

Working Paper

Location Affordability in New Zealand Cities: An Intra-urban and Comparative Perspective

New Zealand Association of Economists 2014 Annual Conference

Prepared by: Peter Nunns (MRCagney)
With support from Stuart Donovan, Saeid Adli,
and Alex Raichev (MRCagney);
and Geoff Cooper (Auckland Council).

MRCagney Pty Ltd

19 June 2014

MRCagney

Document Information

Project Name	**Location Affordability in New Zealand Cities: An Intra-urban and Comparative Perspective**
Document Name	Working Paper
Client	New Zealand Association of Economists 2014 Annual Conference
Job Number	
Prepared by	**Peter Nunns (MRCagney)** With support from Stuart Donovan, Saeid Adli, and Alex Raichev (MRCagney); and Geoff Cooper (Auckland Council). MRCagney Pty Ltd Auckland

Quality Assurance Register

Issue	Description	Prepared by	Reviewed by	Authorised by	Date
1	First Draft Issue	PN	SD, GC	PN	140619

www.mrcagney.com

Contents

List of Figures

1 Abstract

This paper investigates current patterns of location affordability within New Zealand's three largest urban regions, Auckland, Wellington, and Canterbury. It places these results in context using comparative data from other OECD countries and urban regions. It provides a more nuanced perspective on housing costs that incorporates other costs that vary by location, such as transport and household energy, in addition to the costs to purchase or rent a dwelling. Some areas that appear "affordable" based solely on housing costs alone become less so when other costs are considered. Based on this analysis, it discusses potential implications for policy, land use planning and transport infrastructure investment.

2 Introduction

2.1 The need for research into location affordability

This paper investigates current patterns of location affordability within New Zealand's three main urban regions, Auckland, Wellington, and Canterbury, and places these results in context by using comparative data from other OECD countries and urban regions to investigate the broad determinants of affordability. Its aim is to provide a more nuanced perspective on housing costs that incorporates location costs such as transport and household energy in addition to the costs to purchase or rent a dwelling. A more complete analysis of location affordability may find that some areas that are considered "affordable" in terms of housing costs alone are less so after accounting for transport costs due to their relative inaccessibility to employment and amenities, and vice versa.

This paper is timely for two reasons. First, housing affordability is currently an important topic in New Zealand. Widely-reported international studies, such as the annual Demographia housing affordability study, regularly identify New Zealand cities as some of the most "unaffordable" locations for housing on the basis of a comparison between average house prices and per-capita incomes. In New Zealand, the Productivity Commission's 2012 inquiry on housing affordability focused primarily on the supply and demand factors contributing to relatively high housing costs.

Second, the Auckland Plan was recently written to plan for expected future population and economic growth. It establishes a number of targets or goals that have potentially significant effects on affordability, including (1) the goal of containing up to 70% of future development within 2010 urban limits (and accommodating up to 40% of growth outside this area), (2) up-zoning of significant amounts of residential land to allow for higher densities, particularly along public transport corridors, and (3) investments in transport infrastructure to support increased mobility and public transport patronage. Taken together, these factors will influence Auckland's affordability – but in which direction?

2.2 Structure of this paper

This paper includes four main components as follows.

First, we undertake a literature review that looks at previous empirical studies of housing and location affordability, along with economic perspectives on location costs and location affordability. This paper is motivated by three main strands in the literature:

- Previous empirical studies on location affordability that have attempted to examine variation in affordability within New Zealand cities and between cities
- The new economic geography literature, which considers the determinants location choices in urban areas and which studies how land values (and hence housing affordability) respond to changes in productivity or transport accessibility
- The theoretical and empirical literature on the costs and benefits of planning regulations and transport investments, which provides some insights into how policy may affect location affordability.

Second, we develop a new Location Affordability Index (LAI) for New Zealand's three main urban regions (Auckland, Wellington, and Canterbury) using 2013 Census data and transport cost indices. In doing so, we update previous research on housing and transport costs in Auckland (Mattingly and Morrison (2013), which used 2006 Census data). The LAI enables a partial picture of location affordability that compares median household incomes with median rental costs and estimated average car ownership and average commute costs at a detailed geographic level. Results for Auckland are largely consistent with previous analysis due to the fact

that there has been relatively little change the distribution of Auckland's residential population from 2006 to 2013, except insofar as they reflect changes to transport and housing costs.

Second, we discuss avenues for extending the LAI, testing the feasibility of (1) incorporating additional elements of location affordability such as non-commute transport costs and household energy costs, (2) incorporating alternative measures of housing costs based on house price data or estimated mortgage servicing costs, (3) developing additional measures of household income for specific household types to allow for a more nuanced analysis, and (4) improving transport cost estimates using public transport fare data. We find that it is desirable to incorporate additional costs, but that data is not always available to support a robust analysis, especially with respect to non-commute transport costs. We implement several alternative affordability measures for selected household types in the Auckland region, showing that affordability outcomes for two particular household types – single-parent families and retired couples – are significantly worse than for overall Auckland households.

Finally, we place Auckland and New Zealand's location affordability in comparative perspective. In order to do so, we compile a dataset of household budget surveys from 28 OECD countries to conduct a high-level comparison of housing, transport, and household energy costs at a national level. We also analyse outcomes at an urban level for 36 cities in Australia, Canada, New Zealand, and the United States. Internationally, we note that total housing and transport costs make up a remarkably consistent share of average household budgets in OECD countries that vary considerably in average incomes, transport options, and urban form. New Zealand as a whole does not appear to be particularly unaffordable. Auckland and Wellington households spend a greater share of their budgets on location-related costs than households in most Australian and Canadian cities, but a lower share than households in United States cities.

3 Literature review

This paper is motivated by three strands of the economic literature on urban economies, transport and property markets. In this section, we review relevant literature and discuss the implications for an analysis of location affordability within New Zealand cities.

3.1 Previous empirical studies of location affordability

Broadly speaking, previous empirical studies of location affordability fall into two categories.

First, there are studies that focus solely on variations in housing cost, either within or between cities. This category of studies includes international comparisons of house prices, which often compare median house prices to median incomes at an urban level (Demographia, 2013) or at a national level (OECD, 2013b; IMF, 2014). In recent years, these studies have often indicated that New Zealand cities, and New Zealand as a whole, have relatively high house prices. Other studies have attempted to identify variations in housing prices within New Zealand at a regional level (Grimes, Holmes and Tarrant, 2010; Statistics NZ, 2013c) or within Auckland (Leggatt-Cook, 2007).

Housing affordability studies have been influential in policy debates and in the public discourse. Auckland house prices have steadily increased over the last decade, in contrast to trends observed in some other regions, while rents have risen in Christchurch following the 2011 Canterbury Earthquake. The Productivity Commission (2012) conducted an inquiry into housing affordability in New Zealand, focusing on the drivers of high house prices.

Second, a number of recent studies have taken a broader focus than house prices alone. They attempt to incorporate other costs that vary by location, such as transport and household energy, in addition to the costs to purchase or rent a dwelling. Research into urban form and travel behaviour has found that transport costs vary between different locations depending upon a range of factors such as urban form, availability of transport, and accessibility to jobs and services (Bento et al, 2005; Jacob, Craig and Fisher, 2006; Næss, 2006; Currie and Senbergs, 2007; Horner, 2007; Vance and Hedel, 2007; Brownstone and Golob, 2009; Ewing and Cervero, 2010; Donovan and Munro, 2013).

Another strand of the literature on location affordability focuses on the external costs associated with different locations, including infrastructure costs and negative externalities related to energy use and congestion on transport networks. These costs are not consistently borne by households and hence tend to be excluded when analysing impacts on household budgets. External costs include, but are not necessarily limited to:

- Unpriced externalities associated with transport behaviours, including carbon dioxide emissions, noise and vibration, accident costs, and the costs of congestion that are borne by society or the environment (for some documentation, see NZTA (2013), CE Delft (2008)). These externalities are for the most part associated with travel by private vehicle.
- Infrastructure costs, which are not always borne directly by households. Costs to provide transport, water and wastewater, and social infrastructure appear to vary between existing urban areas and greenfield areas (Litman, 2013). Studies from Perth (Trubka, Newman and Bilsborough, 2008) and Sydney (CIE and Arup, 2012) and a forthcoming study of Auckland (CIE and Arup, 2014) identify variations in infrastructure costs between different areas in cities. This research finds that new developments in fringe areas tend to be more costly to service with infrastructure than developments in inner-city areas.

Detailed studies of variations in housing and transport costs have previously been undertaken in several jurisdictions. The Center for Neighbourhood Technology developed a Housing and Transport Cost Index for a

range of cities (Center for Neighborhood Technology, 2006, 2011; Lipman, 2006; Haas, Makarewicz, Benedict and Berstein, 2008). The US Department of Housing and Urban Development and Department of Transport later extended and updated their work in their Location Affordability Index (HUD and DOT, 2013). Litman (2014) summarises a range of other empirical evidence on variations in location-related costs, while Kelly and Mares (2013) consider the equity implications of high housing and transport costs on the fringes of Australian cities.

In New Zealand, Mattingly and Morrissey (2013) estimated housing and transport affordability for Auckland using 2006 Census data. Adli and Raichev (2014) built upon this work to develop an interactive tool for estimating household housing and commute costs. However, the results of New Zealand-specific research are not open to a straightforward interpretation. Mattingly and Morrissey (2013) find that certain areas are more costly than others – and that these areas tend to be home to wealthier households. These results do not establish whether Auckland has a broader problem with location affordability, or whether observed differences simply represent sorting of households within Auckland's land market.

This strand of the literature suggests that it is that it is necessary to quantify all location-related costs when considering affordability. However, the empirical literature is largely silent on whether variations in affordability represent a problem for policy. As Glaeser and Gyourko (2002) note, evidence of variations in the share of household budgets spent on location-related costs is not necessarily evidence that there are problems with policy or land markets – they may simply indicate that some groups face issues with low incomes.

3.2 The new economic geography literature

The new economic geography literature provides theoretical and empirical evidence on the relationship between incomes/productivity, land costs (a determinant of housing costs), and transport accessibility.

The theoretical literature attempts to explain location choices between regions and within urban areas (McCann and Shefer, 2005). It identifies a trade-off between the accessibility of locations (which will be influenced by infrastructure as well as physical density) and land prices (Arnott, 1981; Krugman 1991, 1994). Land prices tend to be higher in more accessible areas, and land uses more intensive. These effects are observed at both a regional level – with manufacturing and service activities tending to locate in large urban areas to be close to markets – and within cities. For example, high-productivity service activities tend to occupy central business districts while activities such as manufacturing and distribution, which require more land, locate in fringe areas.

The empirical literature provides evidence for these predicted relationships. Literature on agglomeration at a regional and intra-urban level suggests that productivity tends to be higher in denser or more accessible places (Venables, 2007, 2010). In a similar vein, Graham and Maré (2009) estimate agglomeration elasticities for New Zealand industries, while Maré (2008) measures variations in productivity and industry location within Auckland. However, it is unclear whether agglomeration effects are caused by higher density or accessibility, or whether they represent self-sorting of firms (Graham and Van Dender, 2010) and households (O'Fallon and Wallis, 2012).

In addition, empirical literature has examined outcomes after the development of new transport infrastructure, observing that an increase in the accessibility of a place is associated with an increase in land values (and in some cases an intensification of land uses). Grimes and Liang (2010) and Grimes and Young (2010) find evidence that the development of new transport infrastructure in Auckland is associated with a rise in relative property prices in the areas affected. Similar work on rapid transit infrastructure in the United States and other jurisdictions (e.g. Cervero, 1992; Cervero and Kang, 2009; Hurst, 2011) suggests that new infrastructure provision is associated with an uplift in land values. However, these studies do not always identify change in the intensity of land use, although Coleman (2010) suggests that highway development in the United States and New Zealand has resulted in a relatively dispersed urban form.

In short, the new economic geography literature predicts a trade-off between housing and transport costs, with more accessible locations commanding a price premium. The fact that higher transport costs offset lower housing costs in some areas is not necessarily evidence of a problem for policy, unless there are significant unpriced externalities such as greenhouse gas emissions or significant external costs for infrastructure that are not borne by households. The implication for this paper is that it would be reasonable to expect there to be a negative correlation between housing prices and accessibility, all other things being equal.

3.3 Research into the costs and benefits of land use regulations

The empirical literature on costs and benefits of land use regulations observes that regulations may act as a tax on urban land markets which introduces a wedge between the cost to build new housing supply and the cost to buy it. When considering these effects, is important to note that the incidence of this regulatory tax is not necessarily confined to the particular area (or type of housing) in which activity is prohibited or limited. It will spill over between fringe and inner-city areas (and vice versa) as a result of households' on-the-margin decisions about location. (In other words, the household that's regulated out of an apartment in Mount Eden buys a detached house down the road in Three Kings, pricing out another buyer who goes to Onehunga instead, and so on and so forth…)

Research into the effect of planning regulations on housing costs has often focused on United States cities. Glaeser and Gyourko (2002) examine these issues across a range of United States metropolitan areas, finding that cities with more regulated housing markets tend to be less affordable. Follow-up work by Glaeser, Gyourko and Saks (2005a, 2005b) shows that changes to regulatory policy since the 1970s have been associated with changing levels of affordability. Other researchers observe similar results in New York (Bram, 2012) and California (Quigley and Raphael, 2005; Quigley, 2007). Other research has focused on specific regulations such as maximum building heights and minimum parking requirements (Portland Bureau of Planning and Sustainability, 2013).

Research from Australia suggests that planning regulations also affect house prices in other jurisdictions. Goodman, Buxton et al (2010) suggests that regulations are likely to have an effect on house prices, but that it is not possible to draw generalised conclusions due to the influence of other variables. Kulish, Richards and Gillitzer (2011) model the effect of a range of factors on urban structure, finding that building height restrictions are likely to raise housing prices and lower inner-city densities relative to the unconstrained equilibrium. McLaughlin (2011a, 2011b) finds both that land use regulations reduce the elasticity of supply of new dwellings and that elasticities of supply vary between different building types.

New Zealand-based research is less developed and has often focused on one particular regulation – Auckland's Metropolitan Urban Limit (MUL), which will be replaced by a more flexible Rural-Urban Boundary after the Auckland Unitary Plan is implemented. Previous analyses have found that this policy has raised house prices, with a negative effect on welfare, by constraining greenfield development (Grimes and Liang, 2007Productivity Commission, 2012; Zheng, 2013; Lees, 2014). However, the MUL is only the tip of the iceberg when it comes to land use regulations. A significant number of regulations, including but not limited to minimum lot sizes, building setbacks, building height limits, minimum apartment sizes, heritage zoning, and minimum parking requirements, constrain development and redevelopment both within the existing urbanised area and greenfield areas. These regulations are likely to constrain new supply in existing urbanised areas – especially considering that the supply of vacant sections within Auckland's urbanised area fell from almost 13,000 in 2002 to under 4,000 in 2012 (MBIE, 2013).

More recent work has attempted to fill this gap in the literature by estimating the costs of a range of other land use regulations. MRCagney (2012, 2013) examine the cost of minimum parking requirements, while Luen

(2014) considers the cost of building height regulations and estimates the difference between the cost to build and the cost to buy (using a methodology drawn from Glaeser and Gyourko, 2002). While this literature is relatively new, we note that many of the specific regulations under study will tend to raise the cost of smaller dwellings in or near the city centre. This is likely to have a disproportional effect on smaller or non-traditional households – working adults living alone, single parents, retirees seeking to downsize from large houses, et cetera – while still ensuring a supply of housing for traditional nuclear families.

The literature on costs of planning regulations suggests that the predictions of new economic geography may not necessarily hold. It may be the case that households are unable to find housing in the optimal location for their budget due to constraints on building in that area. In this case, some households might be expected to spend a greater share of their budgets on location-related costs than others. Furthermore, this may have a geographical component – for example, if households seek to minimise housing costs first and then pay transport and other costs with the remains of the budget.

Consequently, one potential indicator of a problem might be that lower-income households are spending a greater share of their budgets on housing and transport costs, as they are the households that are most likely to be priced out of the most accessible places. This also introduces significant issues around social equity. Following this literature, this paper examines location affordability for several household types that may not necessarily be served well by traditional planning policy.

4 Approach to developing a Location Affordability Index for New Zealand

In this section, we describe our approach to developing an LAI for New Zealand's three main urban regions. It begins by identifying the main categories of location-related costs – housing, transport, and household energy – and approaches to measuring location affordability.

We then define a methodology for measuring housing costs and selected transport costs, and describe the data and estimates underlying the LAI. In addition, we discuss caveats and limitations to our analysis, and identify a number of data sources that could potentially be used to close data gaps and incorporate additional location-related costs, such as non-commute transport costs and household energy (heating) costs, into the LAI in the future.

4.1 Defining and identifying location-related costs

Our review of the empirical literature on location affordability identifies three main categories of location-related costs that are borne directly by households:

- Housing costs, which vary within and between urban areas
- Transport costs, which tend to rise in areas that are more distant from employment, retail, and other attractors of transport demand
- Household energy costs, which are a function of dwelling characteristics and hence often included in housing costs.

As noted in the literature review, households do not necessarily bear all of the costs associated with location choices. While we do not attempt to estimate external costs in the LAI, we note that the social costs of some locations may exceed the private costs of those locations.

4.2 Two measures of affordability

Previous studies on location-related costs have generally adopted one of two approaches to calculating the affordability of different locations.

The first approach, the ratio measure, estimates the share of household incomes that must be spent on housing and transport costs. Alternatively, ratios are used to examine the multiple of house prices to incomes. This approach may understate affordability for higher-income households, as they have larger household budgets to spend on housing and transport, while overstating affordability for lower-income households.

The second approach, the residual measure, estimates how much of an average household's budget is left over after housing and transport costs are deducted. The residual method may provide a better indication of whether location-related costs are likely to result in material deprivation for households. However, interpreting the results clearly requires additional information about households' basic needs in areas other than housing and transport.

LAI estimates are reported as ratios that compare average housing and transport costs to average household incomes. We have chosen the ratio measure, in spite of its drawbacks, due to the fact that it is easier to interpret and compare with previous work. In doing so, we note that the LAI variables can also be used to calculate a residual measure of location affordability. This measure may be particularly useful when seeking to understand whether housing and transport costs result in absolute material deprivation in any areas within New Zealand cities.

4.3 Approach to estimating housing and transport costs in New Zealand cities

Our approach to estimating housing and transport costs at a detailed geographic area in New Zealand cities was informed by a literature review of previous empirical work in this area. Mattingly and Morrissey (2013) developed location affordability estimates for Auckland using 2006 Census data, which enabled estimates of housing costs and some transport costs (car ownership and variable costs for commuters). In the United States, HUD and DOT (2013) developed a more comprehensive index, building on previous research by the Center for Neighbourhood Technology (2006; see also Haas et al, 2008). This work used regression modelling to estimate costs related to car ownership, car use, public transport use, rents, and home ownership based on independent household and local environment variables.

We note that the modelling approach used in the United States offers advantages in terms of its comprehensive coverage of all housing and transport costs. However, implementing it for New Zealand cities is challenging due to the fact that the information required to estimate appropriate regression coefficients is not readily available[1]. As a result, we have adopted a methodology that is consistent with Mattingly and Morrissey (2013)'s approach, while considering opportunities to upgrade or improve upon estimates.

The LAI estimates the share of median household income that is expected to be spent on housing, car ownership, and variable commute costs at a detailed geographic area. Affordability estimates are developed at the level of the Census area unit (AU), a standardised geographic category that generally includes between 500-2,000 households.

Equation 1 describes how we have estimated an affordability ratio for individual area units. We have used median rather than mean values for rents and household incomes to avoid skewing data with outliers; however, when calculating commute and car ownership costs we used mean values to account for different modes of transport.

Equation 1: Ratio measure of location affordability

$$Aff_i = \frac{Rent_i + Car_i + Comm_i}{HI_i}$$

where:

i = selected Auckland area unit

Aff_i = Housing and transport affordability ratio, calculated as average housing, car ownership, and commute costs in area unit i expressed as a percentage of the selected household income measure

HI_i = Selected measure of median household income, either in the region as a whole or in area unit i

$Comm_i$ = Weighted average variable cost of commuting per household in area unit i

Car_i = Average annual cost of car ownership per household in area unit i

$Rent_i$ = Median rent for a dwelling in area unit i.

Equation 2 describes our approach to estimating average car ownership costs at an area unit level.

[1] For example, no data on variation in home ownership costs at a household or detailed geographic area is currently available. In principle, this information could be gathered from Statistics NZ's Household Economic Survey; in practice, confidentiality rules prevent Statistics NZ from making that data readily available.

[2] We have applied the same average car ownership and operating costs across all household types. However, we note that wealthier households are likely to purchase newer or more expensive cars while low-income households may own older or cheaper cars. HUD and DOT (2013) modelled car ownership costs that varied depending upon income level. This may be worth considering in an LAI update.

[3] AA (2013) provides data on ownership costs for cars that are three years old, on average. However, regional vehicle fleets have an average age of 12-14

Equation 2: Estimated car ownership costs

$$Car_i = \frac{NCar_i}{NHH_i} * OwnCost$$

where:

i = selected Auckland area unit

Car_i = Average car ownership cost per household in area unit i

$NCar_i$ = Total number of cars in area unit i

NHH_i = Total number of households in area unit i

OwnCost = Average annual cost of vehicle ownership, including vehicle registration, insurance, warrant of fitness, interest, and depreciation costs.

Equation 3 describes our approach to estimating average variable costs of commutes at an area unit level.

Equation 3: Estimated commute variable costs

$$Comm_i = \frac{\sum_j(PV_{i,j}*D_{i,j}*PVCost)+\sum_j(PT_{i,j}*PTCost_{i,j})+\sum_j(Act_{i,j}*Dist_{i,j}*ActCost)}{\sum_j(PV_{i,j}+PT_{i,j}+Act_{i,j})} * HW_i$$

where:

i = selected Auckland area unit from which commute trips originate

j = Auckland area unit to which commute trips are destined

$Comm_i$ = Weighted average commute cost per household in area unit i

$PV_{i,j}$ = Number of commute trips taken by car (and other private vehicles) from area unit i to area unit j

$PT_{i,j}$ = Number of commute trips taken by public transport from area unit i to area unit j

$Active_{i,j}$ = Number of commute trips taken by walking or cycling from area unit i to area unit j

$D_{i,j}$ = Distance on the road network from the centroid of area unit i to the centroid of area unit j

PVCost = Average per-kilometre cost of operating a motor vehicle during the AM peak

$PTCost_{i,j}$ = Estimated average cost of travelling from the centroid of area unit i to the centroid of area unit j by public transport

ActCost = Average per-kilometre cost of walking or cycling during the AM peak (assumed to be equal to zero)

HW_i = Average number of commuters per household in area unit i.

4.4 Data and estimates underlying the LAI

Data from the 2013 New Zealand Census was the primary source of information used to create the LAI. We obtained the underlying data from Statistics NZ's Meshblock Database (Statistics NZ, 2013a), available online, as well as from custom data requests for further information on household incomes, rents and commuting patterns. We also incorporated additional sources of information on transport costs, including car ownership costs, car operating costs, and public transport fares. Table 1 describes the sources of data underlying the LAI estimates. A summary of this data is provided in the following tables.

