# Measuring housing and transportation affordability: A case study of Melbourne, Australia

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## A B S T R A C T

Housing affordability is traditionally measured using the percentage of household income spent on housing. An important cost that is usually overlooked in measuring location affordability is the transportation or accessibility costs. In this paper, we present a modeling approach, driven by urban open data, to measure location affordability that incorporates both housing and transportation costs. We apply the developed model to assess housing affordability in Melbourne, Australia as a case study. Results suggest that neighbourhoods that appear to be affordable when only housing cost is considered are not necessarily affordable when transportation costs are taken into account. A negative correlation between housing affordability and transportation affordability is observed. We also identify the presence of a strong spatial clustering pattern in the affordability measure across the study area. A major methodological contribution of the paper is the inclusion of comprehensive private vehicle costs and public transportation expenses in the model that contributes to a more robust estimation and understanding of location affordability. The model also distinguishes between different trip purposes. Results suggest that plans and policies to improve housing affordability should be made in coordination with transportation infrastructure investment plans to ensure effective and equitable outcomes. Nevertheless, the focus of the paper is more on the measurement of affordability; rather than reviewing and recommending housing related policies.

## 1. Introduction

Housing is a critical component in urban planning and policy-making. Housing forms a large part of households' wealth and serves a unique and dual role as an investment opportunity and a durable good from which consumption services are derived. However, there is a general perception that the recent housing boom in a number of Organization for Economic Co-operation and Development (OECD) countries including Australia (Kohler and van der Merwe, 2015) has caused a significant decline in housing affordability (Gan and Hill, 2009). The result is a widening of differences in affordability across regions that cause various social and economic problems.

Housing affordability is a complex phenomenon. It is a function of household income, housing costs and cost of the remaining components of a standard living. Assessing housing affordability is often restricted by data availability and limitations on measuring living components' costs. Housing affordability is often defined and assessed in terms of economic viability, overlooking other important factors such as

transportation or accessibility cost. Traditionally, housing affordability is measured by the ratio of housing expenditure over household income (Kutty and New, 2005; Whitehead et al., 2008). As a common rule, households who spend > 30% of their income on housing costs while earning in the bottom 40% of the income range are considered to be under housing stress. This approach has been widely adopted by international housing policies because of its simplicity as it only relies on a few variables that are often easily computable (Mulliner et al., 2013). However, the housing expenditure and income approach has widely been criticised in the literature due to its arbitrary and normative nature (Hulchanski, 1995; Bogdon and Can, 1997; Stone, 2006) as well as its inability to account for transportation costs (CNT, 2012; Isalou et al., 2014; Mattingly and Morrissey, 2014; ITF, 2017).

Housing expenditure greatly depends on housing location. Houses located at the urban periphery or at locations with low residential density might seem more affordable but may suffer from less accessibility to various urban amenities and destinations with longer average travel distances and greater dependence on private vehicle use which

increases household expenditure (Mattingly and Morrissey, 2014; Currie, 2010; Low et al., 2006; Horner, 2002). On the other hand, houses located in and around the CBD areas are likely to attract high rental and mortgage fees. However, such locations often have a lower average travel distance to a wide variety of destinations and less reliance on private vehicles (Ewing and Cervero, 2010; Van Acker and Witlox, 2010). The complementary relationship between transportation costs and land rent has been recognized before in the context of "land rent theory". The relationship, however, has shown to be more complex and dependent on a range of external factors including location and land use (Haila, 1988; Jager, 2003; Alonso, 1964).

The cost of housing tends to decline with distance from nucleus of a city (Mattingly and Morrissey, 2014). However, the lower housing price in outer fringe of a city is often offset by high transportation cost (Currie and Senbergs, 2007). Areas located in urban fringe are more likely to rely on the use of private vehicle due to the lack of public transportation infrastructure. This reliance on the use of private vehicle is generally associated with larger number of vehicles owned per household, greater travel time and distance traveled. In Australia, the cost of transport is estimated as the second or third highest category of average household expenditure (ABS, 2005; 2011). Therefore, a traditional measure of location affordability, which overlooks the cost of transportation, does not reflect the actual cost of housing and thus, is misleading for urban planning and policy making.

