered the impact of omitted variables bias, and whether an unknown variable that is correlated with both housing affordability and mental health is influencing the results. Research has highlighted effects through tenure, wealth effects, and effect modifiers from employment status. Some research also highlighted a bi-directional or reverse causality relationship.

### **1.3 Summary and key gaps in literature**

I have highlighted a growing literature regarding the impact of housing affordability on mental health. In combination with the research on housing affordability, a key gap emerges. Most of the studies identified above have used the ratio measurement of housing affordability, and within these studies, all of them used gross income as the measurement.

Thus, I try to address this issue in this paper by using alternative measures of housing affordability, to see if this affects the relationship of housing affordability and mental health. As noted above, prior research has found the residual income method identifies a larger portion of low-income households in unaffordable housing than the 30/40 method. This paper benefits from the recently developed Australia budget standards, which provide an ideal source for producing the residual income method. In addition to the use of the residual income method, I also compare the results to similar methods to Dackehag et al (2016) and Rowley & Ong (2012), identifying if housing affordability measurements produce similar results to simple questions of whether households can pay housing costs or other bills on time.

Thus, the research questions are like prior studies; do households in unaffordable housing report worse mental health than those in affordable housing when using different measurements of housing affordability? The reason this addresses a key gap in the literature is that changing the measurement of housing affordability will change the “treatment” and “control” groups as according to different measures, households may change from being in the treatment or control group.

This research question can be split into two components:

1. When analysing the relationship between housing affordability and mental health, do the results change according to different measures of housing affordability?

2. How do the results compare to self-reported measurements on ability to pay housing costs or household bills on time?

In the next section, I explain the data sources available to be able to address these research questions.



## 2. Methods

### 2.1 Data

I use two data sources in this paper. The main data source is the Household, Income and Labour Dynamics in Australia (HILDA) survey. The HILDA is an ongoing longitudinal data set, with a representative sample of the national population of Australia (Melbourne Institute 2016). It began in 2001, and has an annual collection, with both face-to-face interviews and as well as self-reported questions (ibid). Data is collected across a significant number of topics, including; health, income, housing, financial situation, nutrition and lifestyle. This makes for a rich source of variables for analysis on mental health, housing costs, household composition, employment, and detailed income components for both gross and disposable income.

The HILDA also provides a significant amount of individual and household information, which are needed to control for various characteristics as set out in the method section. I use waves 1 to 14 of the data set, which reflects an annual collection from 2001 to 2014. The data set comes in multiple files, and for the analyses I used the combined HILDA file for each wave. This is a combined data file for each wave, which has both household and individual information.

A secondary data source is the 2017 Australian Budget Standards (Saunders & Bedford 2017). These contain updates to the 1998 budget standards, as well new budget standards. The updates identified changes in household consumption that have occurred during this time. As noted in the literature review, these were developed based on a detailed analysis on consumption. The budgets were produced on 2013 numbers and inflated to 2016 in the final report. Both the 1998 and 2017 produce more than one standard, and I select two for analysis.

The old standards produce a “Modest but Adequate” (MBA) standard, while the new standards produce a “low-income” standard. I use both to see how the effects may differ. The MBA standards produce estimates higher than the low-income estimates, as they reflect a higher standard of living. The reason for selection of these two standards is that they reflect two distinct levels reflecting different standards of living. Thus, I select one standard from the low end, and one from the high end.

To produce a valid model estimating the effect of housing affordability on mental health, I require reliable data on mental health and housing affordability according to the residual income method. I now explain the data used for these components.

## **2.2 Key variables for mental health and residual income**

### 2.2.1 Mental Health

The dependent variable is obtained from the mental health component in the self-reported SF-36 health measure. It has been a widely used measure, including the prior studies on housing affordability and mental health in Australia. It is made up of 36 items, across a variety of domains. While there is some critique on the use of self-reported health measures, analysis on the first wave of HILDA found self-reported health measures provide similar results to prior Australian and international findings and are viewed as useful in analysing population health characteristics (Butterworth & Crosier 2004). Unfortunately, data on doctor or hospital visits was only collected in two waves, and self-reported data on hospital visits have not always been found to be reliable for those in mental distress (Rhodes & Fung 2004). Other data sources such as diagnosis of mental health conditions or taking prescription medications for mental illness were only asked in two non-consecutive waves of the first fourteen waves of the HILDA, providing insufficient sample sizes for analysis.

For mental health, the mental component in the HILDA data set is transformed to a score between 0-100, and I use this value for analysis, like the work discussed in the literature review. Across the waves, the average raw score for the mental health component was approximately 74 in each wave.

### 2.2.3 Residual Income

To calculate the residual income method of housing affordability, I follow Henman & Jones (2012). This involves using household disposable income, housing costs, and the budget standards. As noted above, I select two standards, the low-income standard, and the modest-but-adequate standard for analysing to different levels of standard of living.

From the HILDA, I use household financial year disposable total income. This is already calculated in the HILDA combined data file, from the sum of all household members. It is obtained by deducting financial year taxes from household gross total income. The HILDA contains

imputed income variables to reduce non-missing data. I use the variables for income which contain the imputed values.