Table 1: Main sources of data used in the LAI

Variable	Description / comments	Source

Household income measures	We included three alternative measures of household income: ↘ Median household income within individual area units ↘ Median household income within regional council areas ↘ Median household income for selected household types at a regional council level	Census 2013
Housing costs	We used median rents as a proxy measure of housing costs. This data was available at an area unit level in the Meshblock Database and for particular sizes of dwellings (e.g. one bedroom dwellings) through a custom data request.	Census 2013
Car ownership	We estimated average car ownership per household at an area unit level based on data in the Meshblock Dataset.	Census 2013
Commute distances and modes	We estimated average commute costs at an area unit level based on Census data on main means of travel to work and on the location of residence and employment. Statistics NZ provided regional origin-destination matrices for travel to work by each mode (private vehicle, public transport, and active modes) that allowed us to estimate distances travelled to work by mode for each area unit. We calculated road network distances between area unit centroids using OpenStreetMap data. Average distances travelled within each area unit were estimated based on the average distance from the area unit centroid to each of 100 randomly selected street addresses within the area unit.	Census 2013; OpenStreetMap data; author's calculations
Annual car ownership costs	We estimated annual car ownership costs based on AA (2013), which estimated ownership costs for petrol cars of various engine sizes, Ministry of Transport vehicle fleet data, which allowed us to estimate variations in fleet composition between regions, and supplementary information on vehicle depreciation and interest costs.	Various; author's calculations
Average car operating costs	We estimated annual car ownership costs based on AA (2013), which estimated operating costs for petrol cars of various engine size and Ministry of Transport vehicle fleet data, which allowed us to estimate variations in fleet composition between regions.	Various; author's calculations
Public transport fare costs	We matched area unit centroids to PT fare zones using geographic information published by regional transport agencies; information about PT network structure was used to estimate transfers and fare zone distances. We note that it is difficult to fully quantify the costs of transferring between different services.	Various; author's calculations

Table 2 summarises the main variables and estimates derived from the 2013 New Zealand Census for each of the three regions included in the LAI. We note some important variations between these three regions:

- Households tend to be larger in Auckland than in Wellington or Canterbury
- Median household income is higher in Auckland and Wellington than in Canterbury
- Average bedrooms per occupied dwelling are similar in all three regions; however, median weekly rents are higher in Auckland than in the other two regions
- Average car ownership per household is lower in Wellington than in Auckland or Canterbury

- Aucklanders travel further to work, on average, than Wellingtonians or Cantabrians
- Wellington has the lowest rate of private vehicle commuting, and the highest rate of commuting by public transport or by walking and cycling
- Auckland and Canterbury have similar private vehicle mode shares; Auckland has a considerably higher rate of commuting by public transport while Cantabrians are more likely to commute by active modes.

Table 2: Summary of main LAI variables, by region

Region	Auckland	Wellington	Canterbury
Household characteristics			
Average household size	3.0	2.6	2.5
Median household income	76,500	74,300	65,000
Housing costs			
Mean bedrooms per occupied dwelling	3.1	3.0	3.1
Median weekly rent	350	300	280
Car ownership			
Mean number of cars per household	1.8	1.5	1.8
Commute travel			
Mean distance travelled to work (km)	10.6	10.0	9.7
Region-wide commute mode share on Census day			
Private vehicle driver / passenger	83.7%	65.4%	85.5%
Bus, train, or ferry	9.9%	19.0%	3.5%
Walking or cycling	6.4%	15.6%	11.0%

Source: 2013 NZ Census

Table 3 summarises the car ownership and operating cost variables that we used to estimate transport costs[2]. These estimates are based on data in AA (2013), with adjustments to reflect expected depreciation and differences in fleet composition[3].

We note that the per-kilometre private vehicle operating costs reported in this table are likely to understate operating costs for the entire vehicle fleet. AA (2013) publishes per-kilometre operating costs are for cars that are three years old; however, vehicle fleet statistics suggest the fuel economy of vehicles entering the New Zealand fleet has increased by approximately 10% over the last eight years (MoT, 2014). As a result, we also tested a higher per-kilometre operating cost of $0.305/km from NZTA (2013), which is likely to reflect additional information about trends in vehicle efficiency and the age of the NZ vehicle fleet. This higher value does not influence our estimate of which areas are relatively more or less affordable.

[2] We have applied the same average car ownership and operating costs across all household types. However, we note that wealthier households are likely to purchase newer or more expensive cars while low-income households may own older or cheaper cars. HUD and DOT (2013) modelled car ownership costs that varied depending upon income level. This may be worth considering in an LAI update.

[3] AA (2013) provides data on ownership costs for cars that are three years old, on average. However, regional vehicle fleets have an average age of 12-14 years (MoT 2014) and as a result we have assumed that vehicle values will be equal to a "residual cost" of approximately 20% of their initial value. We have also used alternative values for depreciation (7% per annum, to reflect slower depreciation in older cars) and vehicle financing costs (12.8%, or the unweighted average of vehicle loan rates published on interest.co.nz).

Table 3: Car ownership and operating costs, by region

Region	Auckland	Wellington	Canterbury
Average operating costs ($/km)	$0.255	$0.254	$0.258
EEM annual operating costs ($/km)		$0.305	
Average fixed costs ($/car/year)			
Vehicle value	$7,935	$7,874	$8,087
Annual registration	$288	$288	$288
Comprehensive insurance	$790	$786	$795
Warrant of fitness (annual)	$98	$98	$98
Total outlay	*$9,110*	*$9,046*	*$9,268*
Interest on outlay (at 12.8% pa)	$1,169	$1,161	$1,189
Depreciation (at 7% per annum)	$555	$551	$566
Total*	**$2,900**	**$2,884**	**$2,936**

** Sum of annual registration, insurance and WOF costs plus interest and depreciation*

Source: AA Petrol Car Operating Cost Report (2013), MoT (2014) Transport Indicators, author's calculations

Table 4 presents data on public transfer fares for the three regions included in the LAI. New Zealand's three main urban regions all have public transport systems that provide service to most urbanised areas. Auckland and Wellington have public transport networks that include buses, trains, and ferries, while Canterbury's public transport network includes only buses and ferries. All three cities have zone-based fare systems in which fares are levied based on the number of zones traversed[4]. Fare zones have generally been equalised between different public transport modes, with some exceptions[5].

In contrast to Mattingly and Morrissey (2013), who estimated public transport costs using road network distances and average per-kilometre fare costs from MRCagney and Wallis (2011), we have attempted to estimate actual public transport fares. In order to do so, we matched area unit centroids to fare zones based on information published by regional transport agencies. We then incorporated information on public transport network structures and urban geography to identify the number of fares and service transfers that would be required to travel between areas. Finally, we used published information on fares for stored-value cards, summarised in Table 4, to calculate the cost of public transport commute trips[6].

Table 4: Public transport fares, by region

Region	Auckland	Wellington	Canterbury
Stored-value card fares for rail or bus trips			
One stage	$1.62	$1.66	$2.50
Two stages	$3.06	$2.73	$3.60
Three stages	$4.05	$3.63	$4.55
Four stages	$5.04	$4.08	N/A

Source: Auckland Transport, Metlink, Metro Canterbury

Finally, we have been forced to exclude parking costs due to a lack of robust, detailed data on parking costs across all three regions[7]. We also lack information about the incidence of parking costs (i.e. whether employees are provided with free parking by employers). While car parks carry a considerable economic cost regardless of where they are located, they are not consistently priced and thus may not carry a direct financial cost for commuters. We note that car parks are most likely to be priced in main centres such as the Auckland and Wellington CBD and some secondary centres. Consequently, we expect that our estimates understate commute

[4] Public transport users who transfer between services often must pay twice to travel within one stage. Auckland and Wellington offer small fare discounts for users of stored value cards, while Canterbury does not charge stored value card users twice for travel within a zone when transferring.

[5] These exceptions principally relate to commercial services such as airport buses and ferries.

[6] In March 2013, Wellington and Canterbury had implemented stored value cards, while Auckland was in the process of rolling out a stored value card. Stored value cards offer discounts on cash fares and as a result we would expect them to be used by regular commuters. Options for purchasing multiple-trip tickets were generally equivalent to fares offered through stored value cards.

[7] Douglass and Abley (2011) present a database on parking supply and parking behaviours as they relate to land use, but do not address parking prices.

costs for areas with high rates of CBD-bound commutes. We discuss options for including parking costs in a future update of the LAI below.

4.5 Estimating location affordability for particular household types in Auckland

We have also incorporated additional measures of household income that allow us to estimate affordability in Auckland for a range of household types. The purpose of this analysis is to examine whether there are any obvious gaps in Auckland's housing market – i.e. whether housing and transport policy is failing to meet the needs of any specific types of households. We focus on three types of household that may be ill-served by traditional housing policy and which are likely to grow in significance in the future due to demographic trends[8]. The three selected household types[9] are:

- Single parent family [One parent with child(ren)]
- Working-age adult living alone [One-person household, aged 15-64]
- Retired couple [Couple only, aged 65 years and older]

These household types have regional median incomes below the median for all households. In addition, they are likely to have somewhat different housing requirements than other families, as they are also smaller than the median household.

We have modelled location affordability for these households using the equations presented above, with some variations as follows:

- We have used regional median household income for selected household types, rather than area unit median household income
- We have estimating housing costs based on the expected average number of bedrooms per household member and area unit level data on median rents for dwellings by number of bedrooms
- We have estimated commute costs based on the average number of working-age adults per household, regional average employment rates for working-age people and estimated variation in per-worker commute cost between different area units
- We have estimated car ownership costs based on estimated variation in car ownership per adults between different area units.

Table 5 summarises key characteristics for selected household types and the housing and transport requirements we used to model housing and transport costs for these three household types.

[8] MBIE (2013) projects that single-person households and couples without children (including but not limited to retired couples) will be the two fastest-growing household types in Auckland over the next two decades.

[9] Based on Statistics New Zealand's Household Composition Classification, Level 2, which includes information on the size and family structure of households.

Table 5: Characteristics of three selected household types, Auckland region

Household description	Single-parent family	Working-age adult living alone	Retired couple
Household Composition Level 2	One parent with child(ren)	One-person household, aged 15-64	Couple only, aged 65 years and older
Average household composition			
Under 15	0.9	0	0
15-64 years	1.7	1	0
Over 65	0.1	0	2
Total	2.7	1	2
Median household income	**39,000**	**45,900**	**49,900**
Modelled housing and transport requirements			
Regional average number of bedrooms	2.0	1.0	2.0
Regional average cars / household*	1.4	0.7	1.5

** Car ownership and commute costs vary between different area units* *Source: 2013 NZ Census, author's calculations*

4.6 Alternative sources of data on housing and transport costs

Although we ultimately used Census data as our primary source of information in constructing the LAI, we considered a broader set of data sources when developing our methodology. An LAI based on Census data is subject to two potential methodological criticisms based on its approach to estimating housing and transport costs.

First, the LAI uses rents as a proxy for housing expenditures, under the assumption that rents provide a good indicator of the value of housing services from both rented and owner-occupied dwellings. This is a potentially controversial choice, as most discussions of housing affordability focus on the costs to purchase dwellings. Using rents as a proxy measure will tend to overestimate actual financial costs for households with significant equity, and potentially underestimate them for households that have purchased more recently. In addition, data published in IMF (2014) and OECD (2013b) suggests that New Zealand's ratio of house prices to rents has risen significantly above its historical average in the last decade. This suggests that in some areas, the cost of servicing a mortgage may be considerably greater than the value of the housing services embodied in a dwelling.

We note that the use of rental prices as a proxy measure of housing costs is consistent with the approach used by Statistics NZ in its calculations of GDP from owner-occupied property. Statistics NZ estimates the value of housing services from owner-occupied property based on "imputed rents" for a similar dwelling (Statistics NZ, 2012). However, we recognise that further analysis of housing costs may be needed and as a result we discuss alternative sources of data that could be used to estimate mortgage costs for owner-occupied dwellings.

Second, the LAI only estimates transport costs related to commute trips and to vehicle ownership, while excluding costs related to other trips (e.g. shopping, education, recreation, et cetera). Commute trips make up a significant share of peak period traffic but a smaller share of overall travel. Data from the Ministry of Transport's (2013) Household Travel Survey suggests that commutes account for around 18% of total trips. By comparison, shopping, personal business and medical trips account for around 36% of total trips. This may mean that we significantly under-estimate total household transport costs in some areas where a greater proportion of non-commute trips must be made by vehicular modes or over long distances. This issue should be considered when using LAI estimates.

We chose to focus on commute costs alone after reviewing alternative sources of information on transport costs in Auckland and finding that at present none were sufficiently detailed and comprehensive to enable a robust analysis of non-commute transport costs.

In order to facilitate a broader discussion about options for improving location affordability measures for New Zealand, we have reviewed the alternative sources of data that could be used to supplement the Census

measures. In doing so, we emphasise that these should be seen as supplementary estimates, rather than replacements for more robust Census data.

Table 6 summarises alternative sources of information on housing and transport costs in New Zealand and comments on the feasibility of incorporating them into the index. In several cases, we identify sources of information that may prove useful for extending the LAI, but in each case methodological and data quality issues pose barriers.

In most cases, alternative sources of data (e.g. on house prices or electronic card spending on fuel) reinforce our findings. Broadly speaking, variations in median rents appear to align with median house prices, while areas with higher estimated car commute costs tend to have higher average electronic card spending on fuel (Polkinghorne, 2014). This suggests that the measures used in the LAI are likely to provide a good estimate of variations in overall housing and transport costs.

Table 6: Alternative sources of data on housing and transport costs in New Zealand cities

Data source	Comments
Housing cost data	
Property IQ / Quotable Value (QV) data on house prices	This data has been used in a range of papers on New Zealand housing markets to estimate affordability for homebuyers. It has also been used in Grimes and Liang (2010) and Grimes and Young (2010) to estimate the impacts of transport improvements on house prices. QV data can be input into a GIS in order to estimate average house prices within area units, potentially supporting an analysis of affordability It would be difficult to align house price data with Census data. The Census asks households whether they rent, own directly, or own through a trust but does not ask about duration of ownership or outstanding value on mortgages. Without further information on homeowners' equity, it would not be possible to robustly estimate average financial costs for households.
Auckland Council rating valuation database	This data is used in MRCagney (2012, 2013) to estimate impacts of minimum parking and minimum apartment size regulations. Access to this data is subject to confidentiality deeds and restrictions around use for other purposes. In addition, we note that it is also subject to the same issues as the QV data.
MBIE New Zealand Housing and Construction Quarterly (NZHCQ) bond lodgement database	NZHCQ publishes quarterly data on mean rents associated with new bond lodgements at a detailed area level. This database has several drawbacks compared with the Census data – it provides no information on continuing tenancies, and is not available at the same detailed geographic level. As a result, it is not a suitable alternative source for rental costs.
Transport cost data	
Marketview Ltd data on retail sales by credit card (presented in Fairgray (2013)	Marketview Ltd publishes information on the location of retail spending by credit card, broken down by location of cardholder. This data covers a significant share of retail transactions and is summarised in Fairgray (2013). This data can be used to identify how far the average household in each Auckland area unit is likely to travel to access retail. Broadly speaking, this data suggests that retail trips are likely to be longer in areas where average commute distances are longer. However, incorporating Marketview Ltd data into the LAI would be challenging due to the fact that it does not contain any information about the transport modes used for retail trips or whether retail trips have been combined with other (work or education) trips.
Fuel purchases by [Westpac] electronic card (presented in Polkinghorne (2014))	Electronic card transaction data can also be used to identify average household spending on fuel, broken down by location of cardholder. This data covers a significant share of overall fuel purchases and as a result provides a good indication of household spending on motor vehicle operation. Polkinghorne (2014) presents and analyses this data, which suggests that households in areas with longer commutes tend to spend more on fuel. While this reinforces our findings from the Census data, it is not possible to incorporate fuel purchase data without risking

	double counting of some household travel costs.
Auckland Transport HOP card data on public transport trips and similar data from stored-value cards used in Wellington and Christchurch	AT's HOP card data could in future be used to identify the origin, destination, and distance of trips taken by public transport. At present, over 60% of public transport trips are taken using HOP, meaning that it is likely to provide a reasonable view on travel by this mode. However, at Census day 2013 HOP had not been widely implemented, meaning that it cannot be compared directly with Census data. In addition, HOP does not contain any information about trip purpose. HOP data, and similar data from Wellington and Canterbury, should be investigated further due to the potential for comprehensive and current data on PT expenditures and travel distances.
Data on school trips collected through Auckland Transport's Travelwise programme and comparable programmes in Wellington and Canterbury	AT collects and publishes some data on education trips through its Travelwise programme, which covered 319 out of Auckland's 540 schools in 2012. AT monitors the transport modes used by students (e.g. walking school buses). Auckland Transport (2013) summarises some of this data. Travelwise data could, in principle, be used to identify variations in transport mode and distance travelled for education trips in different areas of the city. However, accessing and analysing this data may be difficult due to confidentiality issues.
Detailed parking cost data from transport agencies and parking providers	Parking costs are likely to comprise a significant share of variable costs for some commuters. For example, early-bird parking rates in the Auckland city centre are in the range of $13 to $14, and thus are likely to exceed car operating costs for many commuters. However, car parking costs vary considerably throughout cities, as minimum car parking regulation has led to considerable oversupply in some areas. In addition, estimating the incidence of parking costs is difficult, as many workers will be able to access employer-provided car parks. (The cost of employer-provided car parks is likely to be passed on to employees through lower wages.) Mattingly and Morrissey (2013) undertake sensitivity testing of several different parking costs across the whole region. However, they do not account for variation in parking costs between different areas. Ideally, analysis should account for such variations. However, we have not been able to access detailed and comparable data on parking costs for all three regions studied, and as a result we have not incorporated parking costs in the LAI at this stage.
Ministry of Transport Household Travel Survey (HTS)	HTS studies household travel using a travel diary / survey approach. It accounts for all transport modes and trip purposes, and surveys households on travel distances and times. It is conducted on an annual basis, with rolling averages over a four-year period published. However, the HTS has a relatively small sample size – roughly 5,000 households – which means that it is not well-suited for an analysis of transport costs at a detailed geographic level. HTS data is only published at a regional council level.
Household energy costs	
New Zealand Census 2013	A review of the relevant literature suggests that household energy costs are a function of dwelling type (as older, larger, and detached houses cost more to heat), household income (with wealthier households tending to spend more on heating), and household size (as larger households tend to use more lighting, hot water, and appliances). We considered a methodology to use Census data on dwellings to estimate variations in average household energy costs between different area units. Census data allows us to identify dwelling type (i.e. detached or attached dwelling), size of dwelling (i.e. number of rooms), and heating sources, factors which influence heating costs. However, Census data is not sufficient to identify other sources of variation, such as building age and insulation. We did not finalise estimates of household energy costs as preliminary analysis suggests that variation in household characteristics between areas is not great enough to significantly affect the LAI estimates. However, as household energy costs account for 11% of average location-related costs (Statistics NZ, 2013b), it would be worth including them in a future update of the LAI.
Overall household	

budgets	
Statistics NZ Household Economic Survey (HES)	We have used the HES and comparable budget surveys from other OECD countries to conduct an analysis of national and regional housing affordability. The HES presents a comprehensive picture of household housing, transport, and household energy costs. As it is conducted every three years, it also provides information about how affordability is evolving over time. However, the HES has a relatively small sample size – roughly 5,000 households – which means that it is not well-suited for an analysis of affordability at a detailed geographic level. Statistics NZ only publishes HES data for selected regional councils.

5 A location affordability index for three New Zealand regions

In this section, we present our LAI estimates, and underlying variables, for New Zealand's three main urban regions. In addition, we discuss some potential implications of our location affordability estimates for policy.

Broadly speaking, our findings are as follows:

- Location affordability, and underlying variables such as household incomes, rents, and commute distances, varied between different areas. Within each region, it was possible to identify some areas that were relatively more expensive, both in absolute terms and as a share of income for those areas' average households.
- However, some broad trends were observed in all three regions. As distance from the city centre increases, median household income tends to decline, median rents tend to decline, and average commute distances tend to rise. Car ownership rates tended to be lower in city centre areas but did not rise noticeably with distance.
- The net effect of these factors was that median rents did not tend to increase (or decrease) as a share of median household incomes with increasing distance from the city centre. In other words, there is some evidence that households with different levels of income are self-selecting into areas where housing is affordable. (Or, conversely, that household' location decisions are driving rental prices.)
- However, total housing, car ownership, and commute costs tended to rise as a share of household income with increasing distance from the city centre. This suggests that choosing to seek cheaper housing costs further from the city centre may represent a false economy for many households.
- Finally, in Auckland we find lower overall levels of location affordability for two out of three selected household types – single parent families, and retired couples. However, affordability woes for these household types primarily resulted from low average household incomes. By contrast, our third selected household type, working-age adults living alone, appeared to face no distinctive affordability challenges. However, our analysis was not sufficiently nuanced to identify any constraints on availability of smaller dwellings suitable for this household type.

These results present some challenges to interpretation. However, they are consistent, or potentially consistent, with the existing theoretical literature. On the one hand, there appears to be a trade-off between housing costs and commute costs. Workers in areas with lower median rents appear to commute further. This is consistent with the new economic geography literature on land prices and transport costs in cities, and with empirical evidence on changes to house prices in Auckland following transport infrastructure upgrades.

On the other hand, LAI estimates show that households located further away from the city centre tend to pay more, as a percentage of median household income, for housing and transport. This suggests that outlying or less accessible locations are not necessarily an optimal choice for households. This finding raises the question: Why are they choosing to live there? This finding suggests that there may be some policy factors or market failures at work, resulting in either an undersupply of housing in more accessible locations or a lack of affordable transport options for households in areas with lower housing costs.

With respect to the latter point, we note that transport mode choice does not appear to exert a significant influence on variable commute costs, as public transport fares are as costly, or more expensive, on a per-kilometre basis as car operating costs. (Public transport is likely to be cheaper in areas where parking is priced; however, businesses often provide free parking for employees.) Furthermore, car ownership costs, which make

up a large share of overall household travel budgets, do not tend to increase (or decrease) with increasing distance from the city centre. This may suggest that transport policy and planning regulations (e.g. minimum parking regulations) do not allow households to avoid car ownership costs (see e.g. Currie and Senbergs, 2007).

5.1 Approach to presenting results

Here, we present location affordability estimates for three New Zealand regions in graphical format. For ease of interpretation, we have presented the results in two main ways:

- First, as choropleth maps which use colour shading to display variations in average location affordability between area units. These maps can be used to obtain a detailed picture of variations in affordability within urban areas, but do not necessarily lend themselves to an interpretation of underlying relationships.
- Second, as graphs that summarise LAI results and underlying variables as a function of distance to the city centre[10]. These graphs simplify the data and allow us to identify high-level trends in location affordability.

We present the four main input variables to the LAI in graphical format:

- Median household incomes within area units, by distance from city centre
- Median housing costs within area units, by distance from city centre
- Average commute distances for area units, by distance from city centre
- Average car ownership within area units, by distance from city centre.

5.2 Auckland Region

In this sub-section, we present location affordability estimates for the Auckland region.

5.2.1 Main input variables

The following charts summarise the key data underlying the LAI. These charts present data as weighted averages as a function of distance from the city centre. The same data is presented in scatterplot format in the Appendix, showing similar trends but with greater variation between areas that are a similar distance away from the city centre.

Figure 1 summarises 2013 Census data on household incomes, by distance from town hall. It shows that household incomes tend to be lower in areas that are more distant from the city centre. (Household incomes in the city centre itself appear to be lower than in the surrounding suburbs due to its substantial student population.)

[10] We calculated distance to city centre as the straight-line distance between cities' town hall and area unit centroids. In order to summarising results into a single measure, we calculated the average of results for area units within 2 kilometre concentric circles, weighting results by the total number of households in each area unit. Presenting data in this format obviously highlights the overall trend while obscuring variation between different area units. As a result, we present the same data in scatterplots in the Appendix. These scatterplots depict the same relationships as seen in the graphs in this section.