There has been little research to investigate how the combination of housing and transportation cost can impact location affordability measurements. The objective of this study, therefore, is to develop an improved and expanded data-driven model of housing affordability with a focus on the greater Melbourne area in Australia. We build upon recent studies of housing and transportation affordability by the Center for Neighborhood Technology in the US (CNT, 2012), Mattingly and Morrissey (2014) from New Zealand, Acolin and Green (2017) from Brazil, and ITF (2017) from Mexico City. The improved model, in addition to direct housing costs, accounts for transportation costs including both the private vehicle ownership cost and public transportation usage cost. Rather than using a fixed travel cost as in previous studies, we break the travel cost into three categories; weekday work-related travel cost, weekday non-work related travel cost and weekend travel cost. This will give us better estimates of transportation expenditures by households. Note that the new housing and transportation affordability index is based on point estimates at the statistical area level 2 (SA2) which will be further discussed later in the paper. Through various visualizations of housing and transportation affordability, we demonstrate how combined housing and transportation costs vary spatially in the Melbourne metropolitan area and how the new measure presents a different picture of location affordability compared to the traditional measure of housing affordability. The study further investigates the presence of spatial clustering in relation to the new affordability index as well as how zonal socio-economic characteristics are correlated with the new index. The new affordability measure have implications on urban planning and policy making in determining where resources should be focused to enhance affordability.

The proposed housing and transportation affordability measure improves the existing H + T affordability index by taking into account a more realistic and detailed estimation of transportation costs. The proposed and applied measure has a number planning and policy implications and applications in identifying areas with reasonable accessibility for supply of affordable housing, providing location affordability information to homebuyers, revise development policies such as travel plans or reduced parking requirements to support affordable housing in certain areas with lower transportation costs, better evaluation of homebuyers' mortgage repayment capacity given the transportation costs, and better synchronize affordable housing plans with transportation infrastructure investment plans. Areas with lower housing costs and higher transportation costs are often more likely to experience social exclusion because of restricted accessibility and lack

of mobility options that could result in lower economic activity. Our findings identify the existing spatial patterns of affordability in Melbourne, as a case study, supporting previously observed patterns of high private car dependability and lower levels of income in outer suburbs in connection to housing costs. The findings can be used to improve future transportation infrastructure investment and housing plans to reduce the spatial inequality in location affordability and to ease accessibility disadvantage in the identified suburbs.

The remainder of the paper is organized as follows. Section 2 presents a review of previous studies on housing and transportation affordability. Section 3 describes the various data sources used in the development of the new affordability index and the case study. Section 4 explains the methodology for the new index. Section 5 presents the results and a discussion. The paper concludes with a summary of the major findings, assumptions, and limitations of the study.

## 2. Background

Housing affordability broadly refers to ability of households in obtaining and paying for appropriate housing without experiencing undue financial hardship (Milligan et al., 2004; Aribigbola, 2011; Wardrip et al., 2011; Torluccio and Dorakh, 2011; Isalou et al., 2014). A number of methodological approaches are used to measure housing affordability. Most housing affordability studies adopt the ratio approach by measuring the ratio of housing costs over household income. According to Hulchanski (1995), the ratio approach usually uses a benchmark average or percentile level of income and costs to assess the extent of variability between places or household types and/or assessing changing circumstances over time. In this approach, affordable housing is defined as when a household spends < 30% of their income on housing expenses such as rents, mortgages and basic utilities (Ndubueze, 2007). This is consistent with what is currently being used by the ABS housing stress (ABS, 2013) and CBA-HIA (Housing Industry Association, 2016) measurements. However, a simple ratio approach is unable to adjust for important changes such as interest rates, lending practices, the size and quality of dwellings being purchased or rented and changing proportions of first and second (or more) buyers (Sliogeris et al., 2008).

Glaeser and Gyourko (2003) proposed the use of housing price relative to its fundamental costs of production as a measure of housing affordability. The United Nations Human Settlement Programme (UNHSP) and the World Bank have also proposed the housing price to income ratio (PIR) as an indicator to measure housing affordability (Lin et al., 2014). The UNHSP defined housing PIR as the ratio of the median free-market price of a dwelling unit to the median annual household income. However, using the housing PIR as a measure of affordability is still limiting. The PIR approach does not control for changes in the quality of housing. Also the relationship between median house prices and median income does not account for actual financial constraints (Linneman and Megbolugbe, 1992; Lin et al., 2014).

Other researchers have used mortgage repayment rate as an indicator of housing affordability (Duca and Rosenthal, 1994). Robinson et al. (2006) suggested that the housing affordability measure which considers mortgage repayment has a limitation of accuracy due to the fact that long-term homeowners may have much lower monthly repayments, or have fully paid off their loan. Even for a median household mortgage repayment, it does not actually show the true cost of housing at the present state. Also, the mortgage repayment rate method does not often consider factors such as the down payment and loan-to-value ratio (Lin et al. 2014). Alternative housing affordability measures proposed in the literature include purchase and repayment affordability (Gan and Hill, 2009) and residual income after housing cost (Stone, 2006).

More recent studies have begun to address the importance of transportation costs in housing affordability measurement especially in the context of geographic location of housing and accessibility to transportation infrastructure. Currie and Senbergs (2007) showed that