The HILDA contains housing costs in separate variables for owners and renters. For both renters and owners, the questionnaire asks for weekly amounts, and the data set converts the amounts to monthly figures. For those with a mortgage, housing costs are mostly answered by the household, with a small proportion (less than 5%) imputed at each wave. Similarly, for renters, the question is mostly answered at each wave, with a small proportion (less than 5%) imputed at each wave. I subtract these housing costs for each household from the household disposable income to produce the residual income amount.

The budget standards for both the low-income and updated MBA standard are listed in 2016 prices (Saunders & Bedford 2017). As the HILDA income and housing costs figures reflect the value at the time of wave, I change the two budget standards to reflect the price level for each wave of the data. I use the Australian Bureau of Statistics Consumer Price Index (CPI) measure to reflect the value at each wave using mid-year estimates. I follow the work from the budget standards, and adjust the budgets using the “all groups” inflation measurement from the ABS. I adjust real prices at the total budget level rather than each individual component. The developers of the standards note this has minimal impact on the total (Saunders & Bedford 2017). Adjusting each component for inflation of each component is only more relevant for analysis of budget expenditure, rather than the total budget which I am interested in.

The 2017 budget standards were developed for the following household types:

- Single Adult
- Couple no children
- Couple, one dependent child
- Couple, two dependent children
- Sole parent, one dependent child

Through examination of the HILDA data set, these family types cover most of the family types, excluding two: Couple with three children, and sole parent with two children. As the cost of a child (excluding housing costs) is estimated in the budget standards, I calculate budget standards for these two-family types by adding on the estimated cost of a child calculated in budget standards

(Saunders & Bedford 2017). This leaves analysis for the eight most common household types. This is the same for the MBA standard, however, in 1998, some additional budgets were calculated. For the scope of this paper, I select only two of the budget standards which as noted above, are quite distinct from each other.

For the scope of this paper, other family types not included in the budget standards are excluded from analysis. For each wave, the above household types make up more than eighty per cent of the sample. As noted in the literature review, the budget standards listed specific ages for the children; six for the first, and ten for the second. As this would restrict the sample size, and effect the method, I ignore the age from the budget standards, and use all dependent children under eighteen.

To combine the data sets, I create a variable with the budget standard for each household type for each wave. These are displayed for the two budget standards in Appendix 2. I merge the two data sets using the Stata merge function to add in the budget standards as variables for each wave. I then create a dummy variable for whether the residual income amount is lower than the specified budget standard for that household type. If it is, then the household is in unaffordable housing, otherwise it is not. A residual income of zero is treated as being in affordable housing, since this would mean a household has exactly the amount specified by the relevant standard. This is done for both the low-income budget standard, and the MBA budget standard.

#### 2.2.4 Ratio Measures

I compute the ratio measures like the prior literature, deriving a variable for whether a households housing costs are greater than or equal to 30% of their gross household income. Additionally, I created another variable which measures if a households housing costs are greater than or equal to 30% of their disposable household income.

After deriving the key required variables for analysis, I now explain the method I use to estimate the relationship between housing affordability and mental health.

## **2.3 Empirical Model**

To quantify how housing affordability affects mental health, I want to estimate the effect of being in affordable vs unaffordable housing. This raises various methodological issues. I opt for a fixed effects method over other methods for a variety of reasons, which I now outline.

A simple OLS method would likely suffer from omitted variables bias (Angrist & Pischke 2008). As outlined in the literature review, housing affordability is a more significant issue for those in the lower end of the income distribution. Prior studies have also highlighted the issues with using OLS on similar data to estimate the effect of housing affordability and mental health (Pierse et al. 2016).

Other econometric papers have used an instrumental variable approach to estimate casual relationships between variables. Through the literature review I could not identify an appropriate instrument that would satisfy the criteria for an instrumental variable for this study. Business cycles were considered due to their relation to housing and income, however, they have also been shown to be related to health (Gerdtham & Johannesson 2005), ruling them out as an appropriate instrument.

Another possibility would be examining a random experiment. In the case of housing affordability, this would be some sort of change to the housing market which improved the housing affordability of a representative sample, such as a policy change towards housing which improved (or worsened) the housing affordability situation. Recent attempts to housing policy have been rather ineffective in addressing housing affordability (Ong et al. 2017). Increased housing supply has generally focussed on housing for higher income earners, who are much less likely to suffer from housing affordability issues (ibid). Through the literature review I did not identify any sort of shock, or policy change that had this impact. Research has found that other policy changes such as increased grants to first home buyers have not had substantial effects on improving affordability but may have had some impact in regard to obtaining a deposit (RBA 2003). Therefore, this was also ruled out as an empirical approach.

### **2.3.1 Fixed Effects Method**

This leads to a fixed effects model being the most appropriate method to deal with the methodological issues listed above in the other methods. This method is able to deal with

unobserved omitted variables as long as they are fixed over time (Angrist & Pischke 2009). While this is a strength of fixed effects models, they also suffer from some weaknesses that must be considered. The models may suffer from measurement errors (ibid). Additionally, as fixed effects methods only estimate within person differences, this restricts casual inferences as estimation is only possible on those who experience unaffordable housing. While a fixed effects approach may lead to concerns of a selective sample, as identified in the literature review, a significant portion of the population move in and out of affordable and unaffordable housing. This range from 28% to 44% according to the measure. Additionally, Borrowman et al (2017) found these issues tend to be short term, with households moving in and out of unaffordable housing.