Figure 1: Median household income by distance from the city centre, Auckland

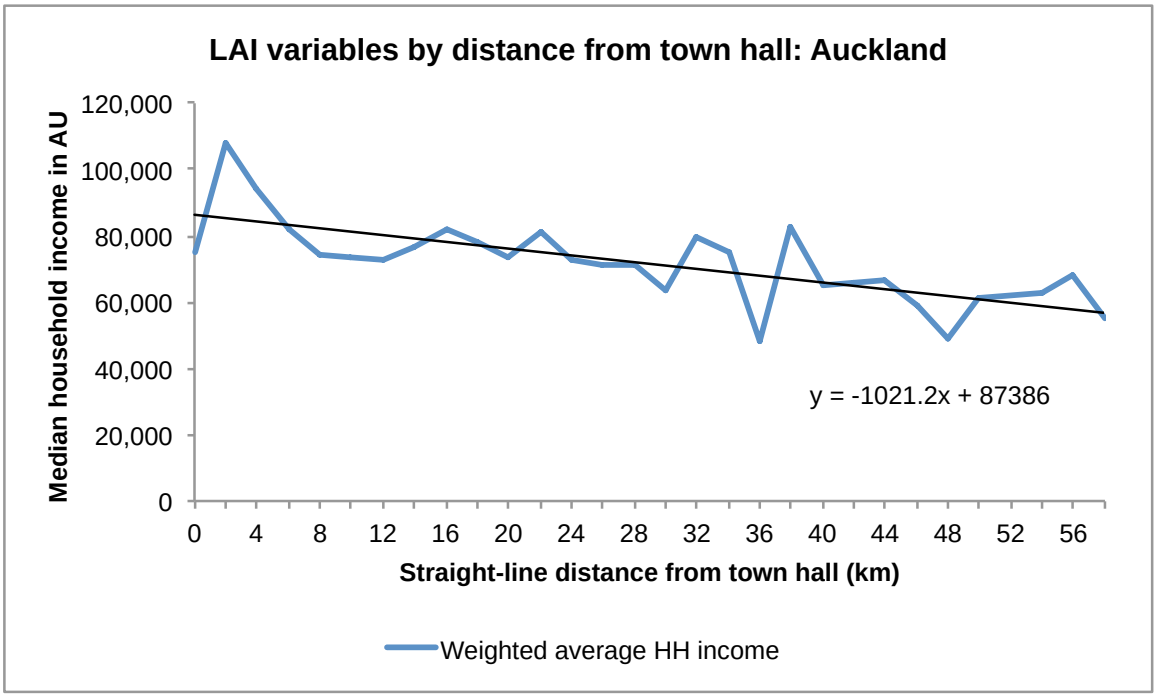


Figure 2 summarises 2013 Census data on weekly rents for three-bedroom dwellings. Once again, it shows that rents tend to decline with distance, suggesting that housing is more affordable in outlying areas. However, we note that this graph is likely to overstate housing costs in the Auckland city centre, where a more permissive regulatory environment has enabled a greater supply of smaller, more affordable dwellings (i.e. apartments with one or two bedrooms).

Figure 2: Median weekly rent for a 3-bedroom dwelling by distance from city centre, Auckland

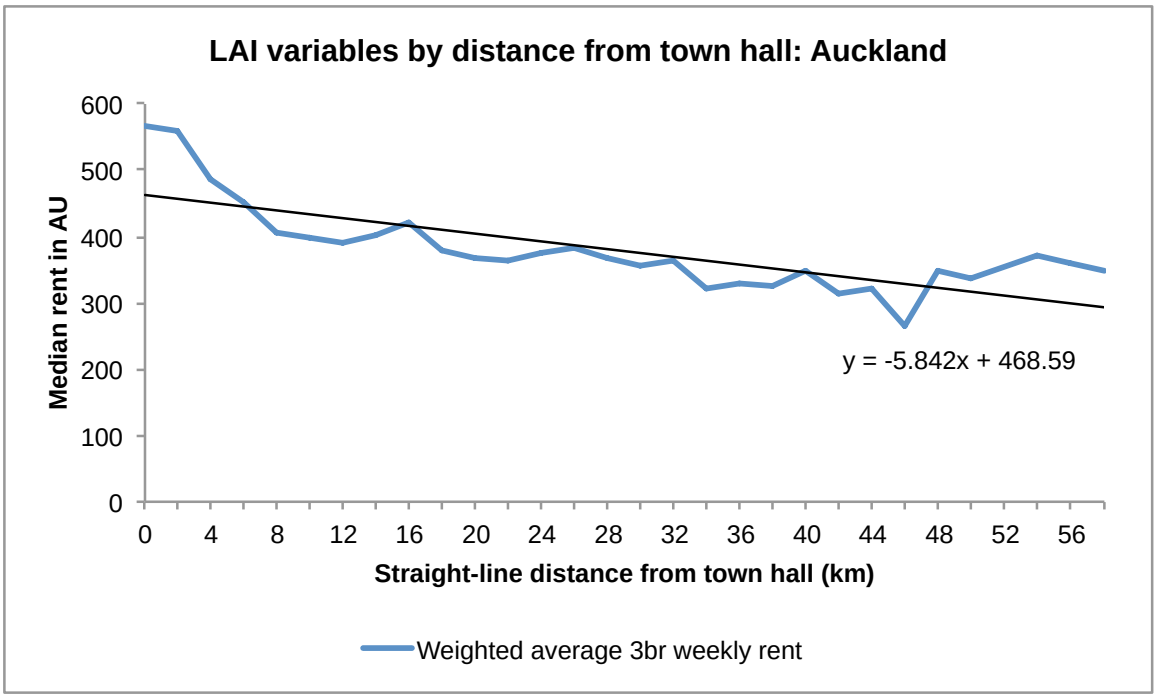
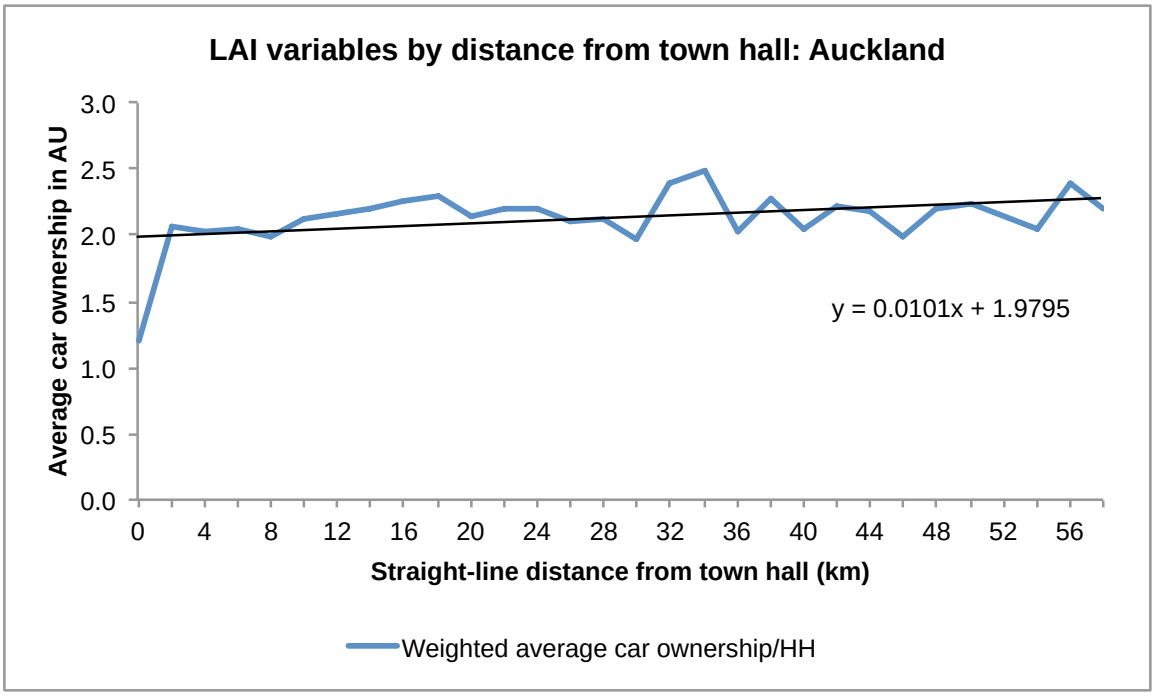


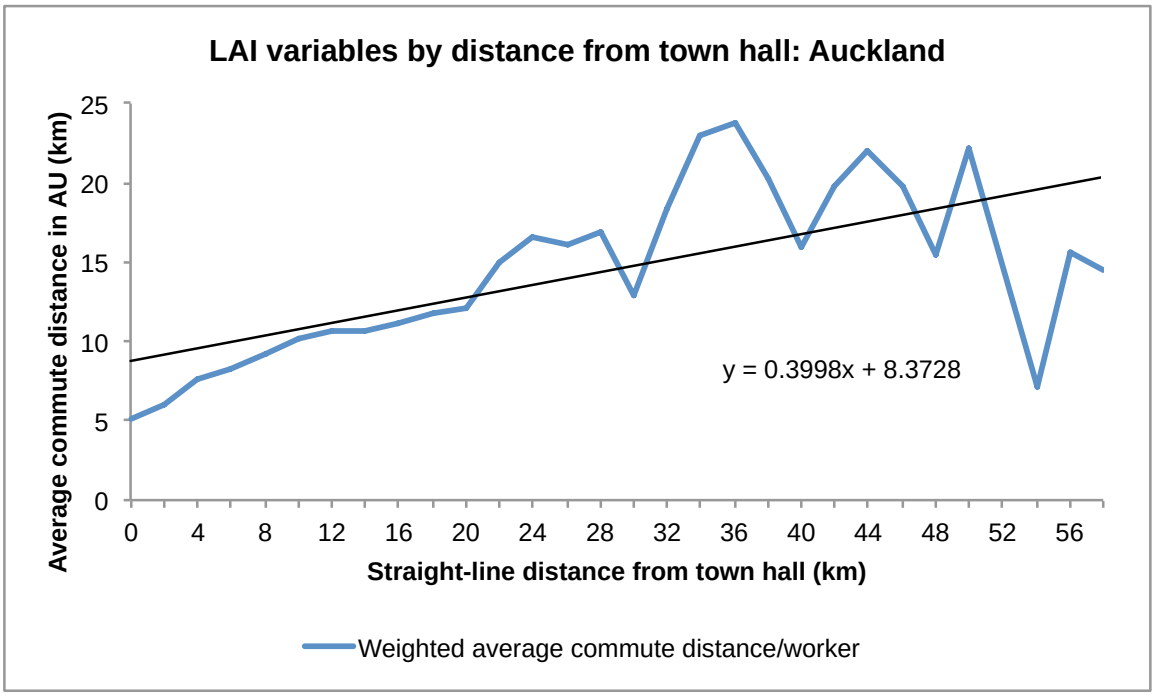
Figure 3 summarises average household car ownership. Average car ownership is lower in the city centre but does not tend to increase with distance.

Figure 3: Average cars per household by distance from city centre, Auckland



Finally, Figure 4 summarises data on average commute distances, showing that commute distances tend to increase as distance from the city centre increases. However, this increasing trend does not appear to be monotonic, possibly due to the fact that Auckland is a polycentric city with employment centres scattered around the region.

Figure 4: Average commute distance by distance from city centre, Auckland



5.2.2 Estimates of location affordability in Auckland

Figure 5 combines the above data into an overall estimate of location affordability. It presents and compares housing affordability and overall housing and transport affordability by distance from Auckland's city centre.

The bottom (blue) line shows housing costs as a share of median household income, weighted across all area units within each 2-kilometre concentric circle radiating outwards from the city centre. It shows that, on average,

households spend a similar share of their overall income on housing costs in both close-in and outlying suburbs. (This weighted average camouflages significant variation between area units in favour of presenting the overall trend. See the Appendix for scatterplots that display both the trend and variation between area units.)

The top (red) line shows that combined housing, car ownership, and commute costs increase as a share of household incomes with increasing distance from the city centre. On average, households that live further out of Auckland spend more on location-related costs, as lower lower rents are offset by added commute costs. (Once again, this weighted average disguises variations between area units while presenting the overall trend.)

Figure 5: Average location affordability by distance from city centre, Auckland

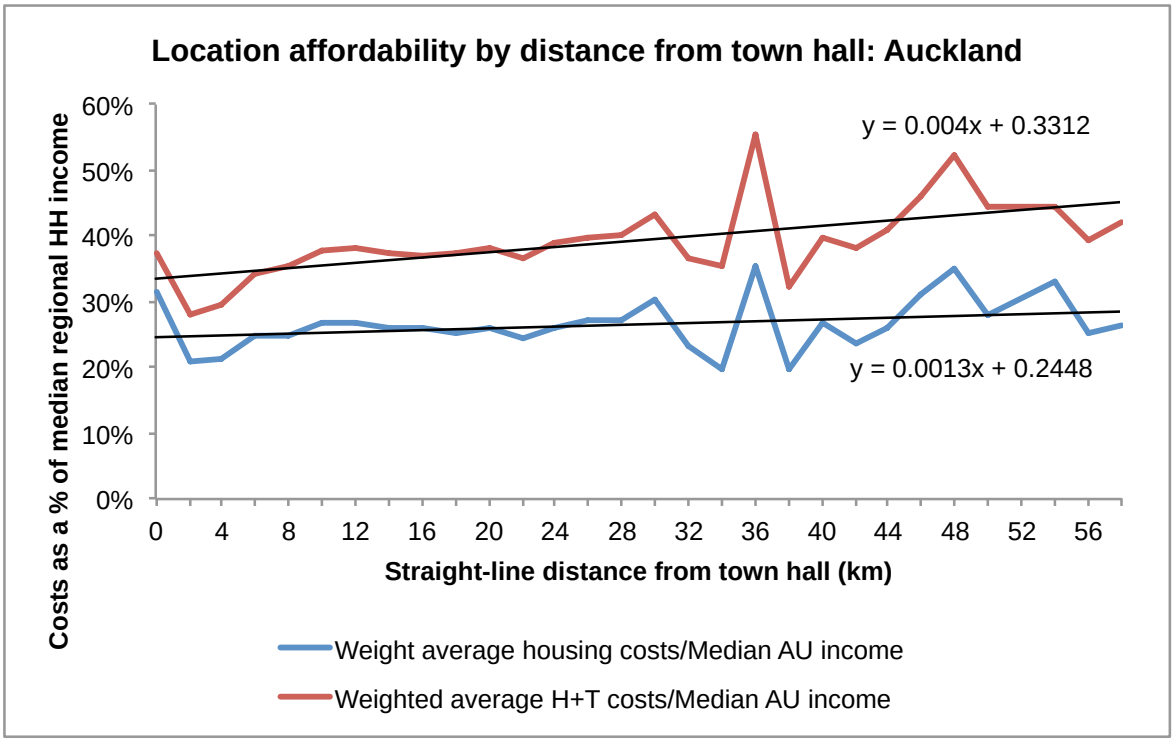


Figure 6 and Figure 7 present the same data in two choropleth maps. The first map, which shows median rents as a share of median incomes in area units, suggests that expected housing costs fall between 20% and 30% of household income in most of the city, although some areas are relatively less affordable. The second map includes car ownership and commute costs. It suggests that overall location affordability is lower throughout the city. Expected housing and transport costs rise to 40-50% in areas of west and south Auckland, as well as the entire Whangaparoa Peninsula. The most affordable areas for their residents tend to be in Auckland's inner isthmus suburbs. (Relatively low commute costs in large, rural area units in Franklin and Rodney are likely to be the result of higher rates of self-employment on farms.)

Figure 6: Map of median housing costs as a share of median household income in Auckland area units

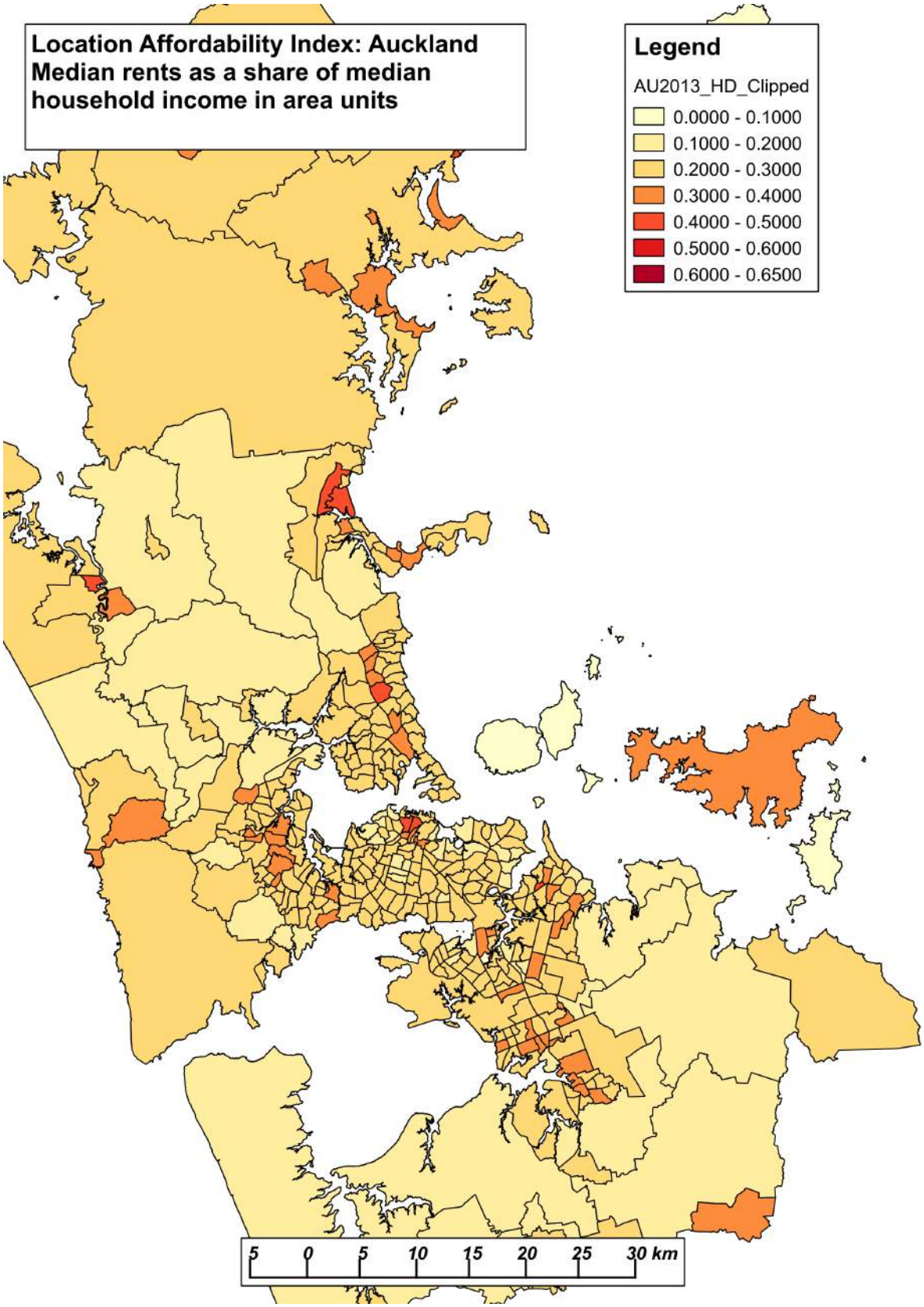
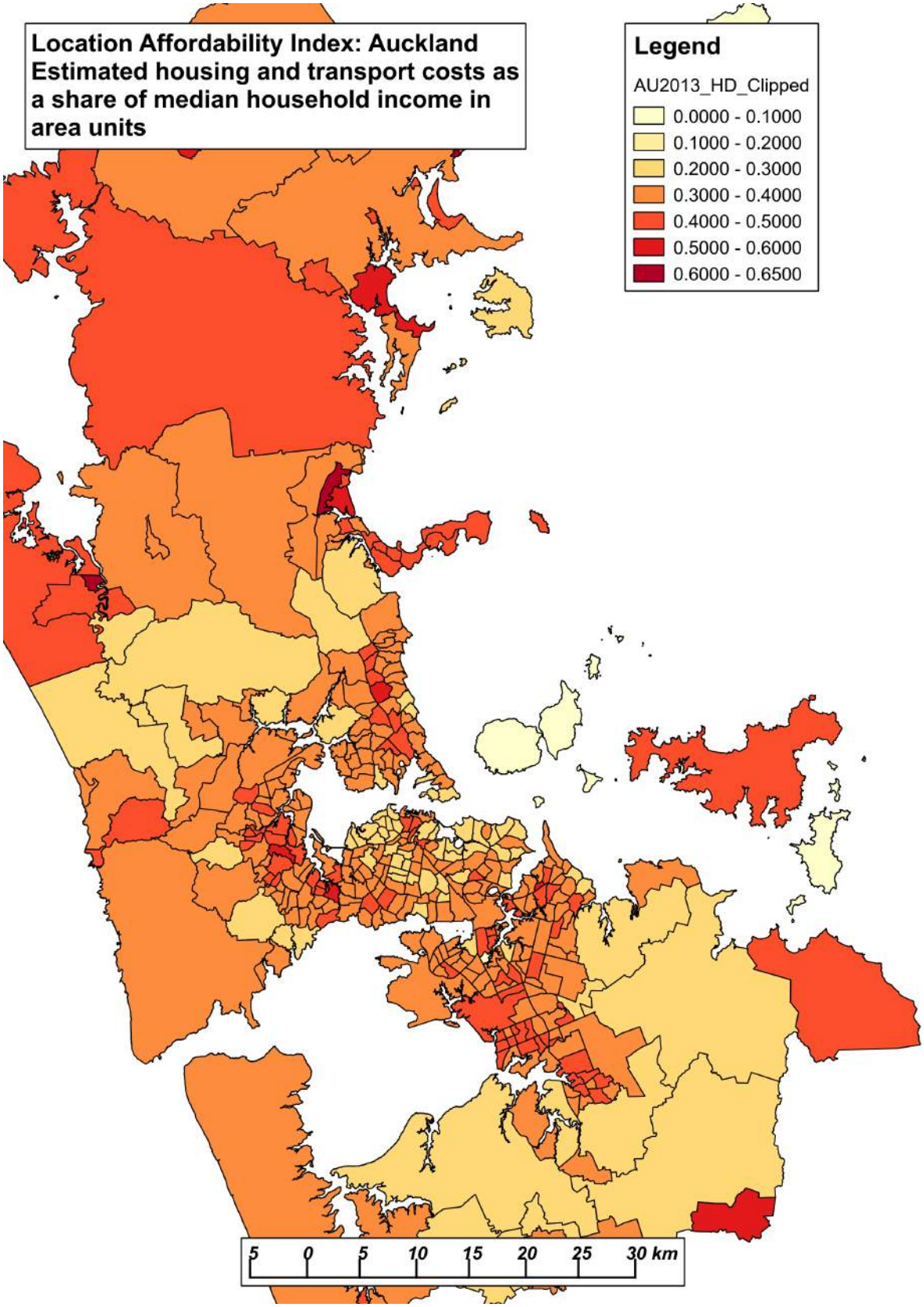


Figure 7: Map of average housing, car ownership and commute costs as a share of median household income in Auckland area units



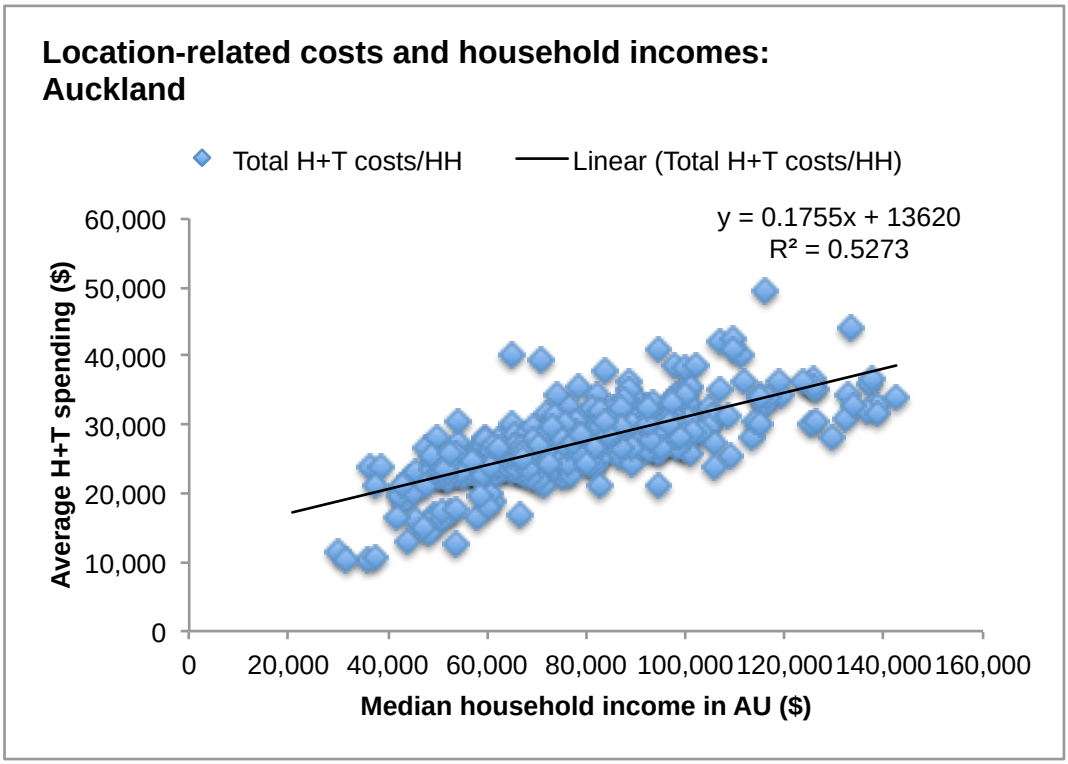
5.2.2.1 Relationship between income and location-related expenditure

Figure 8 shows that at the area unit level there is a reasonably consistent (R^2=0.53) positive relationship between median household income and average housing, car ownership, and commute expenditures. However,

housing and transport spending does not seem to be especially responsive to rising incomes – the slope of the line of best fit in Figure 8 suggests that when area unit median household income rises by $100, average spending on housing and transport increases by $18.

As a result, households in higher-income areas appear to spend a lower share of their income on location-related costs than households in lower-income areas. Initial analysis suggests that this is partly due to housing costs, with households in lower-income areas spending a greater share of household income on housing (rents), and partly due to the fact that average commute costs do not tend to be lower in low-income areas. Aucklanders of all income levels are expected to spend a similar amount on transport costs.

Figure 8: Relationship between household income and location-related costs in Auckland



5.3 Wellington Region

In this sub-section, we present location affordability estimates for the Wellington region.

5.3.1 Main input variables

The following charts summarise the key data underlying the LAI. These charts present data as weighted averages as a function of distance from the city centre. The same data is presented in scatterplot format in the Appendix, showing similar trends but with greater variation between areas that are a similar distance away from the city centre.

Figure 9 summarises 2013 Census data on household incomes, by distance from town hall. It shows that household incomes tend to be lower in areas that are more distant from the city centre.

Figure 9: Median household income by distance from the city centre, Wellington

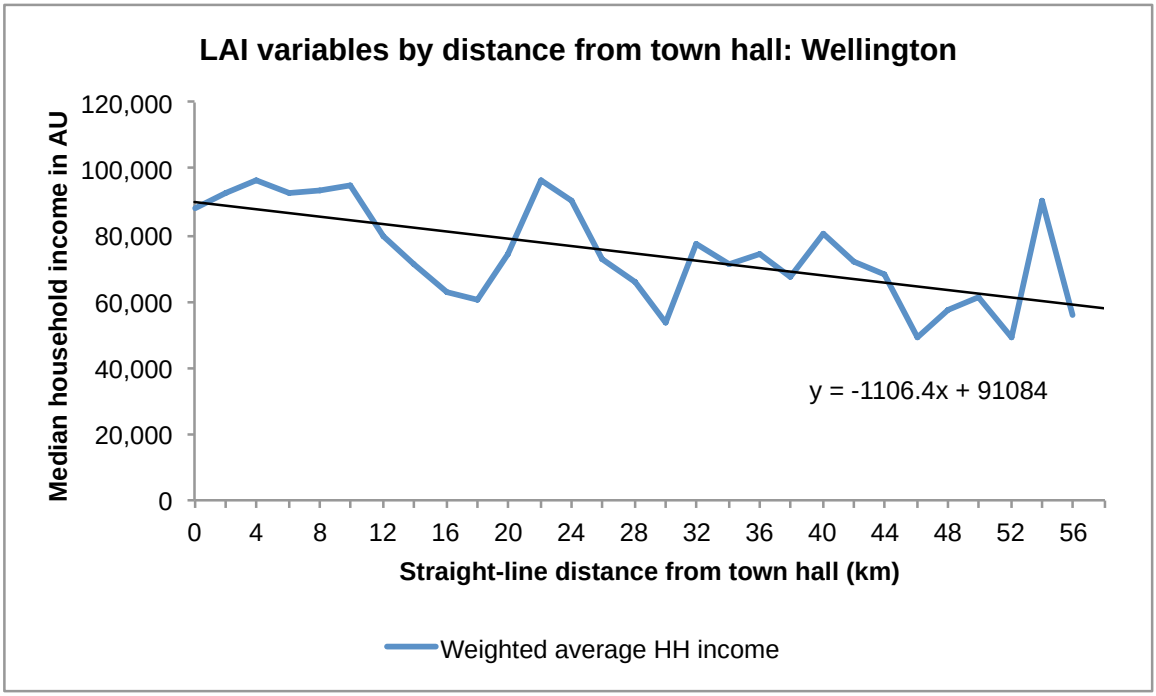


Figure 10 summarises 2013 Census data on weekly rents for three-bedroom dwellings. As in Auckland, it shows that rents tend to decline with distance, suggesting that housing is more affordable in outlying areas. Once again, we note that this chart is likely to overstate housing costs in the Wellington city centre due to the greater mix of smaller, more affordable dwellings.

Figure 10: Median weekly rent for a 3-bedroom dwelling by distance from city centre, Wellington

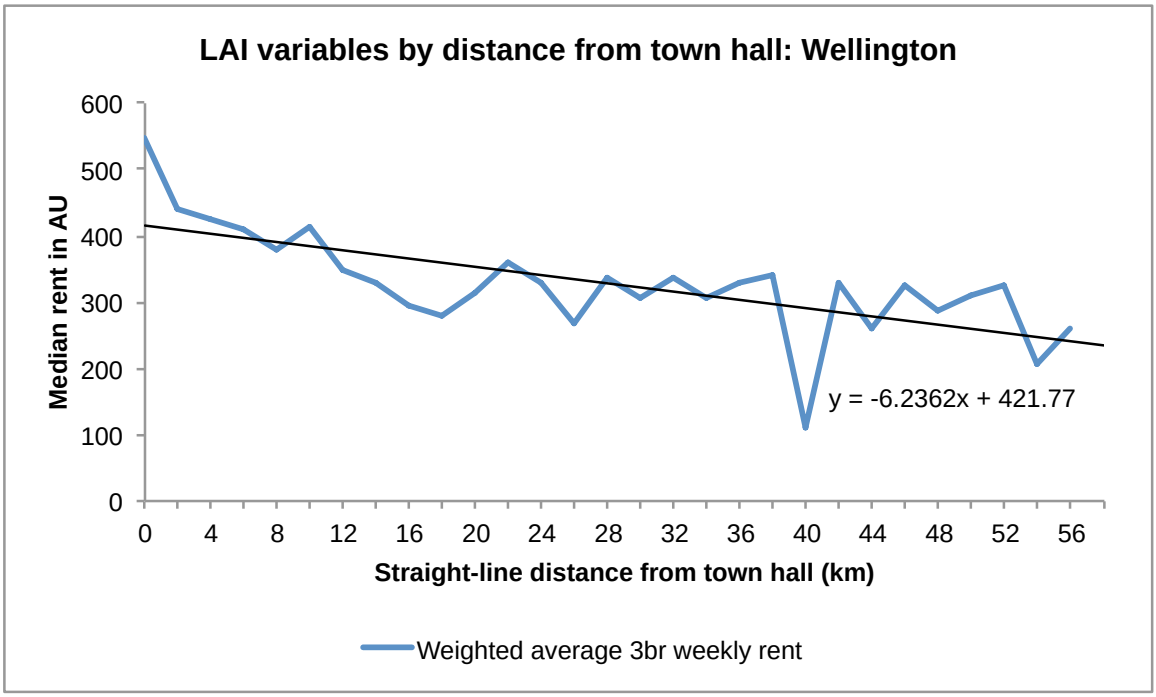
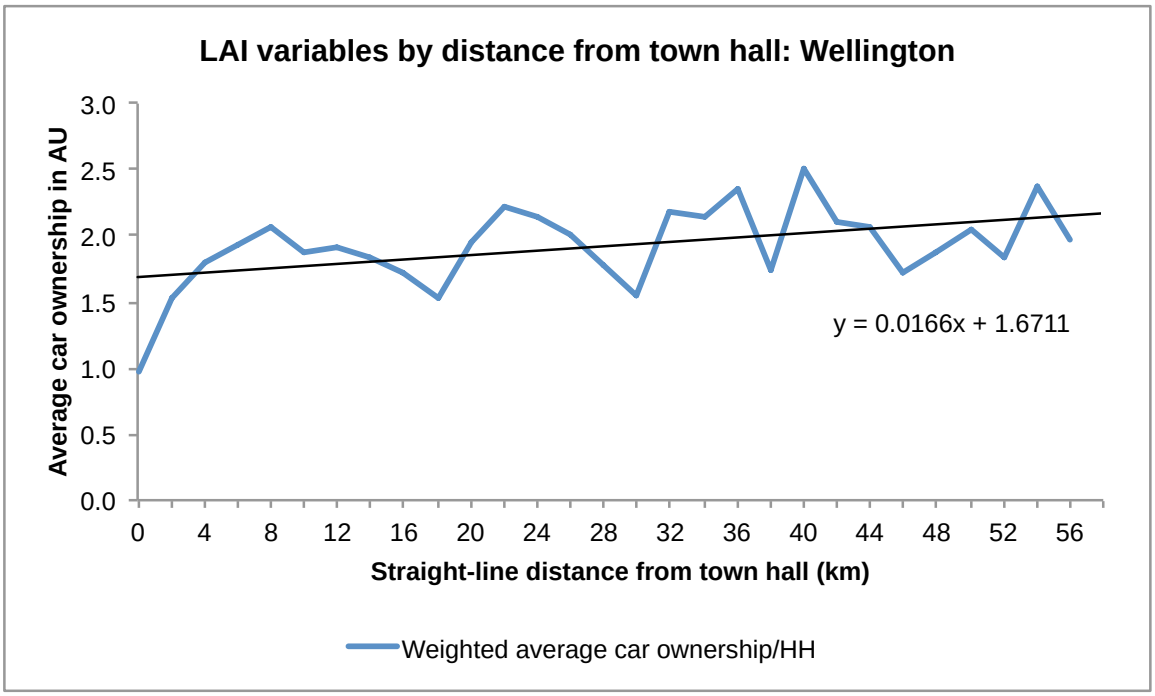


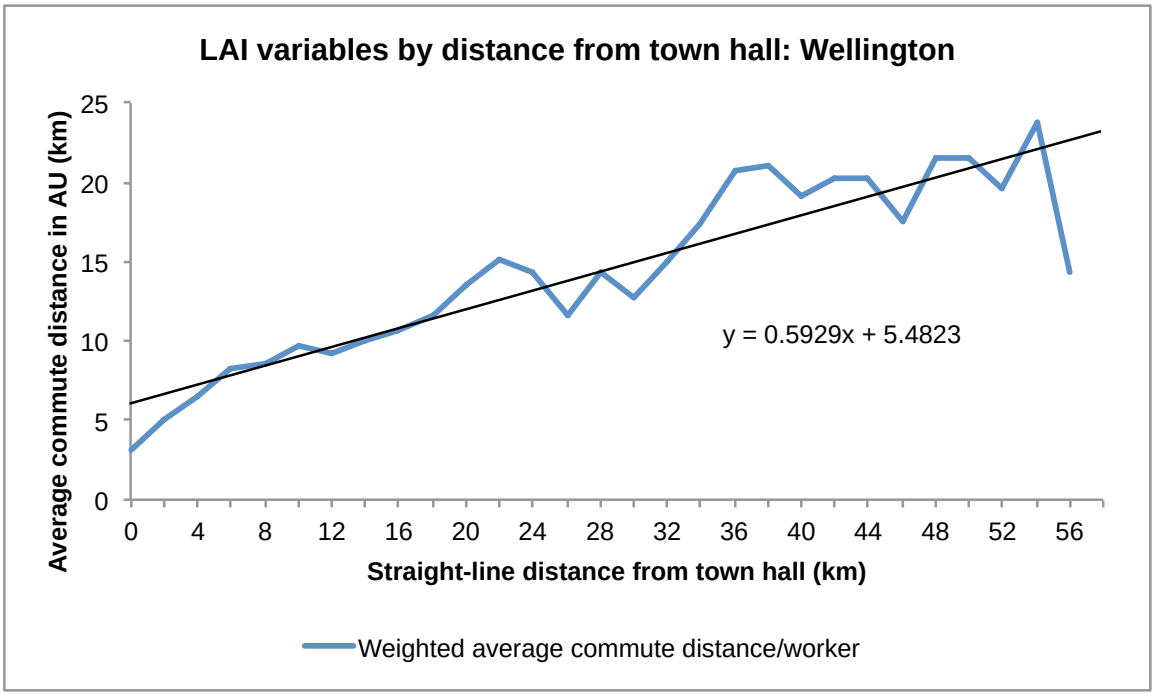
Figure 11 summarises average household car ownership. Average car ownership is lower in the city centre but does not tend to increase with distance. Unlike in Auckland, there appears to be greater variation in average car ownership trends outside of the city centre, which may reflect differences in Wellington's spatial structure and transport infrastructure.

Figure 11: Average cars per household by distance from city centre, Wellington



Finally, Figure 12 summarises data on average commute distances, showing that commute distances tend to increase as distance from the city centre increases. This increasing trend appears to be more monotonic than in Auckland, possibly due to the fact that employment in Wellington is relatively more concentrated in the city centre.

Figure 12: Average commute distance by distance from city centre, Wellington



5.3.2 Estimates of location affordability in Wellington

Figure 13 combines the above data into an overall estimate of location affordability. It presents and compares housing affordability and overall housing and transport affordability by distance from Wellington's city centre.

The bottom (blue) line shows housing costs as a share of median household income, weighted across all area units within each 2-kilometre concentric circle radiating outwards from the city centre. It shows that, on average, households spend a similar share of their overall income on housing costs in both close-in and outlying suburbs. (This weighted average camouflages significant variation between area units in favour of presenting the overall trend. See the Appendix for scatterplots that display both the trend and variation between area units.)

The top (red) line shows that combined housing, car ownership, and commute costs increase as a share of household incomes with increasing distance from the city centre. On average, households that live further from the centre spend more on location-related costs, as lower lower rents are offset by added commute costs. (Once again, this weighted average disguises variations between area units while presenting the overall trend.)

The overall magnitude of these effects is similar to those observed in Auckland.

Figure 13: Average location affordability by distance from city centre, Wellington

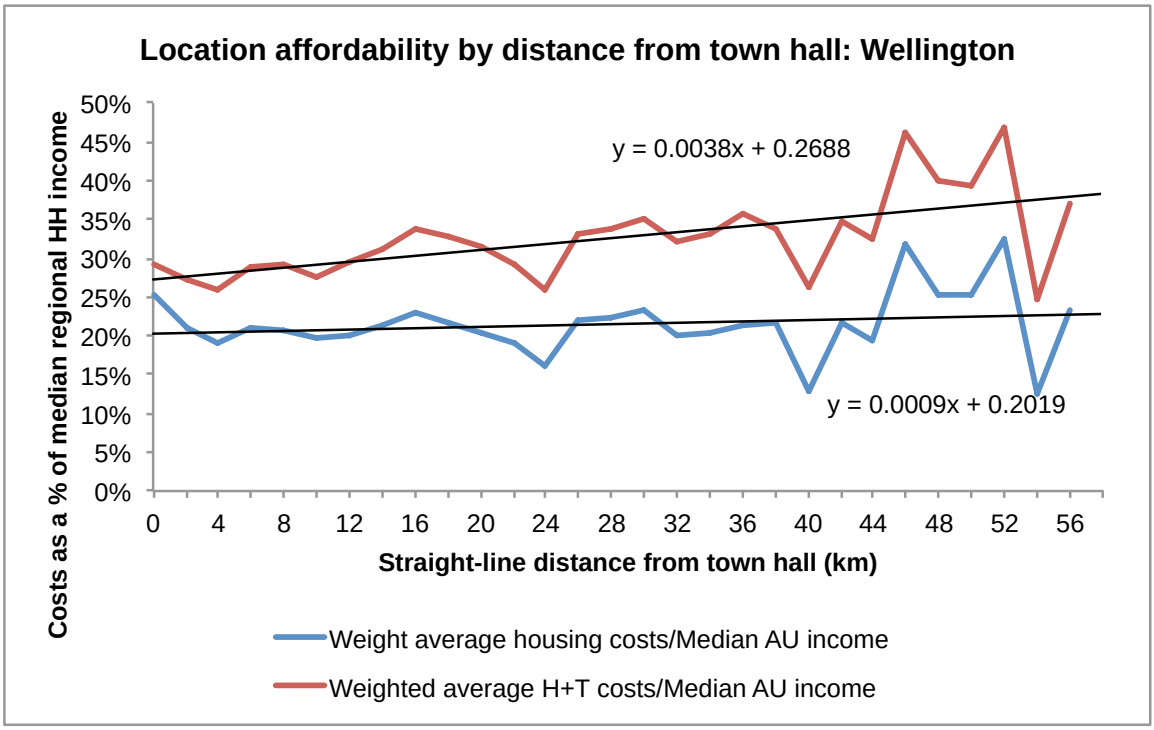


Figure 14 and Figure 15 present the same data in two choropleth maps. The first map, which shows median rents as a share of median incomes in area units, suggests that expected housing costs fall between 20% and 30% of household income across much of the region, although some areas, especially around Wellington City's northern suburbs, are relatively more affordable. The second map includes car ownership and commute costs. It suggests that overall location affordability is considerably lower in outlying areas, but less so in Wellington City itself. Expected housing and transport costs rise into the 30-40% range in much of the Hutt Valley, Porirua, and the Kapiti Coast. The most affordable areas for their residents tend to be in Wellington City's northern suburbs and inner city areas. (Once again, relatively low commute costs in thinly-populated rural area units are likely to be associated with higher rates of self-employment on farms.)

Figure 14: Map of median housing costs as a share of median household income in Wellington area units

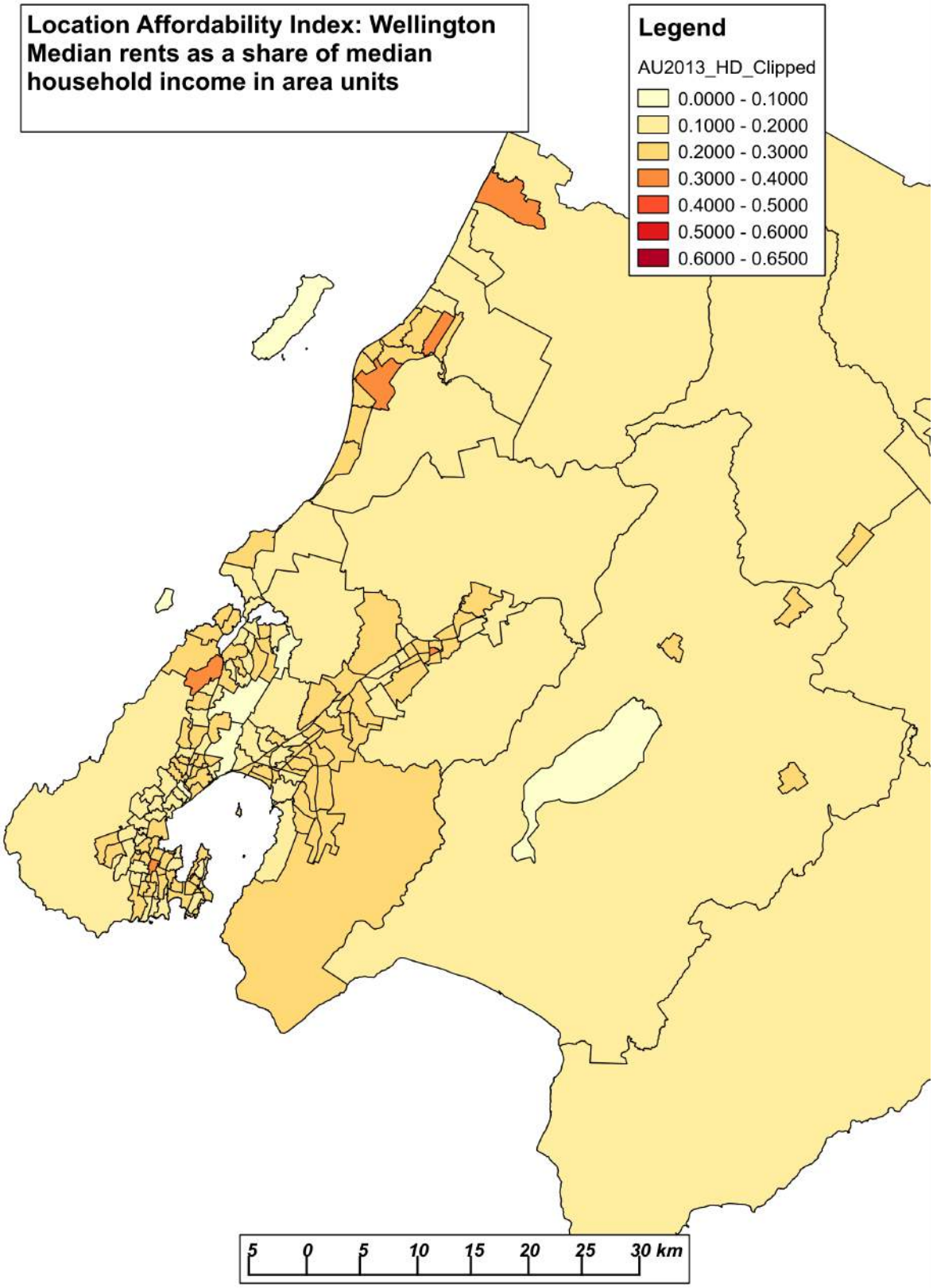
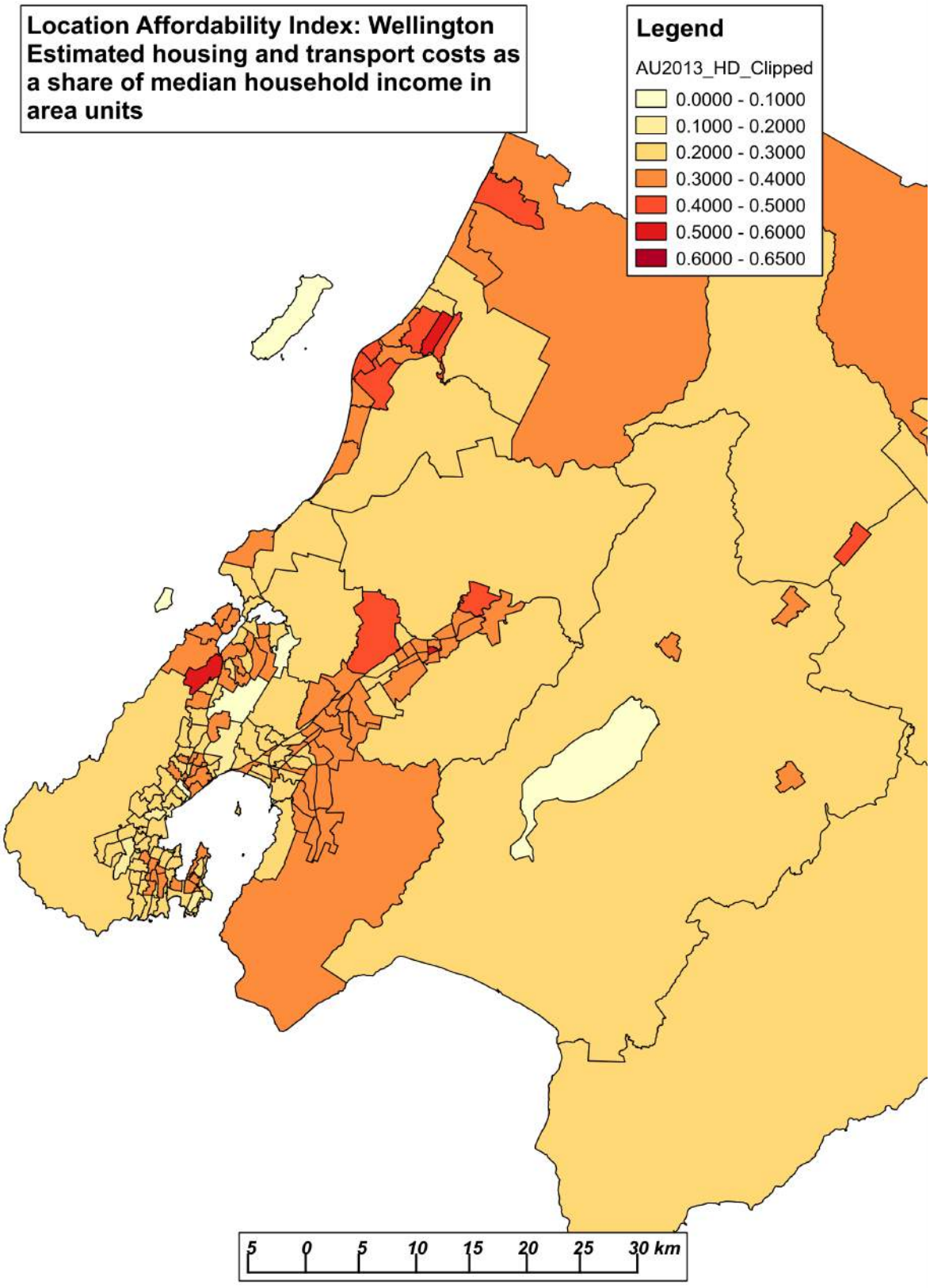