To specify an empirical method, I follow similar methods to Bentley et al. (2011) with key the difference being alternating the measurement of housing affordability. This is to address the research question on how the effects of housing affordability may change according to different measures of housing affordability. Changing the measure may alter both when a household is in unaffordable housing, and include and exclude prior households who are now in different groups. I estimate multiple models to identify how the results change according to the measure of housing affordability.

The first model is estimated using the low-income budget standard. The second model is estimated using the MBA budget standard. Models 3 and 4 are the same as Models 1 and 2 respectively, but with employment security added as a control variable. This is based on the work of Bentley et al. (2016b), who found effects from employment security had significant impacts on the relationship between housing affordability and mental health. The reason for this as a separate model is that in this specification, I must restrict the analysis only to households who are in the labour force.

Model 5 is estimated using the ratio measure with gross household income. Model 6 is the estimated using the ratio measure with disposable household income. For comparison, Models 5 and 6 are only estimated on the family types used in the other models. While the different measures will identify different samples, they will at least be drawing from the same population, which covers most household types. If I included all family types in the ratio model, it would then begin to identify families that could not be included in the other models, which won't allow for a direct comparison of the measurement effect of housing affordability. In the discussion, I compare the results to the prior research who estimated similar models using more family types.

The models are estimated at the individual level with some of the variables defined at the household level. For example, household income and housing costs are household level variables, where all individuals in the same household will have the same values for individual related items. The mental health score is unique to each individual.

The fixed effects model is estimated as follows:

$$MH_{it} = \alpha + BX_{it} + V_i + Z_g + T_t + e_{it} \quad (1)$$

$MH_{it}$  refers to mental health for individual  $i$ , at time  $t$ . Time in the models refers to one of the fourteen waves used in the analysis.  $\alpha$  is the constant term.  $B$  contains the vector of all the coefficients I select to analyse.  $V_i$  is the error term specific to the individual, that is unobserved, and fixed over time.  $Z_g$  refers to location dummies, while  $T_t$  refers to year dummies for each of the fourteen waves.  $E_{it}$  is the error term that is not fixed, and varies over time, and across the individuals. Robust standard errors are estimated for all models.

Within the vector of coefficient,  $B$ , is the variable of interest; housing affordability. For all the models, this is a binary variable, with a value of 0 for being in affordable housing, and 1 for being in unaffordable housing, according to which measurement of housing affordability is used. As this is a fixed effects estimator, the models estimate the within person difference from being in affordable and unaffordable housing, according to which measure of housing affordability is used.

### Control variables and sample selection

For analysis, I select the working age population, only looking at those aged between 25 and 64 years old. This is to focus on the working age population. From this age group, I only select those who are grouped in affordable and unaffordable housing at least once in the fourteen waves of data. This is due to the nature of fixed effects estimation which only examines the within person difference. Unlike some of the prior research of I do not restrict the sample to the lowest 40% of the income distribution. As the purpose of the method is to examine the amount of income left after housing costs, meaning where individuals are in the income distribution is less relevant than in the 30% measure. In the discussion, I discuss results from other studies who used the 30/40 measure.

All models contain year dummies, and location dummies which are for each capital city, and each rest of state area. To separate any low-income effect compared to housing affordability effect, I control for household equivalised income decile in each year using the OECD equivalence scale. Equivalised income is generally seen as a better indicator of a households rank in the income distribution than using total household income.

All models are adjusted for serious injury or illness in the survey year, and divorce/separation in the survey year. As I run fixed effects models only, I do not need to control for variables that do not vary over time, such as ethnicity or gender. As a result, I run some additional models separately for males and females to identify if there are any differences.

Employment security follows the method of Bentley et al. (2016b) and is calculated at a household level. If any of the household members are in permanent or fixed-term employment, then all the household members are categorised as secure employment. If the highest level of employment is casual, then all household members are in insecure employment. If no household member is in the labour force, then for models 3 and 4, they are removed from the analysis.

Like prior analysis using HILDA, social housing tenants are excluded from the sample due to insufficient sample sizes. As they make up a small portion of households in Australia (less than 5%) and are in unaffordable housing less commonly than other renters (AIHW 2017), they are unlikely to significantly influence the results. This is relatively unique to Australia, as much of housing support comes from rental income assistance rather than government provided housing.

For each model, only households who experience at least one wave of being in unaffordability according to the measure in that model are included. Since the MBA budget is a higher living standard, this means that all households viewed as in unaffordable housing under the low-income budget will also be in unaffordable housing under the MBA budget. However, the reverse is not true, which leads to a larger sample if using the MBA budget.

As households may change into family types not in one of the family types with a specified budget standard, this creates a sample with missing waves, or many non-consecutive waves. After cleaning the data to ensure no non-missing variables, I then restrict the sample only to those who have at least five non-consecutive waves. I base this decision on the HILDA top-up sample which brought new households in wave 11, with each of these households having five waves.