Figure 15: Map of average housing, car ownership and commute costs as a share of median household income in Wellington area units



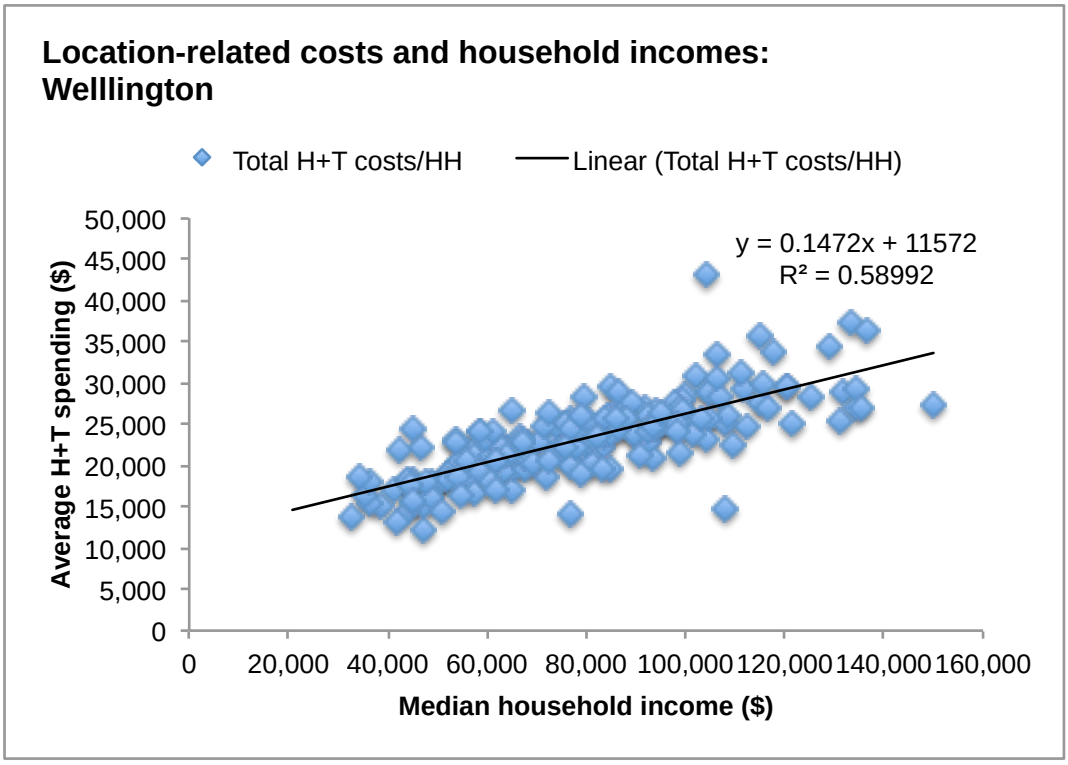
5.3.3 Relationship between income and location-related expenditure

Figure 16 shows that at the area unit level there is a reasonably consistent (R^2=0.59) positive relationship between median household income and average housing, car ownership, and commute expenditures. However,

housing and transport spending does not seem to be especially responsive to rising incomes – the slope of the line of best fit in Figure 8 suggests that when area unit median household income rises by $100, average spending on housing and transport increases by $15.

As in Auckland, this means that households in higher-income areas appear to spend a lower share of their income on location-related costs than households in lower-income areas. Initial analysis suggests that the underlying causes are similar as well. The negative relationship between household income and average location affordability in area units is partly due to housing costs, with households in lower-income areas spending a greater share of household income on housing (rents), and partly due to the fact that average commute costs do not tend to be lower in low-income areas. Wellingtonians of all income levels are expected to spend a similar amount on transport costs.

Figure 16: Relationship between household income and location-related costs in Wellington



5.4 Canterbury Region

In this sub-section, we present location affordability estimates for the Canterbury region.

5.4.1 Main input variables

The following charts summarise the key data underlying the LAI. These charts present data as weighted averages as a function of distance from the city centre. The same data is presented in scatterplot format in the Appendix, showing similar trends but with greater variation between areas that are a similar distance away from the city centre.

Figure 17 summarises 2013 Census data on household incomes, by distance from town hall. It shows that household incomes tend to be lower in areas that are more distant from the city centre. However, this graph highlights several important differences between Canterbury and Auckland and Wellington. First, median household incomes appear be lower near the Christchurch city centre. Second, the trend for household incomes to fall with distance is much less pronounced than in Auckland and Wellington. In short, Christchurch appears to be distinctive in some respects.

Figure 17: Median household income by distance from the city centre, Canterbury

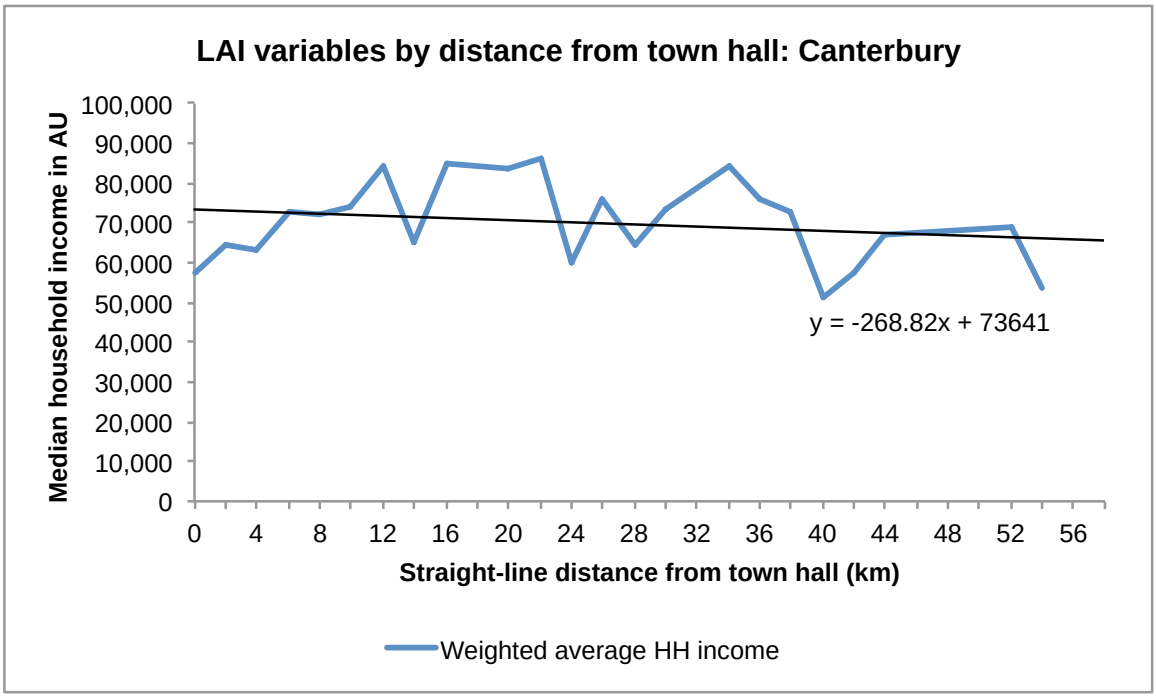


Figure 18 summarises 2013 Census data on weekly rents for three-bedroom dwellings. Once again, it shows that rents tend to decline with distance, suggesting that housing is more affordable in outlying areas. Median rents are generally lower throughout the Canterbury region compared with Auckland and Wellington, possibly reflecting Canterbury's lower average household incomes.

Figure 18: Median weekly rent for a 3-bedroom dwelling by distance from city centre, Canterbury

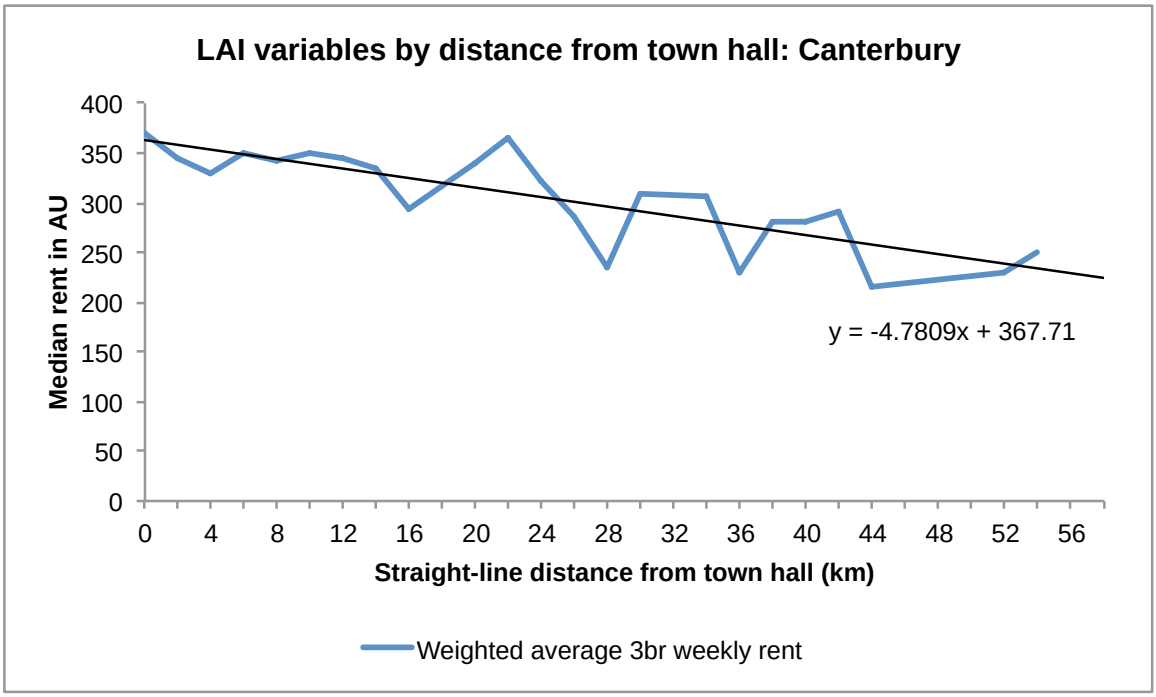
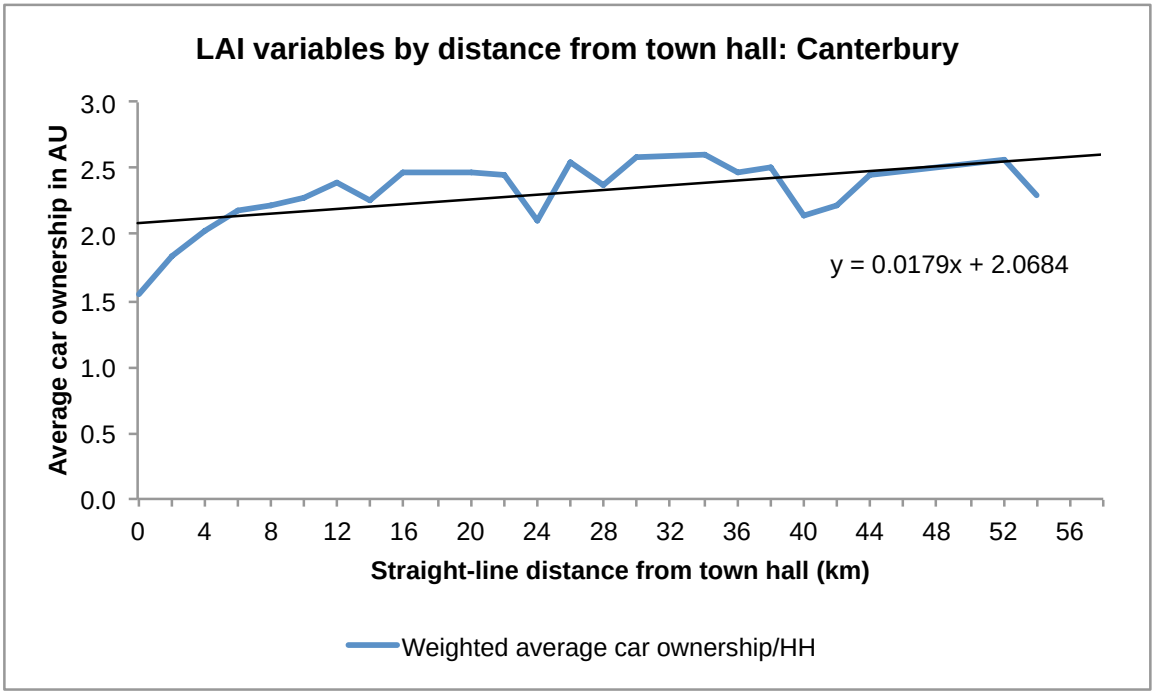


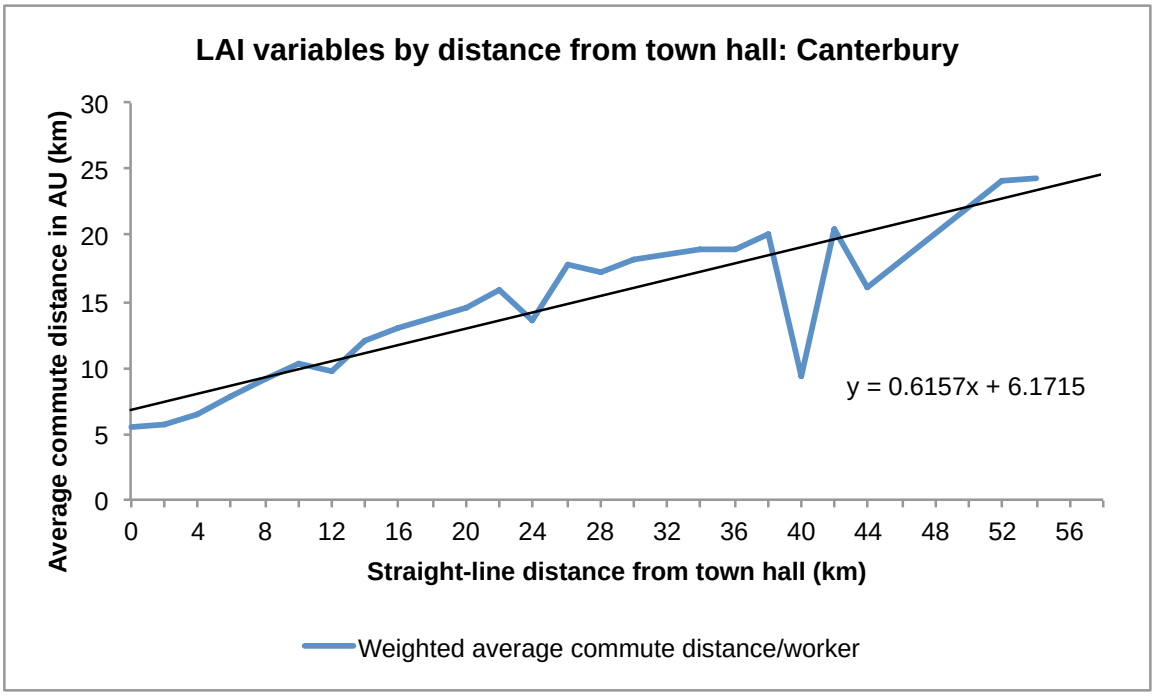
Figure 19 summarises average household car ownership. Average car ownership is lower near the city centre but does not tend to increase with distance. The number of cars per household in outlying areas of the Canterbury region appears to be higher than in comparable areas in Auckland and Wellington.

Figure 19: Average cars per household by distance from city centre, Canterbury



Finally, Figure 20 summarises data on average commute distances, showing that commute distances tend to increase as distance from the city centre increases. As in Wellington but unlike in Auckland, average commute distances rise monotonically, probably due to the relative concentration of employment in Christchurch City.

Figure 20: Average commute distance by distance from city centre, Canterbury



5.4.2 Estimates of location affordability in Canterbury

Figure 21 combines the above data into an overall estimate of location affordability. It presents and compares housing affordability and overall housing and transport affordability by distance from Christchurch's city centre.

The bottom (blue) line shows housing costs as a share of median household income, weighted across all area units within each 2-kilometre concentric circle radiating outwards from the city centre. It shows that, on average, households spend a slightly smaller share of their overall income on housing costs in outlying suburbs than in close-in suburbs. This result contrasts with findings from Auckland and Wellington, where household spending on housing did not appear to decline with distance. (This weighted average camouflages significant variation between area units in favour of presenting the overall trend. See the Appendix for scatterplots that display both the trend and variation between area units.)

The top (red) line shows that combined housing, car ownership, and commute costs increase as a share of household incomes with increasing distance from the city centre. On average, households that live further out of Christchurch spend more on location-related costs, as lower lower rents are offset by added commute costs. However, this effect was less pronounced than in Auckland and Wellington. (Once again, this weighted average disguises variations between area units while presenting the overall trend.)

Figure 21: Average location affordability by distance from city centre, Canterbury

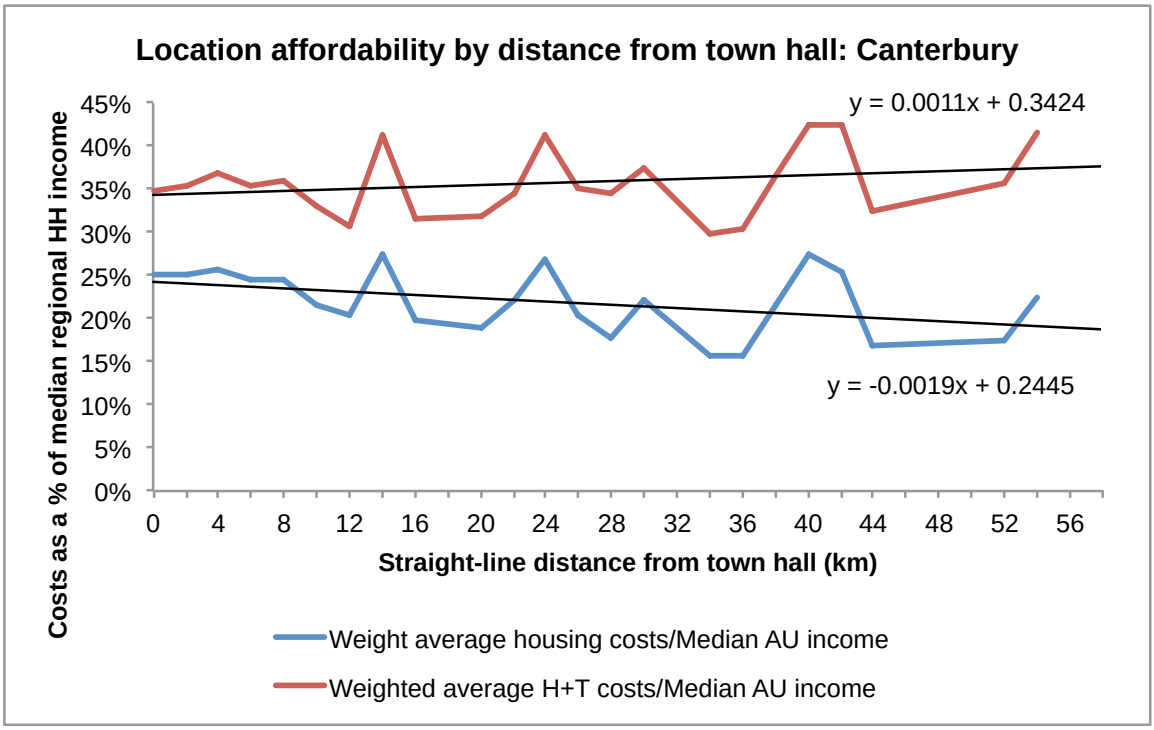


Figure 22 and Figure 23 present the same data in two choropleth maps. The first map, which shows median rents as a share of median incomes in area units, suggests that expected housing costs fall between 20% and 30% of household income throughout most of Christchurch City, while rural areas immediately around the city are likely to be more affordable. The second map, which includes car ownership and commute costs, suggest that overall location affordability is lower throughout Christchurch City as well as in outlying centres to the north and west of the city. Expected housing and transport costs rise into the 30-40% range, or in some cases higher, throughout the city. Kaiapoi and Rangiora, which have grown significantly following the earthquake, are less affordable, with expected housing and transport costs in the 40-50% range. (Once again, relatively low commute costs in thinly-populated rural area units are likely to be associated with higher rates of self-employment on farms.)