### Indicators of financial stress

As a comparison, I run an additional model using two separate annual questions in the HILDA on paying costs related to housing on time. The first question is if in the prior year they were unable to pay the mortgage or rent on time due to a shortage of money. The second question is if in the prior year they were unable to pay electricity, gas or telephone bills on time due to a shortage of money. The purpose of this is for a few reasons. First, it follows the work of Dackehag et al. (2016) which examined financial stress using a similar variable. Second, it builds on the work of Rowley & Ong (2012) who compared housing stress measures to this measure, though they did not test the relationship with mental health. This is to examine whether the measures of housing affordability show similar results to indicators of financial stress directly related to housing.

Third, it highlights a problem previously unaddressed in the literature; the time period of housing affordability. Due to nature of panel data collection, the prior work has analysed the relationship reflecting annual income and annual housing costs, when housing affordability could be an issue that changes or affects in shorter time spans for household. As housing costs are often paid monthly, or bi-monthly, households may move in and out of affordable/unaffordable housing each month. This model is estimated first with tenure modification, and the same control variables as the other models. Lastly, it acts as a comparator for what should be a very good proxy for a housing affordability measure.

Unfortunately, the HILDA did not contain sufficient data for any sort of comparison for the dependent variable. Searching through the data dictionary, there were some objective measures available, such as having seen a mental health professional, or take prescription medication for depression or anxiety, but they were only available in 1 or 2 waves. This was not sufficient for estimating any of the models with.

### 3. Results

Across the different models, there were varying levels of observations in unaffordable housing, which was expected. Table 2 displays the different samples used in each of the four models, plus the comparison to the 30% method. The models using the MBA budget have larger samples, as they have a higher budget threshold, meaning more households fall below this threshold.

Table 2 shows the lower mental average mental health for those in unaffordable housing. This is also true for renters, who on average have lower mental health scores. In each model, tenure is free to change over time, with the classification of owner/renter reflecting the housing situation at the time of interview at each wave. Across most measures, there are also a higher proportion of renters than owners in unaffordable housing. This reflects some of the earlier discussed selection effects of tenure. For a full list of the budget standard applied for each measure, refer to Appendix 1, which reflects the inflation adjusted budget standards for the major household types.

Table 2: Summary statistics for different samples

Sample	(1) Low income budget standard	(2) Modest but adequate budget standard	(3) Low income budget standard, in labour force	(4) Modest but adequate budget standard, in labour force	(5) 30% measure
N	7,709	10,422	3,926	5,809	12,621
Renters	4,283	4,358	2,269	2,212	4,582
Owners	3,426	6,064	1,657	3,597	8,039
Mean MH score	71.76	72.78	74.07	74.97	73.30
Mean MH score in affordable housing	73.38	74.66	74.64	75.62	74.60
Mean MH score in unaffordable housing	68.00	69.42	71.56	72.97	69.06
25-44	5,133	7,176	2,852	4,299	8,854
45-65	2,576	3,246	1,074	1,510	3,767
Male	3,581	4,909	1,879	2,907	6,023
Female	4,128	5,513	2,047	2,902	6,598

Serious injury/illness in year	685	844	252	340	985
Divorce	72	91	39	51	107
Household has secure employment <sup>1</sup>	-	-	3246	4,953	-
Household has casual employment	-	-	680	856	-
Equivalised household income	34,484	34,612	38,543	37,809	44,230

a) Sample sizes differ substantially as each measure of housing affordability identifies different samples of the population who experience unaffordable housing according to measure used. Summary statistics for first five models displayed only.

Table 3 presents the results of the housing affordability coefficients for each of the models. No significant results are found using the residual income method. The sample sizes differ substantially between the measures, reflecting that each measure of housing affordability identifies different samples in the population. This is discussed further in the next section. A significant negative relationship was found using the ratio measurement, with a decrease in self-reported mental health of approximately 1 if an individual is in unaffordable housing compared to affordable housing. This is consistent with the prior literature which used this measure. Appendix 3 shows the results for models 1 and 5<sup>2</sup> for males and females separately.

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<sup>1</sup> As noted in text, this refers to the household. If at least one individual in the household has secure employment, the household is measured as having secure employment.

<sup>2</sup> Models 1 and 5 are estimated separately for males and females to identify any differences of two different models. I selected only these two models for estimation, as model 1 has never been estimated in the literature, while similar versions of model 5 have, without consideration for gender.

**Table 3: Fixed-effects regression models, dependent variable self-reported mental health**

Dependent variable: Self-reported Mental Health					
Independent variable	(1) Low income budget standard	(2) Modest but adequate budget standard	(3) Low income budget standard, household in Labour force	(4) Modest but adequate budget standard, household in Labour force	(5) 30 % measure
Housing Affordability	-0.615 (-0.513)	-0.151 (0.423)	-0.647 (0.751)	-0.556 (0.548)	-0.558* (0.259)
Renter	-1.485 (0.767)	0.707 (0.649)	-0.809 (0.964)	0.121 (0.776)	0.084 (0.489)
Major life event – serious injury/illness	-3.712*** (0.622)	-3.714*** (0.555)	-4.339*** (0.968)	-4.091*** (0.823)	-4.002*** (0.530)
Secure employment	-	-	0.384 (0.771)	1.304 (0.689)	-
N	7,709	10,422	3,926	5,809	12,621
Employment variables	No	No	Yes	Yes	No

a) Standard errors in parentheses, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

b) All models are fixed effects, and include year dummies, location dummies, equivalised income decile, age groups, and whether divorced in year

c) Sample size differ between models as each model is only run on individuals who experience at least one wave of unaffordable housing according to the measure tested

Table 4 shows the results from questions of financial stress, using the question on paying housing costs on time, and paying other bills on time. These results show a significant and larger negative coefficient than all the other models. This is a much larger negative coefficient than has been found in the prior literature and represents about one sixth of the standard deviation of SF-36 scores in the sample.

**Table 4: Fixed-effects regressions on payment difficulties and mental health. Dependent variable, self-reported mental health**

Dependent variable: Self-reported Mental Health				
Independent variable	(6) Payment difficulties with housing	(7) Payment difficulties with bills	(8) Payment difficulties with housing – household in labour force	(9) Payment difficulties with bills – household in labour force
Unable to pay housing costs on time	-2.787*** (0.405)	-	-2.188*** (0.526)	
Unable to pay bills on time	-	-2.676*** (0.433)	-	-2.261*** (0.564)
Renter	-0.698 (0.747)	-0.643 (0.748)	0.977 (0.821)	0.980 (0.818)
Major life event – serious injury/illness	-4.431*** (0.674)	-4.529*** (0.678)	-3.911*** (0.821)	-3.873*** (0.939)
Secure employment	-	-	0.658 (0.958)	0.721 (0.960)
N	6,078	6,063	3,836	3,386

- a) All models are fixed effects, and include year dummies, location dummies, equivalised income decile, age groups, and whether divorced in year.
- b) Standard errors in parentheses, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001
- c) Sample size differ between models as each model is only run on individuals who experience at least one wave of unaffordable housing according to the measure tested

In Appendix 4, I display the comparison between the housing affordability measurements, and the questions on ability to pay bills. These findings are consistent with Rowley & Ong (2012) who found that being in unaffordable housing according to the 30% measure was not highly correlated with ability to pay bills on time. This is also true of the residual income method. There was a significant amount of observations that were not found to be in unaffordable housing but answered yes to the questions on being able to pay the bills on time.

## 4. Discussion

The results vary according to which measure of housing affordability was used. This reflects that the measures identify different groups. As I used a fixed-effects approach, I only included individuals who had at least one wave of unaffordable housing. This means between the measures, there are both differences in which individuals/households were included in the sample, and which waves had affordable vs unaffordable housing. I did not estimate OLS models for comparison, as the literature review showed this has already been estimated on HILDA data, and suggested of providing bias estimates.

The residual income method did not find significant results using either the low-income or MBA budget standard, which reflect two different levels of standard of living. This compared to the ratio measures, which revealed a significant negative relationship, of approximately a self-reported raw mental health score of one lower when in unaffordable compared to affordable housing. Given the well-established link between housing affordability and mental health, this suggests that the ratio measure is an effective tool in analysing the relationship between housing affordability and mental health. Additionally, analysis using questions in the data set on paying housing costs of bills on time reveals a significant negative relationship with mental health, which is far larger in magnitude than the estimates from the ratio measures.

There are a few possible causes of these results. First, regarding the results from the residual income measure, the results were slightly unexpected. Based on the literature review, I expected a higher negative coefficient from the residual income models to the ratio measure. This assumed that the residual income method would be better at identifying those in unaffordable housing, which would then more precisely measure the relationship between housing affordability and mental health. Given the substantial literature on the negative relationship between housing affordability and mental health, it is unlikely that these results refute the earlier findings. Rather, it appears the residual income method in the format I used may not be able to capture the relationship between housing affordability and mental health.

A possible reason for this is that the households differ too far from the original budget standards, and thus lose some of their applicability. Given the specification of the model, it was not possible to run a fixed effects estimator using the exact family types due to ages of either adults or children.

As the budget standards state a specific age for children this would only allow one observation for each household (and in some rare cases, two). For adults, this would require only analysing when they are aged between 35-40, which would leave far too small a sample for analysis. Additionally, while I adjusted for inflation, the authors note compositional changes also affect budget levels for households as consumption habits change.

Another reason is how individuals view housing affordability. There are multiple domains of housing affordability that could influence households, and it may be their view of the situation that drives the negative self-reported mental health outcomes (Dackehag et al. 2016). If this is the case, the results suggest households better identify housing affordability based on how much of their income they are spending on it, rather than how much is left.

Interestingly, significant results were found when I estimated two of the models separately for males and females, with a significant effect found for females. As much of the prior literature had used a fixed-effects approach, this possibility had been mostly ignored in the prior studies. From the literature review, and data used in this paper, it is difficult to explain the precise cause of this. This is certainly an area where future research should examine, particularly with the rise of single person and single parent households in Australia.

Appendix 4 shows the groupings of households into affordable and unaffordable housing according to measurement. The disagreement between the measures is substantial, demonstrating the challenge in measuring exactly what housing affordability is. If viewing not being able to pay either housing costs or bills on time as a measure of housing affordability, then there is even larger disagreement in housing affordability measurement. Appendix 4 displays that there were a large portion of households viewed in affordable housing who struggled during the year to pay housing costs or bills on time due to money shortages, with the reverse also being true. This is like earlier findings by Rowley & Ong (2012) where there are significant amounts of periods where households were viewed in unaffordable housing and did not suffer payment difficulties, or vice versa. This suggests conventional measures of housing affordability do not identify precisely those suffering from financial stress related to housing costs.