Figure 22: Map of median housing costs as a share of median household income in Canterbury area units

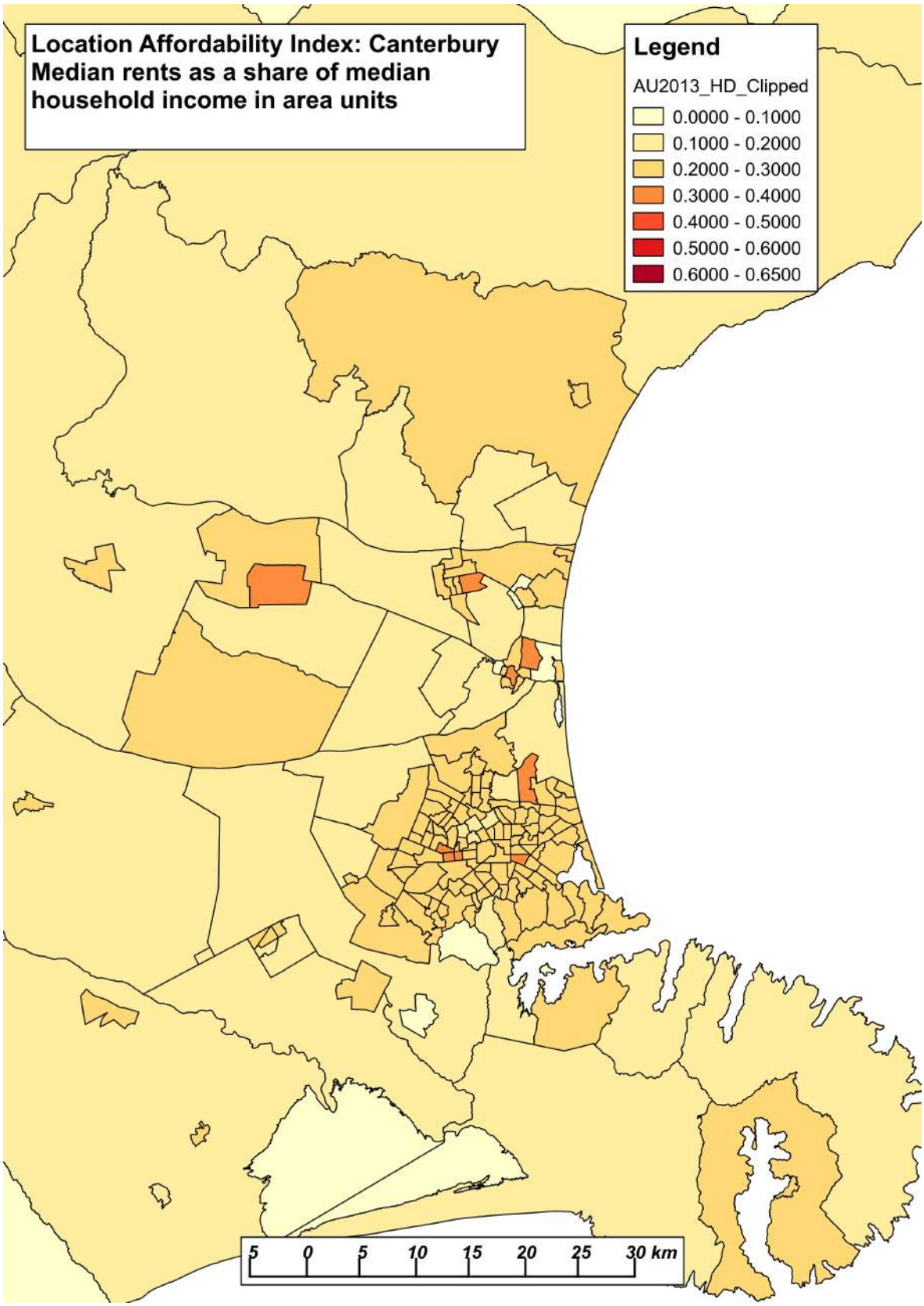
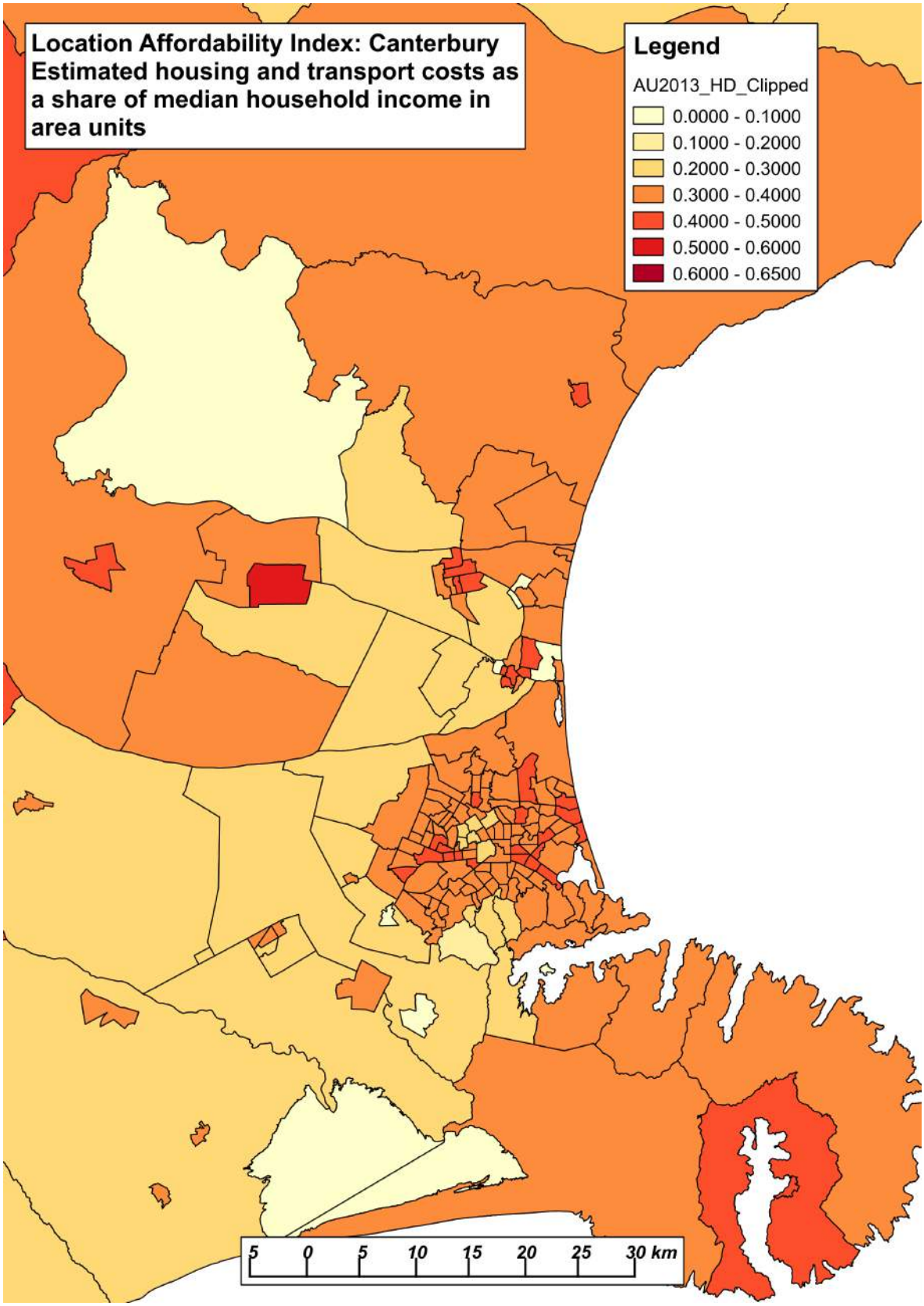


Figure 23: Map of average housing, car ownership and commute costs as a share of median household income in Canterbury area units



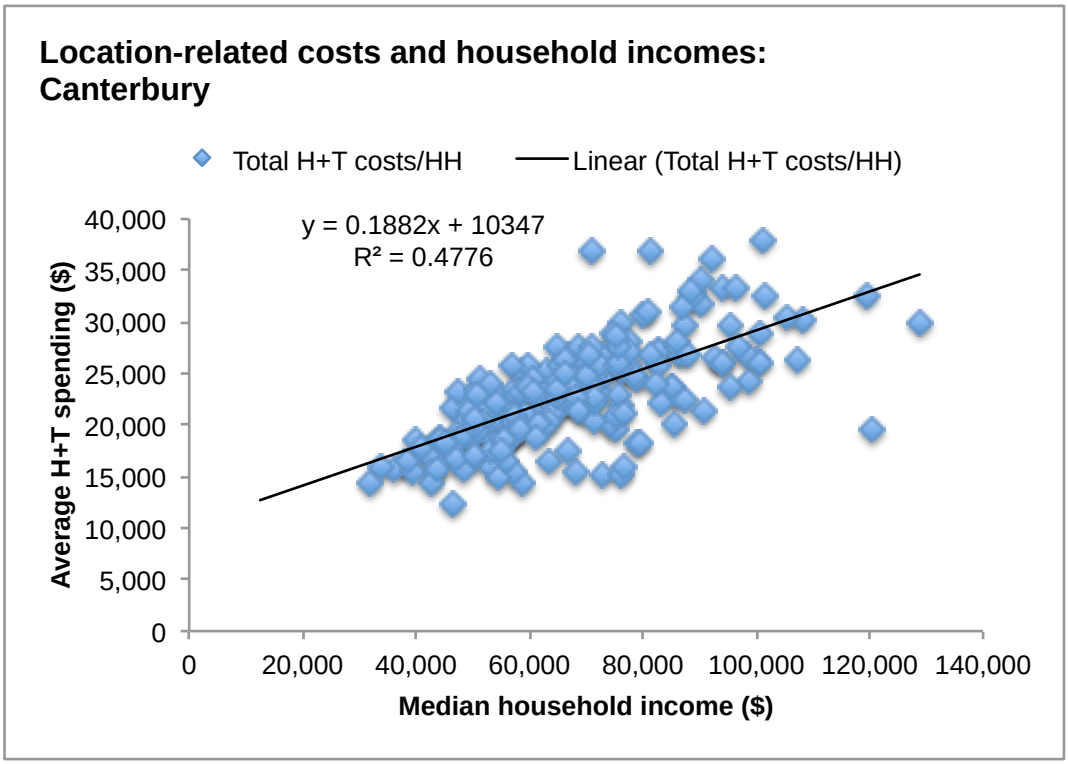
5.4.3 Relationship between income and location-related expenditure

Figure 24 shows that at the area unit level there is a reasonably consistent (R^2=0.48) positive relationship between median household income and average housing, car ownership, and commute expenditures. However,

housing and transport spending does not seem to be especially responsive to rising incomes – the slope of the line of best fit in Figure 24 suggests that when area unit median household income rises by $100, average spending on housing and transport increases by $19.

As a result, households in higher-income areas appear to spend a lower share of their income on location-related costs than households in lower-income areas. Initial analysis suggests that this is partly due to housing costs, with households in lower-income areas spending a greater share of household income on housing (rents), and partly due to the fact that average commute costs do not tend to be lower in low-income areas. Cantabrians of all income levels are expected to spend a similar amount on transport costs.

Figure 24: Relationship between household income and location-related costs in Canterbury



5.5 Comparison of results for three New Zealand regions

In order to understand how results compared between New Zealand regions, we examined the distribution of location affordability at an area unit level.

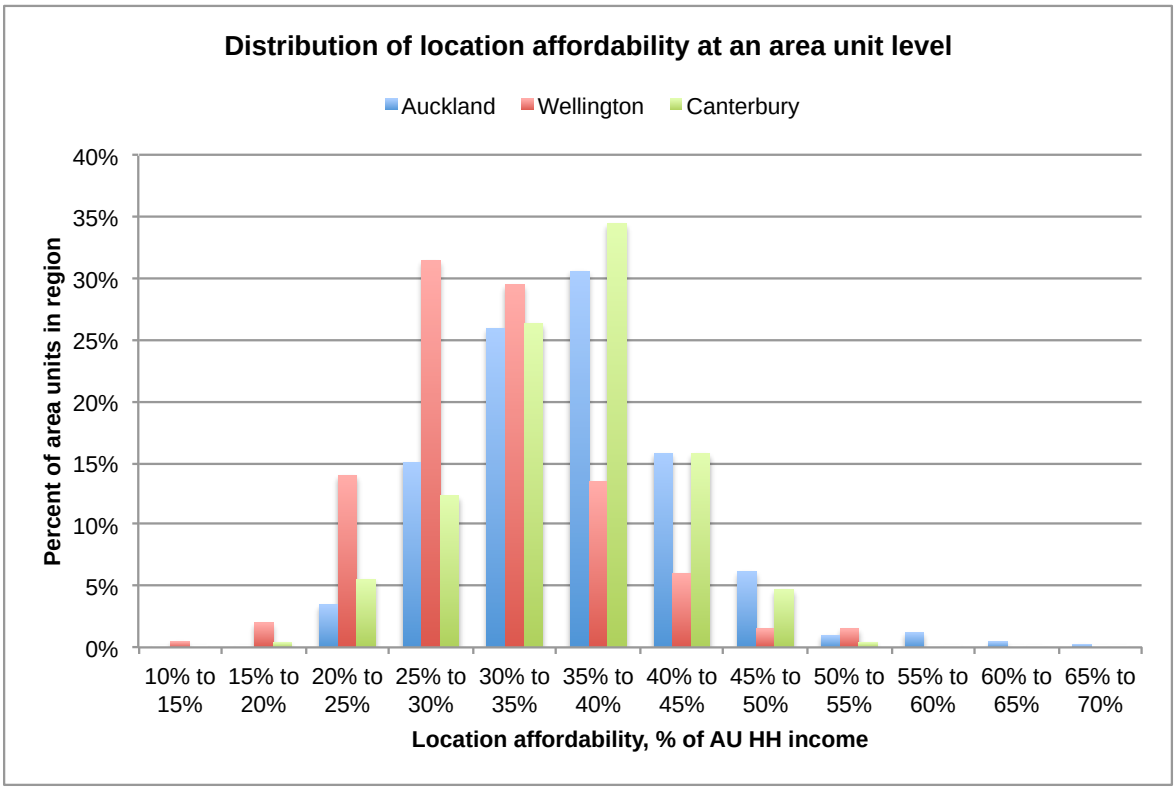
Figure 25 compares LAI estimates at an area unit level for the three regions in a histogram. It shows how location affordability is distributed in each city – i.e. whether a greater share of area units are relatively affordable or relatively unaffordable. Area units are grouped into 12 bins that represent average housing and transport costs as a share of median household income (X axis).

Regions with a distribution that is skewed to the left will have more areas that are relatively affordable for their residents, while regions with distributions that are skewed to the left have more areas that are relatively unaffordable for their residents.

Figure 25 suggests that location affordability is distributed differently in New Zealand's three main urban areas. Wellington has a greater share of areas that are relatively affordable once housing, commute, and car ownership costs are factored in. Half of Wellington area units had average housing and transport costs that fell below 30% of median household income, while only one-fifth of area units in Auckland and Canterbury had location costs under 30% of household income. This result suggests that it is relatively easier to find an affordable location in Wellington than in other regions.

Conversely, one-quarter of Auckland area units and one-fifth of Canterbury area units had average housing, car ownership and commute costs that exceeded 40% of median household income, compared with less than one-tenth of Wellington area units. This result is due in part to Wellington's higher household incomes. However, it does ask why affordability is distributed differently in this region.

Figure 25: Distribution of location affordability at an area unit level in three New Zealand regions



5.6 Focusing on areas of need in Auckland – an analysis of three household types

We used the LAI estimates to examine how affordable Auckland area units are for three specific household types which are likely to have particular housing needs due to the fact that they are smaller than the Auckland average household and tend to have lower incomes. The selected household types, which are described in the previous section, are:

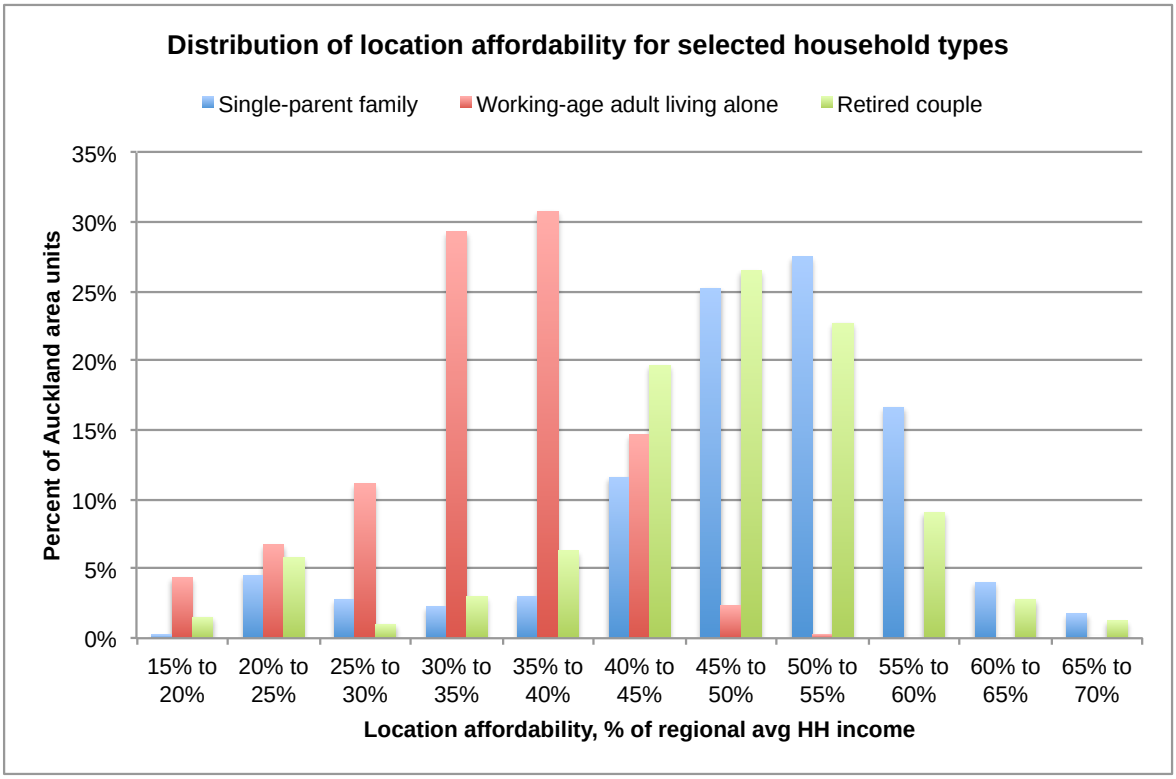
- Single-parent families
- Working-age adults living alone
- Retired couples.

Figure 26 presents a histogram of affordability at an area unit level for the three selected household types. Like Figure 25, it shows how location affordability is distributed in each city – i.e. whether a greater share of area units are relatively affordable or relatively unaffordable. Area units are grouped into 12 bins that represent average housing and transport costs as a share of median household income (X axis).

Household types with a distribution that is skewed to the left are likely to find that more areas are relatively affordable for them, while household types with distributions that are skewed to the left will find a greater proportion of Auckland area units to be relatively unaffordable. Figure 26 suggests that the affordability picture is very different for these three household types, with fewer areas offering affordability for single-parent families and retired couples.

Low levels of affordability for these household types are partly a result of their low average incomes. It is difficult to draw implications for policy without undertaking a more nuanced analysis of the determinants of affordability. However, these results are consistent with other research that suggests that policy influences affordability by reducing the supply of smaller dwellings through land-use regulations or subsidising the development of car-dependent suburbs.

Figure 26: Distribution of location affordability at an area unit level for three household types in Auckland



5.6.1 Working-age adults living alone face fewer affordability challenges

Working-age adults living alone do not appear to face greater affordability challenges than average Auckland households. Their average housing, car ownership and commute costs fall are estimated to fall between 30% and 40% of median household income in 60% of Auckland area units, and under 30% in a further 22% of Auckland area units.

Figure 27 shows how location affordability for working-age adults living alone varies with distance from the city centre. These results suggest that this household type may be able to benefit from cheaper housing costs in outlying areas. It also appears to indicate that city centre and city fringe areas are relatively less affordable, on average. (Scatterplots displaying the same results are presented in the Appendix. They display considerably more variation in affordability between more central areas.)

However, it is worth noting that these estimates include information on rental prices (for one-bedroom dwellings) but do not directly account for any potential supply shortfalls. It may be the case that regulatory constraints reduce the supply of small dwellings in more affordable areas – or, equally, that they are resulting in rising prices in areas of high demand such as the city centre fringe areas.

Figure 27: Average location affordability by distance from city centre for working-age adults living alone in Auckland

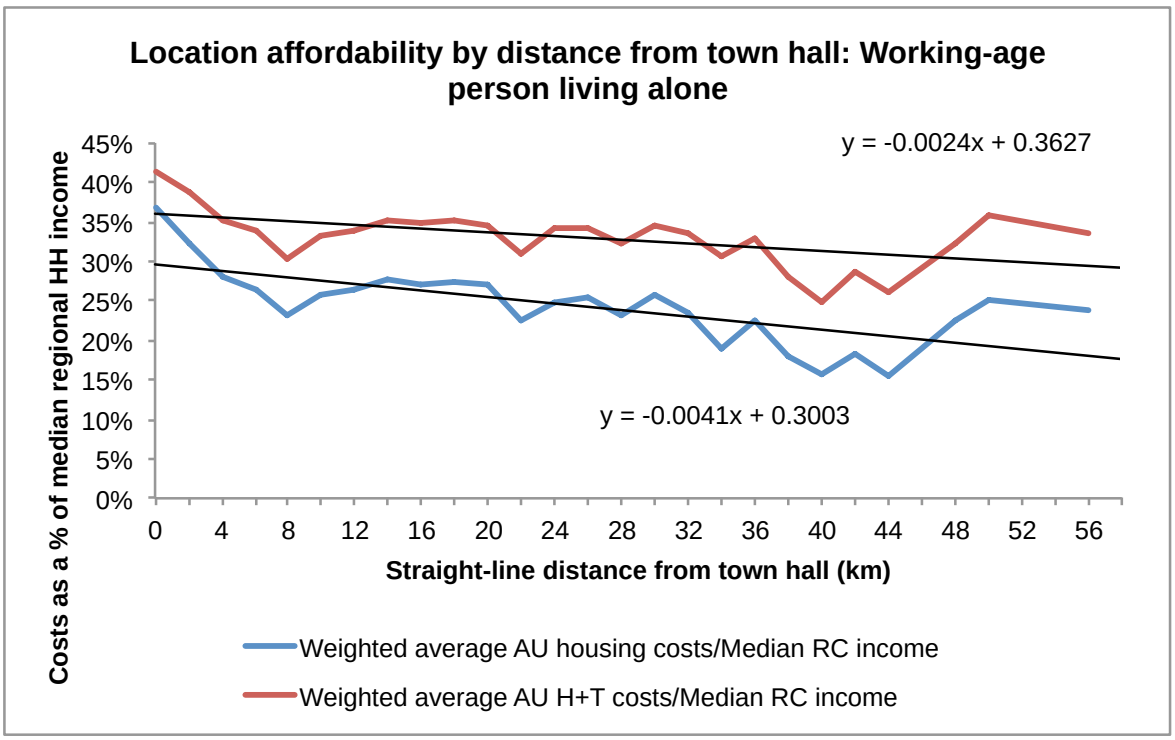
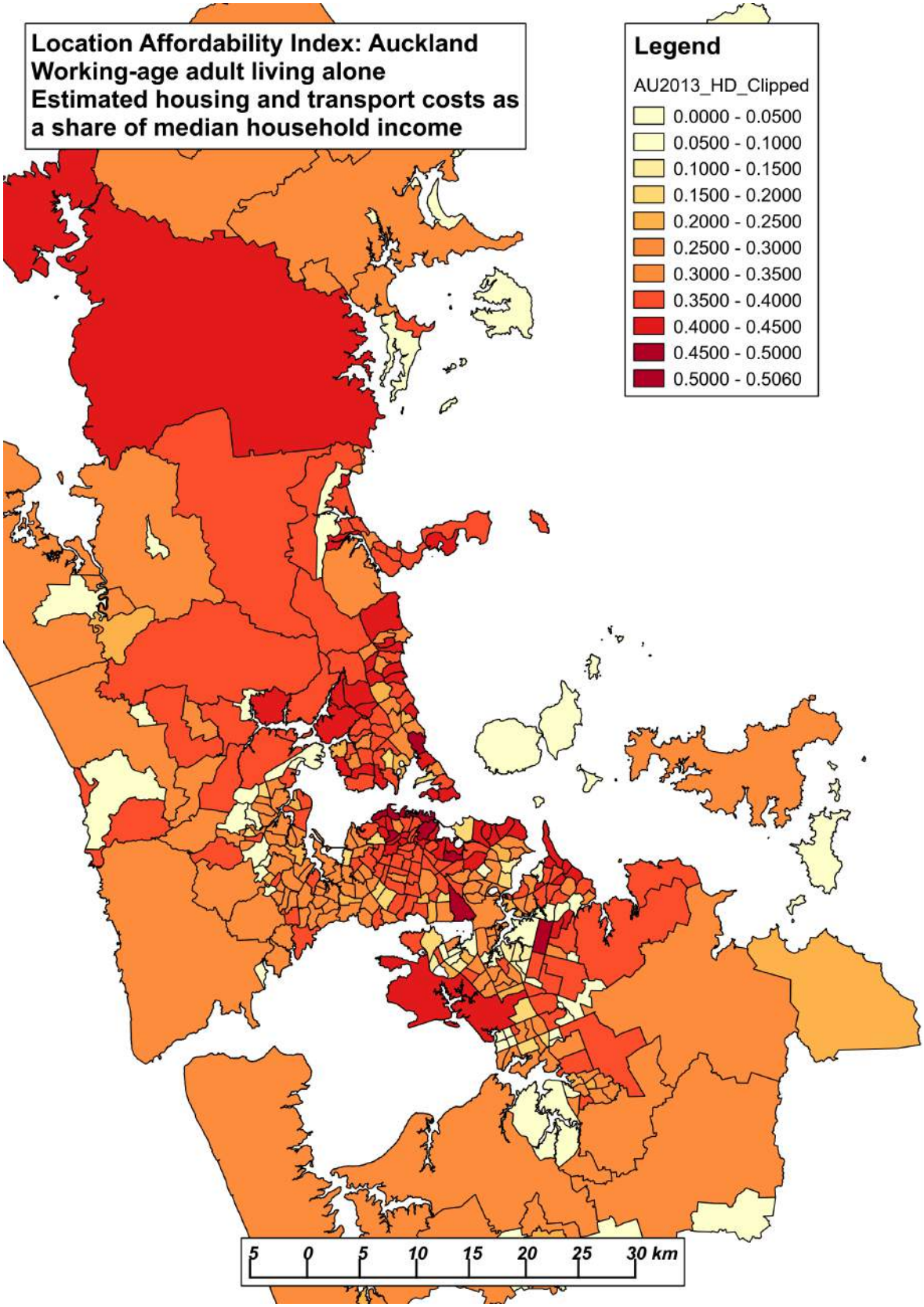


Figure 28 presents the same data in a choropleth map.