From the results in the paper, the significant effects found for some of the models may appear small in magnitude. A lower SF-36 Mental health score of 1 from being in unaffordable housing may seem like a relatively small effect. However, the frequency with which this occurs is high,

meaning that we see a small drop in mental health for a significant portion of the population. The effect for paying housing costs or bills on time was approximately three times larger and reflects about one sixth of a standard deviation.

Some of the effect could also be driven by the timing of each of the variables. In this case, the mental health question is at the time of interview. Housing affordability questions are based on annual household income, and housing costs on a monthly basis. This means the model is testing whether housing affordability based on data in the period before the interview leads to lower self-reported mental health at the time of interview.

As Rowley and Ong (2012) note, if housing affordability measurements do not accurately predict the ability of households to pay bills on time, it suggests the measures may not represent financial stress for households. While some of my work replicates part of theirs, the comparison adds to their work, demonstrating that the residual income method of housing affordability also does not appear to be very related to a household's ability to pay bills or housing costs on time. In this case, both the residual income and ratio measure may then miss out on identifying the relationship with mental health, as the variable of interest, housing affordability is not accurately reflecting significant housing affordability issues for many households.

There is one issue with regards to the indicators of financial stress. Prior studies have noted issues with analysing both self-reported measures of financial stress and self-reported health (Bridges & Disney 2010). However, the questions used in the models appear less subjective than those raised in the prior literature. The concern is that those with mental health issues may be more likely to report worse results on subjective questions of their financial situation. However, as the HILDA questions are direct, and state whether the household had trouble paying either housing costs or bills due to shortage of money, this is likely less of a concern than using a question asking how a household rated their housing affordability. While Rowley and Ong (2012) analysed the measure as a form of well-being (independent variable), I analysed it as a proxy for housing affordability (dependent variable).

While a fixed-effects approach avoids the concern of omitted variables bias between the treatment and control group, it can still suffer from omitted variables bias for anything that varies within the individual across time. I have followed the literature regarding identifying critical confounding variables, such as equivalised income and employment security. Additional variables were used



regarding any major life changes, or any health shocks. However, it is possible that some unknown variable is driving the results found in the models using indicators of financial stress or the ratio measure. Fixed-effects methods also may suffer from measurement error problems due to less variation in the variable (housing affordability) within individuals. It also means any effects of time-invariant variables, such as gender, cannot be estimated. As a result, I estimated two of the models separately for males and females. This revealed a more negative relationship for females, an area mostly overlooked in the literature.

In Appendix 4, I display agreement tables between the measures of housing affordability. While it is not surprising that there is disagreement between the residual income method and the ratio method, it is rather surprising how many households had issues paying housing costs on time but were not identified as in unaffordable housing by different measures of housing affordability. While housing affordability is not always seen as struggling to pay housing costs or bills, it is substantial how many households are not measured as in unaffordable housing, but report issues of struggling to pay bills.

One issue which is not considered in the literature or this paper is the inclusion of housing affordability as a continuous variable. This would either be including the ratio or residual income amount as a variable. This is an area for future research, as refinements would be needed for the econometric approach. However, given the extensive research on housing affordability, financial stress, and mental health, it seems plausible that mental health may reduce as housing costs increase at lower levels of income.

From a policy perspective, I add to the literature on the negative relationship between housing affordability and mental health, suggesting that the current measurements of housing affordability may understate or miss the negative impact on self-reported mental health. However, I also note that the budget standards may not be useful if applied to households not matching the exact characteristics they were designed for.

Like the prior research, as I used all adult household members in the analysis, this could skew the results. However, it is also difficult to separate the effect to individual members of a household, given all the housing affordability measures are based on household income and total housing costs for the entire household.

#### 4.1.1 Strengths and weaknesses of the paper

From the literature review, there was limited applied research on the residual income method. I used established budget standards at two different levels to test an alternative measure of housing affordability, and how this impacts the relationship with mental health. I made use of a large data set, which had most of the required confounding variables to estimate a reliable fixed effects model of housing affordability and mental health. While focussing on housing affordability measurements may seem trivial, from an empirical standpoint, it changes the treatment and control groups by measuring different samples. Given the relative lack of empirical basis for the 30% measure, comparing it to alternative approaches, including indicators on household having payment difficulties is important with the rise of housing affordability issues.

The paper also provides a comparison across different budgets, and different measures of housing affordability to highlight the differences between housing affordability measurements, and how this identifies different samples. The HILDA is a representative data set, but I was forced to cut the sample down based on response rates, and family types. This may have excluded households who have different housing affordability issues to the more common family types. As noted in the literature review, the budget standards were developed for children at specific ages, whereas I used dependent children under 15.

As noted above, while a fixed-effects approach was preferred, it still suffers from various limitations including issues from measurement error, and not being able to estimate any effect from time-invariant factors.

While I was able to test sensitivity of measurement according to housing affordability measure, due to data limitations, I was unable to do similar for mental health. As Dackehag et al. (2016) noted, objective measures of mental health may provide more policy relevant variables for analysis, such as prescription drug use associated with financial stress.

#### 4.1.3 Areas for future research

Due to data availability issues, I could not include valid debt and wealth variables in the analysis. These were only collected in three of fourteen waves I examined, with significant time gaps between waves. While rising house prices may be related positively with well-being for owners (Atalay et al. 2017), home ownership is generally accumulated through debt which in Australia is

at historically high levels for households. (IMF 2017). There may be counteracting forces in the financial side of home ownership, where debt has negative effect on mental health, while property price rises has a positive effect. Additionally, wealth could be a plausible explanation for the difference between housing affordability measurements and ability to pay bills on time, since households could use wealth sources for housing costs (Windsor et al. 2013). If fixed-effects models are estimated, the results suggest separate models should be run for males and females, as the negative relationship between housing affordability and mental health may be more pronounced in females. This is also an area for qualitative research, to understand further why the relationship between housing affordability and mental health may differ for males and females.

Second, I have not discussed the possibility of unaffordable housing having any influence on access to mental health care services. The mental health care economy in Australia is very broad, as there are many different facilities both in the public and private health sector that would offer treatment. This was not considered in any of the previous studies examining housing affordability and mental health using HILDA. While this would not affect measurement of the dependent variable in my model, it could impact self-reported mental health through households with worse access to mental health reporting worse mental health. If access to mental health is correlated with housing affordability, then this would bias the estimates. Housing affordability research could also be combined with dwelling condition, to see if there is any correlation between poor housing affordability and poor dwelling condition.

A final issue is the measurement of housing costs, which affects all measurements of housing affordability. Housing affordability likely reflects more than just rental costs or mortgage costs, and an often-ignored area is transport costs. As suggested in Mason et al. (2013), more detailed measurements of the true cost of housing would be beneficial for studying housing affordability and mental health, along with many other issues related to housing. The models using questions on ability to pay housing costs or bills may have picked up some of this effect as the costs of these items have been reflected in the answer to the question.

The results suggest that future studies examining housing affordability as an independent variable should consider using multiple measures to test how this may impact any results, given the significant differences in the major measures of housing affordability. For mental health, the results in this paper are substantially different in magnitude and significance, suggesting more

research is needed in this area. The analyses using indicators of financial stress highlights that the issues with mental health may come from payment difficulties. Future research could also add wealth dimensions to standard measures of housing affordability, though reliable wealth data can be hard to come by. Given recent work on transport costs, this should be an issue considered in future studies on the impact of housing affordability on different aspects of health. These issues may help to highlight why conventional measures of housing affordability reveal very different results to questions on payment difficulties associated with the cost of housing.

As this paper focussed on how the relationship between housing affordability and mental health changes according to different measures of housing affordability, I excluded testing of a bi-directional relationship. Future research could examine different measures of housing affordability with a lagged model, like either Baker et al. (2014) or Dackehag et al. (2016).

## 5. Conclusion

In this paper, I examined the relationship between housing affordability and mental health using alternative measures of housing affordability to the prior literature. While the residual income method has gained recent traction as a reliable base for generating policies for household budgets, the simple ratio measure of housing affordability identified a more significant negative relationship with mental health. This suggests that the ratio measure of housing affordability is an effective tool for identifying the negative effects of being in unaffordable housing. However, when models were estimated separately for males and females, and significant negative relationship was found for females. A nearly threefold larger negative result was found using binary questions on ability to pay housing costs of household bills, suggesting that conventional measures of housing affordability may not be effective in identifying when households face payment difficulties from the cost of housing. This suggests that when using a measure of housing affordability as an independent variable, it is important to consider how different the measures are. I highlighted the challenges in applying the residual income method to a large panel data set with heterogeneous households, as the budget standards used in the residual income method may be less reliable as they become more generalised across households. Further research should focus on refining measurements of housing affordability and analysing the relationship of housing affordability and mental health using objective measures of mental health.

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## Appendixes

### Appendix 1: Mean and median household disposable incomes in Australia, 2001-2014.

Year	Mean (\$)	Median (\$)
2001	68,828	59,175
2002	69,452	59,772
2003	69,257	59,816
2004	71,370	62,176
2005	74,547	65,794
2006	78,963	68,171
2007	83,593	71,172
2008	85,132	73,647
2009	87,806	78,208
2010	87,764	75,690
2011	87,746	74,102
2012	89,405	76,849
2013	90,336	77,500
2014	90,809	77,662

Source: Melbourne Institute (2016). Converted to 2016 prices to reflect same price levels as budget standards.

**Appendix 2: Low-income Budget standards (\$AUD, 2016 Prices), monthly prices.**

Wave	Single Adult	Couple only	Couple with one dependent child <15 years old	Couple with two dependent children <15 years old	Sole parent, one child <15 years old	<sup>a</sup> Sole parent, two dependent children <15 years old	<sup>a</sup> Couple with three children <15 years old
1	839	1,314	1,721	2,134	1,297	1,710	2,547
2	863	1,351	1,770	2,194	1,334	1,758	2,618
3	885	1,386	1,816	2,251	1,369	1,804	2,687
4	908	1,421	1,862	2,309	1,403	1,850	2,755
5	930	1,457	1,908	2,366	1,438	1,896	2,823
6	967	1,515	1,984	2,460	1,496	1,972	2,936
7	988	1,546	2,026	2,512	1,527	2,013	2,998
8	1,032	1,615	2,116	2,624	1,595	2,102	3,131
9	1,046	1,638	2,146	2,661	1,618	2,132	3,176
10	1,079	1,689	2,213	2,744	1,668	2,199	3,275
11	1,117	1,749	2,292	2,841	1,727	2,277	3,391
12	1,131	1,770	2,319	2,876	1,748	2,304	3,432
13	1,158	1,813	2,375	2,944	1,790	2,360	3,514
14	1,193	1,867	2,446	3,033	1,844	2,431	3,620

Budget standards obtained from Saunders & Bedford (2017), deflated using ABS June quarterly estimates from 2016 prices. Prices in Australian Dollars.