Figure 28: Map of average housing, car ownership and commute costs as a share of median household income for working-age adults living alone in Auckland



5.6.2 Single-parent families have trouble finding housing in Auckland

Unlike working-age adults living alone, single-parent families and retired couples appear to face greater affordability challenges. The median single-parent family faces expected housing and transport costs of over

50% of household income in half of Auckland's area units. Only 13% of Auckland's area units have expected housing, car ownership and commute costs under 40% of median income for a single-parent family. As these households are likely to have relatively low incomes to start with, this is likely to lead to material deprivation or the need to share accommodation.

Figure 29 shows how location affordability for single-parent families varies with distance from the city centre. Once again, it shows that there may be a slight advantage to fringe locations after housing, car ownership and commute costs are factored in. (Scatterplots displaying the same results are presented in the Appendix. They display considerably more variation in affordability between more central areas.)

Figure 29: Average location affordability by distance from city centre for single-parent families in Auckland

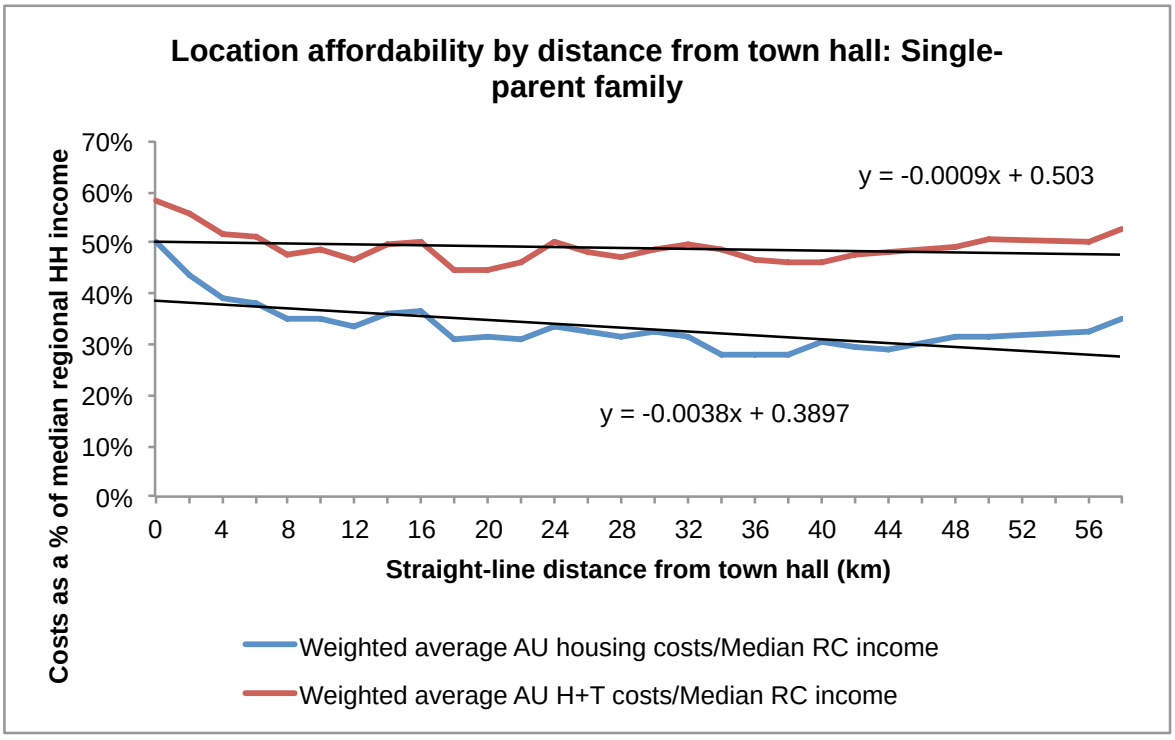
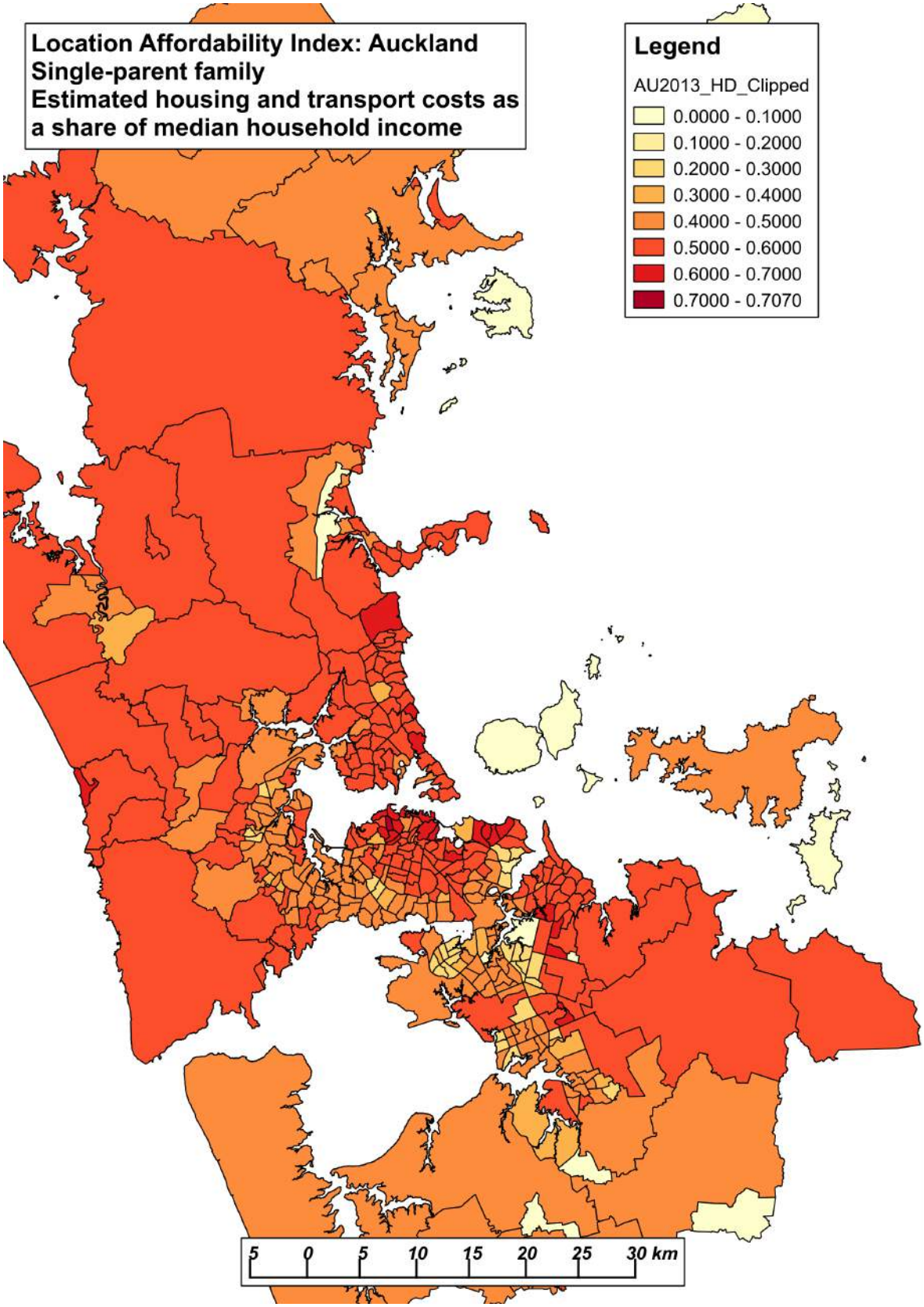


Figure 30 presents the same data in a choropleth map.

Figure 30: Map of average housing, car ownership and commute costs as a share of median household income for single-parent families in Auckland



5.6.3 Retired couples also face affordability challenges

Retired couples face similar challenges, in spite of the fact that they have negligible estimated average commute costs. The average retired couple in Auckland faces expected housing and transport costs of over 50% in 36%

of Auckland's area units. Only 18% of Auckland's area units have expected housing and transport costs below 40% of median income for a retired couple. We note that this estimate understates affordability challenges for retired couples, due to the fact that it excludes non-commute travel.

Figure 31 shows how location affordability for retired couples varies with distance from the city centre. It shows that there may be a slight advantage to fringe areas, due to lower housing costs, although we caution that this result is difficult to interpret due to a lack of information on non-commute travel costs. (Scatterplots displaying the same results are presented in the Appendix. They display considerably more variation in affordability between more central areas.)

Figure 31: Average location affordability by distance from city centre for retired couples in Auckland

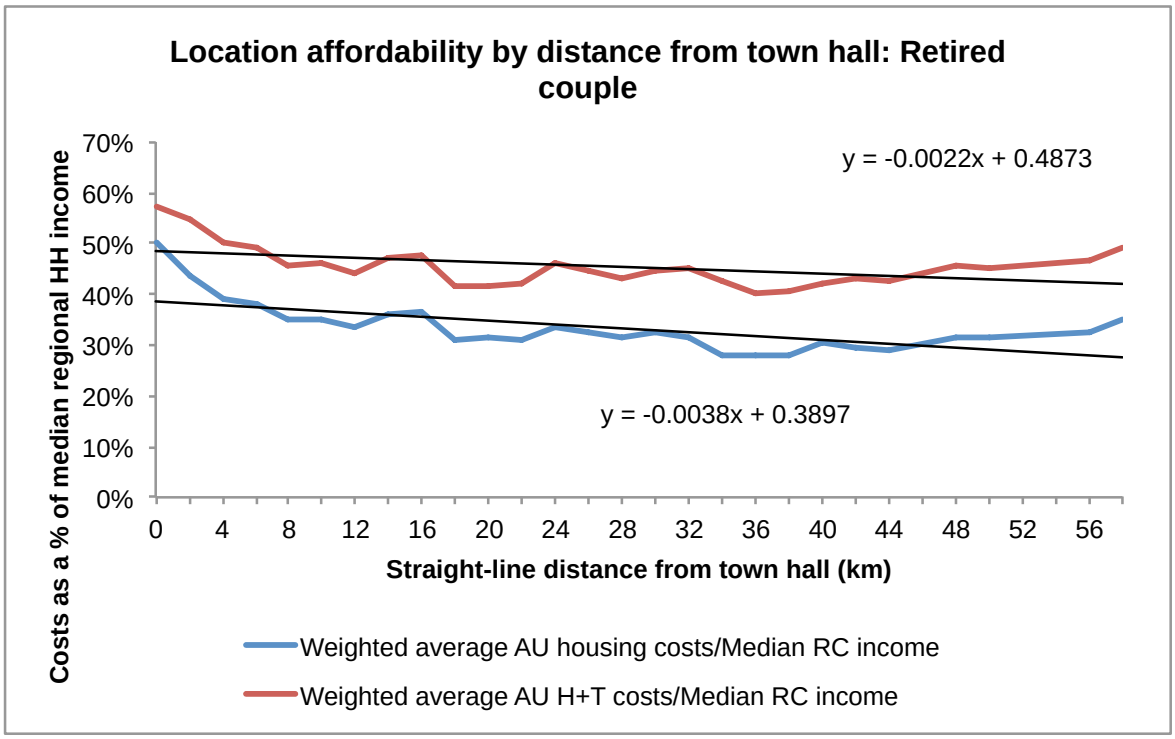
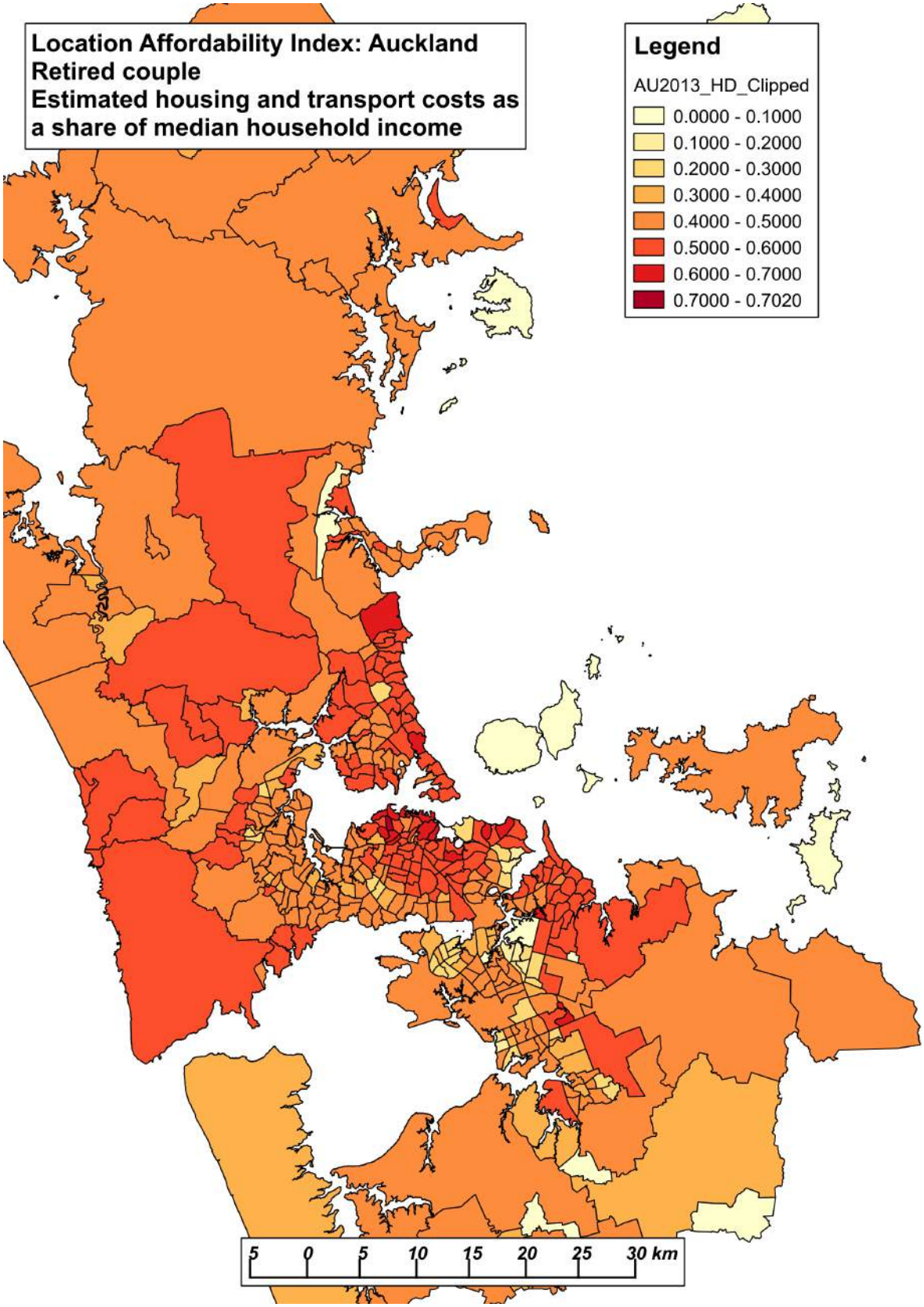


Figure 32 presents the same data in a choropleth map.

Figure 32: Map of average housing, car ownership and commute costs as a share of median household income for retired couples in Auckland



6 International comparisons

In this section, we place location affordability in comparative perspective by compiling a dataset of household budget surveys at a national level, for 28 Organization for Economic Cooperation and Development (OECD) countries, and at an urban level for 36 cities/urban regions in Australia, Canada, New Zealand, and the United States. We use this data to determine whether New Zealand as a whole, and Auckland in particular, is relatively affordable or unaffordable in comparative perspective.

This dataset should be seen as a useful complement to widely-reported measures of house prices across OECD countries and major cities (e.g. Demographia, 2013; OECD, 2013b). It provides a more comprehensive and meaningful picture of actual location costs borne by households.

Initial analysis of this dataset suggests that New Zealand as a whole is not especially affordable or unaffordable relative to other OECD countries. While New Zealanders' incomes tend to be lower than in other OECD countries, the average New Zealand household spends a similar share of its budget on housing, household energy, and transport.

An interesting finding from this dataset is that there was a remarkable degree of consistency in housing and transport expenditures, as a share of average household budgets, across countries with very different levels of income, transport provision, and housing and urban development policy. For example, New Zealand households spent an average of 37.8% of household budgets on location-related costs – slightly higher than Australia (36.3%) and the Netherlands (36.6%) but slightly less than Germany (39.9%) and Finland (38.1%). A few countries stood out as relatively expensive (United States, 44%) or relatively affordable (Portugal, 28%).

Similar results were obtained when comparing New Zealand's three main urban regions – Auckland, Wellington, and Canterbury – to cities and urban regions in Australia, Canada, and the United States. Based on comparable data from 2009-2010, we found that average household expenditure was lower, on a purchasing-power parity basis, in all three New Zealand regions than in most other cities. Average housing and transport costs consumed a greater share of household budgets in Auckland and Wellington than in almost all cities in Australia and Canada, which is consistent with other evidence on the high cost of housing in these cities. However, the New Zealand cities were relatively affordable compared with American cities[11].

This data does not necessarily support the conclusion that New Zealand cities are less affordable for residents than comparable cities in other New World countries. Further investigation and extension of this dataset is required to fully consider the determinants of affordability at an urban level.

The existence of a comparable dataset that includes both housing and transport costs provides further opportunities to examine the cross-sectional determinants of location affordability. One potential approach would be to gather national- or urban-level data on a range of key variables such as household incomes, average house prices, and household travel behaviours and test which are correlated with higher or lower levels of affordability. This approach could seek to examine whether the determinants of affordability at the level of individual households also influence outcomes at the aggregate level.

6.1 Compiling and comparing household budget survey data

Most OECD countries conduct household budget surveys similar to Statistics New Zealand's three-yearly Household Economic Survey to identify household spending on a range of goods and services. These surveys are

[11] We note that this result may be due to unidentified differences in household expenditure classifications.

generally conducted using a similar methodology and reported using a consistent set of high-level classifications[12]. We gathered data on total or average household expenditure on 28 OECD countries for a generally consistent time period (2010-2013) from several principal sources:

- Statistics NZ, Household Economic Survey 2012/2013
- Australian Bureau of Statistics, Household Expenditure Survey 2009/2010
- Statistics Canada, Survey of Household Spending 2012
- United Kingdom Office for National Statistics, Living Costs and Food Survey 2012
- United States Bureau of Labour Statistics, Consumer Expenditures Survey 2012
- Eurostat, Final consumption expenditure of households 2012, which provided data on 23 European countries in the OECD[13].

6.2 Location affordability at a national level

Our national household budget survey dataset is summarised in

Table 7, which displays the share of overall household budgets spend on housing (including household energy costs) and transport for 28 OECD countries.

This dataset suggests that average housing and transport costs are broadly consistent among OECD countries, in spite of considerable variation in average incomes, transport options, and urban form. 23 out of 28 countries had average housing and transport costs that fell between 30% and 40% of household budgets. Half of these countries had combined costs in the range of 35%-38% of household budgets. The United States (44%) and Luxembourg (43.5%) spent the greatest share of average household budgets on location-related costs, while Poland (28%) and Switzerland (31.7%) spent the least.

Interestingly, there appears to be more variation in housing costs as a share of household budgets than there is in transport costs. In addition, there is no evidence of a consistent trade-off between housing costs and transport costs – the countries with higher transport costs do not necessarily have lower housing costs.

New Zealand's location costs were slightly higher the average OECD country, with the typical NZ household spending 24.9% of its budget on housing and household energy (compared with an unweighted average of 23.7%), and 13.9% on transport services (compared with an unweighted average of 13.0%).

[12] Inconsistencies between classification systems were minimal at the top level of classification. The main exception was in the treatment of household energy costs. Most countries included household energy costs within housing costs. To ensure consistency in estimates, we added household energy costs into housing costs for the two countries – Australia and the United States – that classify these expenditures into separate top-level categories. In the case of the US, we also excluded some costs related to household operation (e.g. cleaning services).

[13] Eurostat data was published within European National Accounts data but based on household budget surveys. See European Commission (2003) for a description of the methodology behind these surveys.

Table 7: Housing and transport expenditures at a national level for 28 OECD countries, 2009-2013

Housing and transport costs across OECD countries

		Costs as a % of household expenditure		
Country	Year	Housing* costs	Transport costs	Combined H+T
Australia	2010	20.7%	15.6%	36.3%
Austria	2012	21.6%	13.3%	34.9%
Belgium	2012	24.3%	12.0%	36.3%
Canada	2012	21.0%	14.9%	35.8%
Czech Republic	2012	26.3%	9.4%	35.7%
Denmark	2012	29.3%	12.5%	41.8%
Estonia	2012	19.7%	13.3%	32.9%
Finland	2012	27.1%	11.1%	38.1%
France	2012	25.6%	13.9%	39.6%
Germany	2012	24.2%	13.7%	37.9%
Greece	2011	23.8%	11.8%	35.6%
Hungary	2012	21.6%	12.7%	34.3%
Iceland	2012	21.7%	15.8%	37.4%
Ireland	2012	23.2%	13.1%	36.3%
Italy	2012	23.3%	12.5%	35.8%
Luxembourg	2012	24.5%	19.1%	43.5%
Netherlands	2012	24.5%	12.1%	36.6%
New Zealand	2013	23.9%	13.9%	37.8%
Norway	2012	21.0%	15.1%	36.1%
Poland	2012	23.1%	10.2%	33.3%
Portugal	2012	16.5%	11.5%	28.0%
Slovakia	2012	25.6%	7.7%	33.3%
Slovenia	2012	19.5%	16.1%	35.6%
Spain	2012	21.2%	11.4%	32.6%
Sweden	2012	27.0%	12.9%	39.9%
Switzerland	2009	24.2%	7.5%	31.7%
United Kingdom	2012	26.0%	14.2%	40.3%
United States	2013	26.5%	17.5%	44.0%

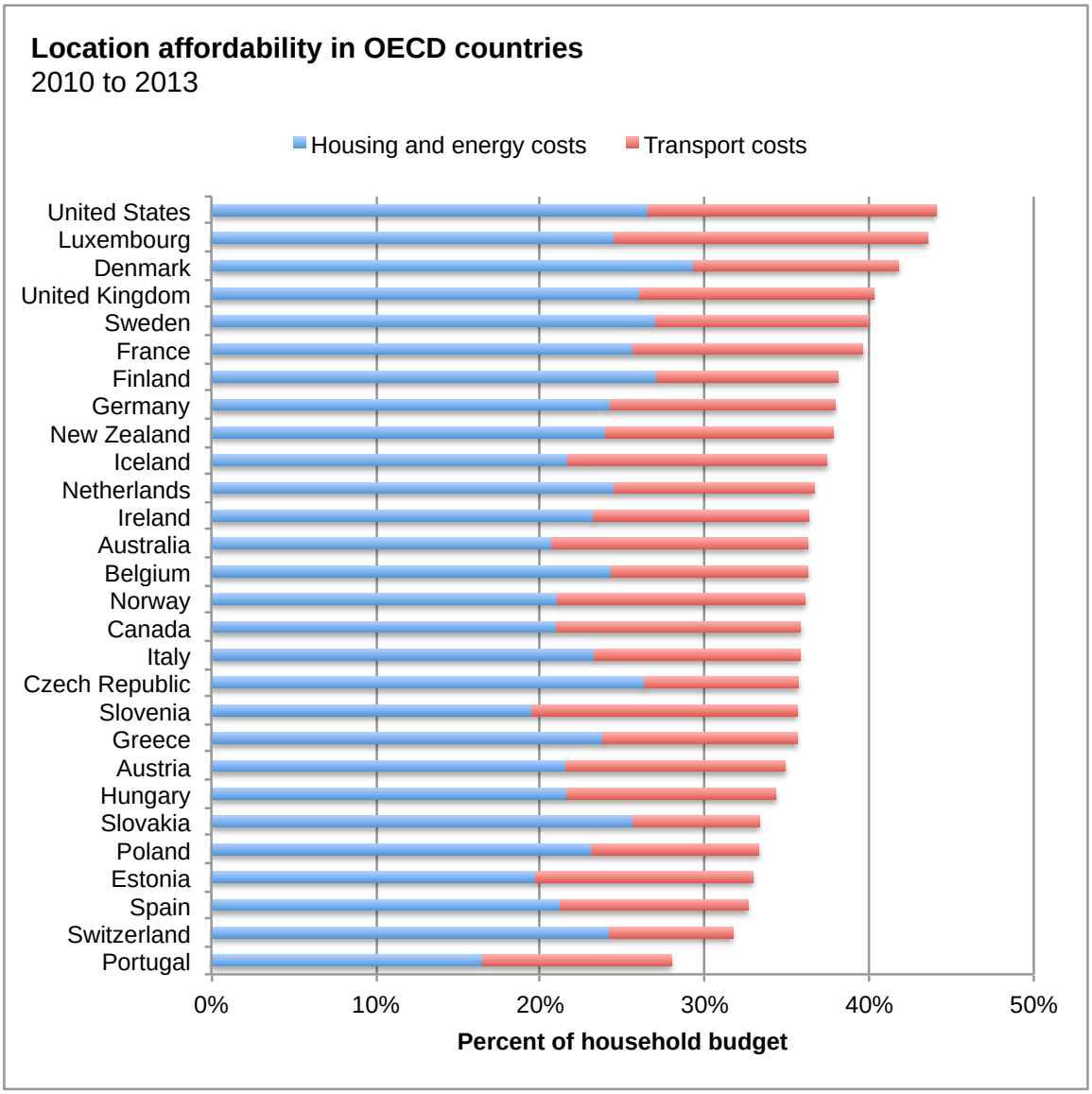
** Including housing services and household energy but excluding household operation and furnishings*

Sources: ABS, Stats NZ, StatCan, US BLS, Eurostat, UK ONS

s. New Zealand was ranked ninth out of 28 countries in the sample.