- a. These were not in the original budget standards but were calculated using the cost of an extra child as noted in the budget standards.
- b. Note family types are restricted to exact wording. Any that meet above definitions but have other household members are excluded.
- c. Wave 1 is 2001, and each wave after is the following year

**Modest-but-Adequate Budget standards (\$AUD, 2016 Prices), monthly figures.**

Wave	Single Adult	Couple only	Couple with one dependent child <15	Couple with two dependent children <15	Sole parent, one child <15	<sup>a</sup> Sole parent, two dependent children <15 years old	<sup>a</sup> Couple with three children <15 years old
1	1,009	1,592	1,857	2,552	1,439	2,133	3,247
2	1,037	1,637	1,910	2,624	1,479	2,193	3,338
3	1,064	1,680	1,960	2,692	1,518	2,251	3,425
4	1,092	1,722	2,009	2,761	1,556	2,308	3,513
5	1,119	1,765	2,059	2,829	1,595	2,365	3,600
6	1,163	1,835	2,142	2,943	1,659	2,460	3,743
7	1,188	1,874	2,186	3,004	1,693	2,511	3,822
8	1,241	1,957	2,284	3,138	1,769	2,623	3,992
9	1,258	1,985	2,316	3,182	1,794	2,660	4,049
10	1,297	2,047	2,388	3,282	1,850	2,743	4,175
11	1,343	2,120	2,473	3,398	1,915	2,840	4,323
12	1,360	2,145	2,503	3,439	1,939	2,875	4,375
13	1,392	2,197	2,563	3,521	1,985	2,944	4,480
14	1,434	2,263	2,640	3,628	2,045	3,032	4,615

Budget standards obtained from Saunders & Bedford (2017), deflated using ABS June quarterly estimates from 2016 prices. Prices in Australian Dollars.

- a. These were not in the original budget standards but were calculated using the cost of an extra child as noted in the budget standards.
- b. Note family types are restricted to exact wording. Any that meet above definitions but have other household members are excluded.
- c. Wave 1 is 2001, and each wave after is the following year

### Appendix 3: Fixed effects models separated by gender

Dependent variable: Self-reported Mental Health				
Independent variable	(1) Low income budget standard		(5) 30% ratio measure	
	Males	Females	Males	Females
Housing Affordability	0.594 (0.712)	-1.698* (0.738)	-0.332 (0.368)	-0.772* (0.364)
Renter	-1.411 (1.034)	1.534 (1.100)	0.342 (0.656)	-0.130 (0.706)
Major life event – serious injury/illness	-4.307*** (0.843)	-3.302*** (0.898)	-4.419*** (0.739)	-3.680*** (0.763)
Secure employment	-	-	-	-
N	3,581	4,128	6,023	6,598
Employment variables	No	No	No	No

a) Standard errors in parentheses, \* p<0.05, \*\* p<0.01, \*\*\* p<0.001

b) All models are fixed effects, and include year dummies, location dummies, equivalised income decile, age groups, and whether divorced in year

c) Sample size differ between models as each model is only run on individuals who experience at least one wave of unaffordable housing according to the measure tested

## Appendix 4: Comparison between affordable and unaffordable housing across the housing affordability measures.

The following tables show agreement between different measures of housing affordability used in this paper. Agreement was tested on the samples used in the models in the paper.

### 1. Low-income standard and 30% ratio

	30% ratio		Total
Low-income standard	0	1	
0	4,327	1,054	5,381
1	352	1,976	2,328
Total	4,679	3,030	7,709

This sample is Model 1. 0 refers to affordable housing per the measure, 1 refers to unaffordable.

### 2. MBA standard and 30% measure

	30% ratio		Total
MBA standard	0	1	
0	5,766	899	6,665
1	1,154	2,603	3,757
Total	6,920	3,502	10,422

This sample is Model 2. 0 refers to affordable housing per the measure, 1 refers to unaffordable.

### 3. Payment difficulties with housing and 30% measure

	Payment difficulties with housing		Total
30% measure	No difficulties	Difficulties	
Affordable	3,330	1,250	4,580
Unaffordable	8,99	584	1,483
Total	4,229	1,834	6,063

This sample is Model 6. 0 refers to affordable housing per the measure, or no payment difficulties, 1 refers to unaffordable.

### 4. Payment difficulties with housing and low-income budget standards

	Payment difficulties with housing		Total
Low income Residual method	No difficulties	Difficulties	
Affordable	3,182	1,186	4,368
Unaffordable	1,047	648	1,695
Total	4,229	1,834	6,063

This sample is Model 7. 0 refers to affordable housing per the measure, or no payment difficulties, 1 refers to unaffordable.