Figure 33 presents the same data in graphical form. It shows that New Zealand households spend a similar share of their budgets on housing and transport costs to many other OECD countries. New Zealand was ranked ninth out of 28 countries in the sample.

Figure 33: Graph of housing and transport expenditures at a national level for 28 OECD countries, 2009-2013



Source: Household budget survey data, author's calculations

6.3 Location affordability at an urban / regional level

Several OECD countries also published household budget survey data at a disaggregated level, allowing us to compare location affordability measures at a regional or city level. We gathered data on 36 cities or urban regions in across four countries:

- Australia (8 cities; state capitols plus Canberra)
- Canada (7 cities; provincial capitols or largest cities)
- New Zealand (3 regions that include New Zealand's largest cities)
- United States (18 large cities from all major regions)[14].

[14] The US household budget survey data shows considerably higher expenditure on housing and transport – and hence lower affordability. This is true in high-income cities (Washington, DC, San Francisco) and low-income cities (Miami, Cleveland), which may suggest that methodological differences between household budget surveys may play a role. A review of BLS's Consumer Expenditure Survey glossary (http://www.bls.gov/cex/csxgloss.htm#expn) seems to suggest that housing and transport expenditure categories used in the US are consistent with those used in Australia and NZ. Further investigation may be needed to determine whether the US results represent a statistical artefact or a higher underlying cost structure.

To enable comparisons between cities, we gathered data for 2009-2010 and converted household expenditures to purchasing-power parity (PPP) international dollars using PPP exchange rates sourced from the OECD statistical service.

Table 8 presents our dataset of household budget survey data at the level of cities or urban regions. It presents average annual total household expenditure, housing (and household energy) spending, and spending on transport. This dataset shows that New Zealand's three urban regions had relatively low average household spending. Average household expenditure was highest in Wellington and lowest in Canterbury.

Average housing expenditure in New Zealand's urban regions fell within the range of expenditure observed in Australian cities, but was generally lower than expenditure observed in Canadian and United States cities. For example, average annual housing expenditure in Auckland ($10,800) was slightly higher than average annual housing expenditure in Sydney ($10,600), in spite of considerably lower incomes in Auckland. This is consistent with Grimes, Holmes and Tarrant (2010), who suggest that house prices are converging across New Zealand and Australian markets. As a result of this, households in Auckland and Wellington spend a greater share of their budgets on housing costs.

However, average transport expenditures were markedly lower in New Zealand's urban regions than in other cities in this dataset. This appears to improve affordability outcomes in New Zealand. It may be worth investigating the reasons for this result – whether New Zealanders tend to travel less on average or pay lower prices for transportation (e.g. by purchasing older cars). Transport prices do not appear to be lower in New Zealand than in other comparator countries: public transport fares are higher in Auckland and Wellington than in selected Australian and North American cities (Wallis and MRCagney, 2011), while petrol taxes are higher in New Zealand than in other countries in this sample (OECD, 2013a).

Overall, this dataset does not provide any conclusive evidence than housing and transport is systematically less affordable in New Zealand cities. Average households in Auckland and Wellington spend a greater share of their budgets on location-related costs than households in most Australian and Canadian cities. However, they spend a lower share than households in United States cities.

Table 8: Housing and transport expenditures in 36 New World cities, 2009-2010

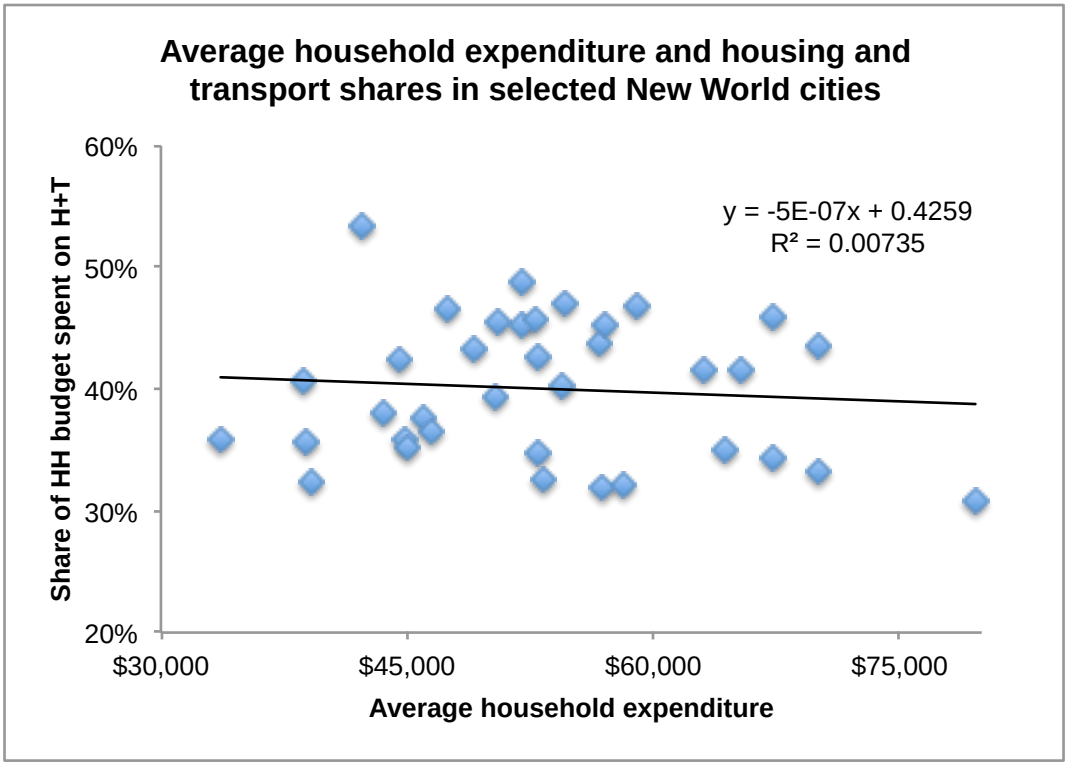
Housing and transport costs in a range of New World cities

		Annual household expenditure (2010 PPP dollars)			Costs as a % of household expenditure		
Country	City / region	Total expenditure	Housing* costs	Transport costs	Housing* costs	Transport costs	Combined H+T
Australia	Sydney	$46,052	$10,633	$6,647	23.1%	14.4%	37.5%
	Melbourne	$44,916	$9,241	$6,902	20.6%	15.4%	35.9%
	Brisbane	$46,483	$10,012	$6,937	21.5%	14.9%	36.5%
	Adelaide	$38,858	$8,149	$5,692	21.0%	14.6%	35.6%
	Perth	$44,993	$9,218	$6,633	20.5%	14.7%	35.2%
	Hobart	$39,195	$7,314	$5,402	18.7%	13.8%	32.4%
	Darwin	$50,402	$11,784	$8,051	23.4%	16.0%	39.4%
	Canberra	$52,905	$10,399	$7,997	19.7%	15.1%	34.8%
Canada	Montreal	$53,381	$10,420	$6,955	19.5%	13.0%	32.5%
	Toronto	$70,130	$14,374	$8,929	20.5%	12.7%	33.2%
	Winnipeg	$56,873	$10,700	$7,467	18.8%	13.1%	31.9%
	Calgary	$79,614	$14,523	$10,009	18.2%	12.6%	30.8%
	Edmonton	$67,353	$13,901	$9,257	20.6%	13.7%	34.4%
	Vancouver	$64,294	$14,594	$7,951	22.7%	12.4%	35.1%
	Halifax	$58,172	$11,347	$7,318	19.5%	12.6%	32.1%
New Zealand	Auckland	$38,705	$10,819	$4,937	28.0%	12.8%	40.7%
	Wellington	$43,552	$11,270	$5,262	25.9%	12.1%	38.0%
	Canterbury	$33,634	$7,647	$4,410	22.7%	13.1%	35.8%
United States	New York	$58,942	$19,644	$7,944	33.3%	13.5%	46.8%
	Philadelphia	$52,041	$16,584	$6,960	31.9%	13.4%	45.2%
	Boston	$63,063	$17,043	$9,104	27.0%	14.4%	41.5%
	Washington, D.C.	$70,075	$20,501	$10,067	29.3%	14.4%	43.6%
	Baltimore	$52,815	$17,569	$6,566	33.3%	12.4%	45.7%
	Atlanta	$47,502	$14,927	$7,164	31.4%	15.1%	46.5%
	Miami	$42,266	$16,011	$6,569	37.9%	15.5%	53.4%
	Dallas-Fort Worth	$52,977	$14,529	$8,016	27.4%	15.1%	42.6%
	Houston	$56,764	$15,442	$9,410	27.2%	16.6%	43.8%
	Los Angeles	$54,576	$17,175	$8,540	31.5%	15.6%	47.1%
	San Francisco	$67,360	$22,397	$8,509	33.2%	12.6%	45.9%
	San Diego	$52,012	$18,419	$6,963	35.4%	13.4%	48.8%
	Seattle	$65,317	$17,064	$10,054	26.1%	15.4%	41.5%
	Phoenix	$49,016	$13,218	$8,008	27.0%	16.3%	43.3%
	Chicago	$57,022	$17,187	$8,662	30.1%	15.2%	45.3%
	Detroit	$50,608	$13,576	$9,460	26.8%	18.7%	45.5%
	Minneapolis-St. Paul	$54,420	$14,381	$7,482	26.4%	13.7%	40.2%
	Cleveland	$44,561	$12,017	$6,931	27.0%	15.6%	42.5%

** Including housing services and household energy but excluding household operation and furnishings* *Sources: ABS, Stats NZ, StatCan, US BLS, OECD*

This data suggests that at an urban level there is no consistent positive or negative relationship between average household expenditure and the share of household budgets spent on housing and transport. In short, average households in wealthier cities do not tend to spend a greater share on location-related costs. This finding is generally consistent with the new economic geography literature, which stresses the relationship between productivity (which influences household income), land prices, and accessibility. However, it does not offer any insight into outcomes within cities, where particular types of households may have difficulty finding affordable locations due to low incomes, regulatory or market failures, or insufficient or misplaced infrastructure investment.

Figure 34: Relationship between average household expenditure and the share of household budgets spent on housing and transport



Source: Household budget survey data, author's calculations

7 Discussion and conclusions

7.1 Overview of findings

Our analysis of estimates from the LAI and of results from household budget surveys from across the OECD suggests that location affordability varies both within cities and between cities.

First, our LAI estimates are broadly consistent with the prediction, drawn from the new economic geography literature, that there are trade-offs between housing costs and transport accessibility. While outcomes may vary between areas, housing costs tend to fall with increasing distance from city centres, while commute distances, which drive variable transport costs, tend to increase. All other things being equal, higher rates of public transport use did not appear to improve transport affordability due to the fact that New Zealand's public transport fares are comparable to or higher than car operating costs. However, car commuting is likely to be more costly in areas where parking is priced – a factor that we were not able to robustly estimate.

Car ownership rates, which drive a large share of transport costs, tend to be fairly consistent outside of city centres. One of the benefits of providing public transport and walking and cycling infrastructure is that it enables households to reduce car ownership costs. Conversely, policies such as minimum parking regulations tend to encourage higher rates of car ownership by ensuring abundant and low-priced parking.

Second, our findings are also potentially consistent with arguments drawn from the literature on the cost of planning regulations. Once car ownership and commute costs are included, overall location affordability tends to fall with distance from city centres. Lower-income households appear to be sorted into areas where they must spend a greater share of their budgets on location costs.

It is unclear whether this finding suggests that households are making location decisions based on incomplete information about location-related costs, or whether broader planning and investment decisions have reduced the supply of housing in relatively more affordable locations (or encouraged the supply of housing in less affordable locations). The evidence compiled in this paper is not sufficient to identify particular planning or investment decisions that are reducing location affordability in New Zealand cities.

We observe similar results in all three New Zealand regions that we studied, albeit with slightly different magnitudes. The LAI estimates represent a low estimate of location-related costs, as we were not able to develop robust estimates of non-commute transport costs. Other sources of data on non-commute transport costs suggest that in Auckland households in areas with higher average commute costs also tend to travel further to retail (Fairgray 2013) and spend more on fuel purchases (Polkinghorne 2014).

Third, planning and investment decisions that reduce location affordability are likely to cause significant equity issues. Insufficient supply of housing in relatively accessible areas will tend to have negative effects on low-income households, as they are priced out into less accessible areas and consequently have to spend a greater proportion of their household budget on location-related costs. This is one potential implication of LAI estimates, which show that expected housing and transport costs consume a greater share of household budgets in low-income areas.

Furthermore, Auckland-specific analysis of three household types that may not be well-served by traditional planning policy suggests that affordability is likely to be a challenge for some household types, such as single-parent families and retired couples. We did not observe any particular affordability difficulties for working-age adults living alone – although we note that these results should be interpreted with caution as we have not directly considered whether there are constraints to supply of smaller dwellings. However, these results may be

driven by the relatively low median incomes of these household types. It is not clear whether housing or transport policy is the appropriate policy lever to address affordability shortfalls for these household types.

Fourth, our findings are broadly consistent with previous work on housing affordability in New Zealand cities. Household budget survey data allowed us to provide a more comprehensive and comparable view on the relative affordability of New Zealand's cities. At a national level, we find that the share of New Zealand's household budgets consumed by housing and transport costs was in line with most OECD countries. While low average incomes may place financial stress on New Zealand households, housing and transport costs are not necessarily structurally out of line with incomes at an aggregate level.

Household budget survey data also enabled a comparison between 36 cities in Australia, Canada, New Zealand, and the United States. We found that location expenditures as a share of household budgets were higher in Auckland and Wellington than in most Australian and Canadian cities, but lower than in United States cities. Location expenditures as a share of household budgets in Canterbury were in line with Australian and Canadian cities.

At an urban level, housing costs appeared to be a more important driver of affordability than transport costs. New Zealand's three main urban regions stand out as having lower average (purchasing power parity-adjusted) household expenditures than almost all other cities in the dataset. Average housing and household energy expenditures were on par with Australian cities, meaning that New Zealand households spent a slightly greater share of income on housing. However, average transport spending in all three New Zealand regions was lower than any other city in the sample. This finding is worth further investigation, as transport prices – as indicated by petrol taxes (OECD, 2013, Taxing Energy Use) and public transport fares (Wallis and MRCagney, 2011) – are higher in New Zealand than in the other three countries.

7.2 Policy implications

The data presented in this paper represents a rich new source of information on housing and transport costs in New Zealand cities. We discuss some potential policy implications of this analysis, while noting that the analysis in this paper does not allow us to identify any particular policies that should or should not be implemented.

First and foremost, our findings strongly suggest that policymakers should consider all location-related costs when attempting to address affordability for households. A focus on house prices is too narrow and can result in poor affordability outcomes for households. Our finding that commute distances, and hence household transport costs, tend to rise with increasing distance from city centres suggests that developments in outlying areas are not necessarily affordable.

Second, we find that housing costs play a significant role in shaping affordability both within cities and between cities. Auckland and Wellington stand out, relative to Australian cities, as having high housing expenditures relative to household incomes, but relatively low overall transport expenditures. Within cities, rents tend to decline with distance from city centre, although not to a sufficient degree to offset higher transport costs in fringe areas.

A focus on the determinants of housing costs is justified. Our findings are potentially consistent with the literature on the costs of planning regulations, which suggests that a range of land use regulations impose a "tax" on housing supply. However, they do not allow us to identify which types of regulations are most costly.

Previous analysis on the costs of regulation has focused on the impact of Auckland' Metropolitan Urban Limit. LAI estimates are potentially consistent with this analysis, as the existence of the MUL may mean that house prices in fringe areas are held at too high a level to adequately price in transport costs. Conversely, if households

are locating in fringe areas that are relatively unaffordable due to higher transport costs, it may be due to regulatory controls that restrict dwelling supply in inner suburbs and price out poorer households.

It is difficult, at this point, to distinguish between these explanations. Furthermore, it is not possible to say whether removals of specific regulatory controls would result in increased welfare without a more comprehensive analysis of location-related costs.

Finally, this discussion underlines the need for further research into the determinants of location affordability in New Zealand. The data compiled in this paper suggests that the causes of location affordability (and unaffordability) are complex. No single policy is likely to solve all problems with affordability. Making robust policy in this area requires a deeper evidence base that examines the costs and benefits of transport investments and planning regulations as they relate to location affordability.

7.3 Further directions for research

We suggest that the datasets compiled in this paper provide three potentially promising avenues for further research.

First, the LAI estimates and underlying income, housing, and transport variables allow for further spatial analysis on the determinants of affordability in New Zealand cities, including policy factors such as planning regulation and infrastructure provision. For example, the LAI measures could be used to study the effects of infrastructure provision (e.g. the availability of rapid-transport networks or road networks) or planning regulations. As the fact that the LAI covers three regions with considerable historical differences in built form, geography, policy, and infrastructure provision, it offers opportunities to study the impacts of region-wide policy decisions as well as variations within regions.

Second, there is the potential to extend the LAI to reflect a more complete picture of location costs. Our survey of data sources on non-commute transport costs and household energy costs has identified several opportunities to do so. While we have not done so at this point due to challenges with data collection and the potential for double counting some costs, this is a promising area for further research. In particular, we note that it would be desirable to have a more complete understanding of the relationship between rents and house prices in New Zealand's main urban areas.

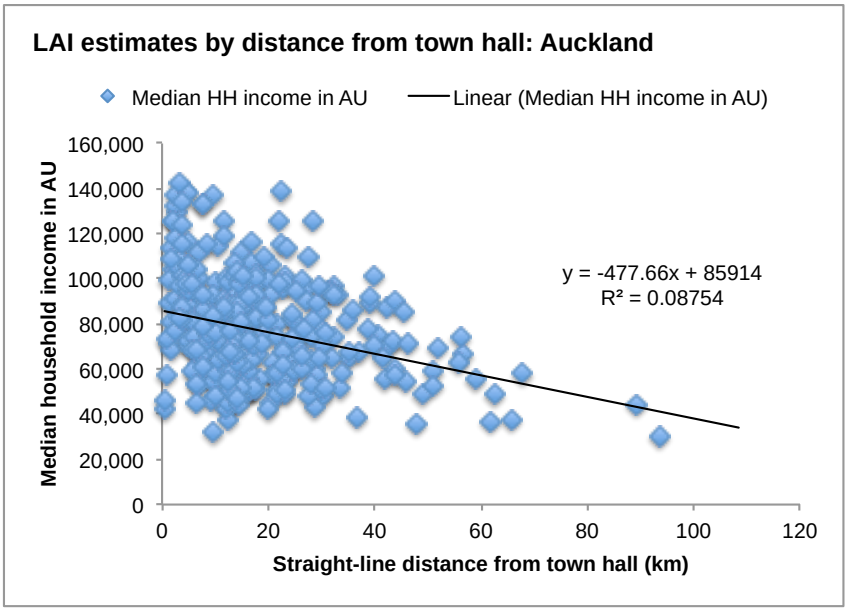
Third, our international and inter-urban dataset of household budget surveys provides opportunities to study the determinants of affordability at a cross-sectional level. For example, further work could be done to examine the relationship between location affordability and other national- or urban-level variables such as incomes, house prices, car ownership, household travel behaviours, and urban form.

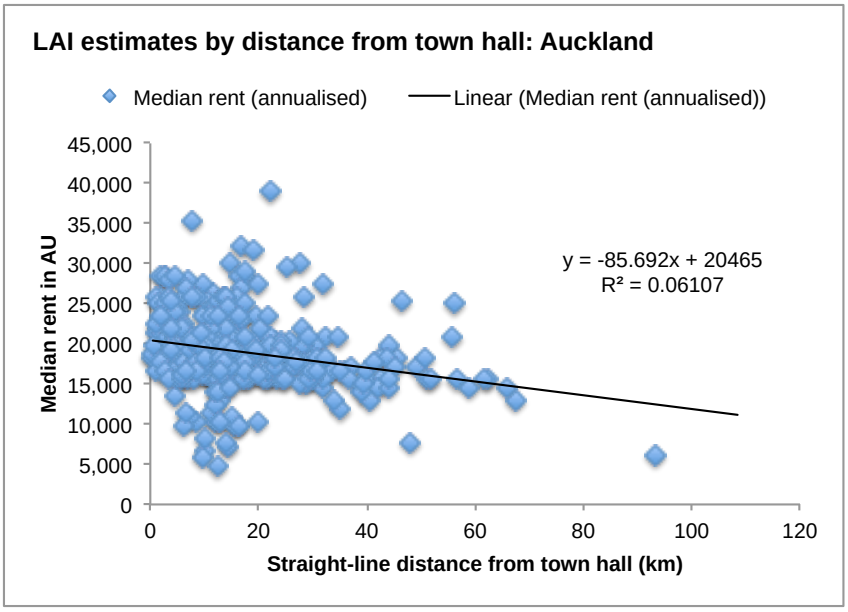
APPENDIX A Scatter-plots of LAI variables and outputs

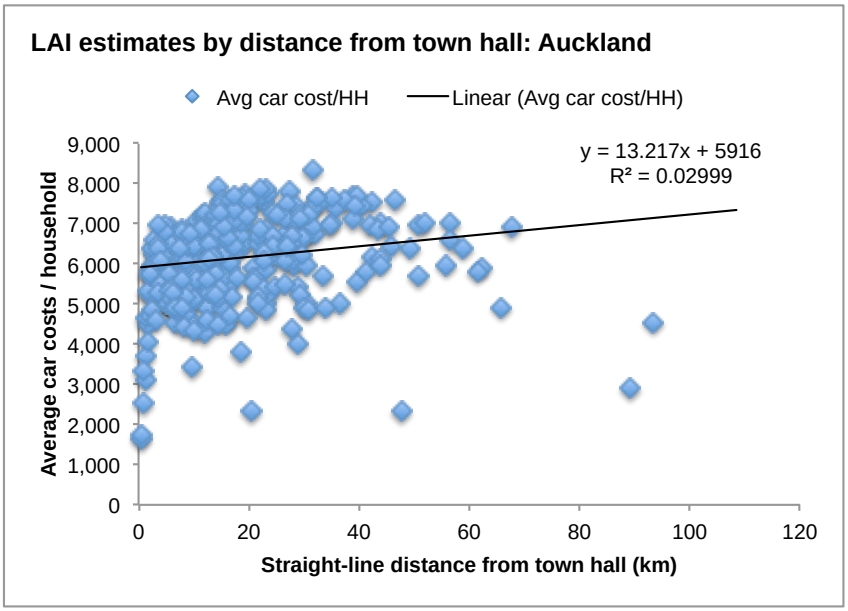
This Appendix presents scatterplots displaying key LAI variables and estimates for each of the three urban regions and for the three selected household types in Auckland.

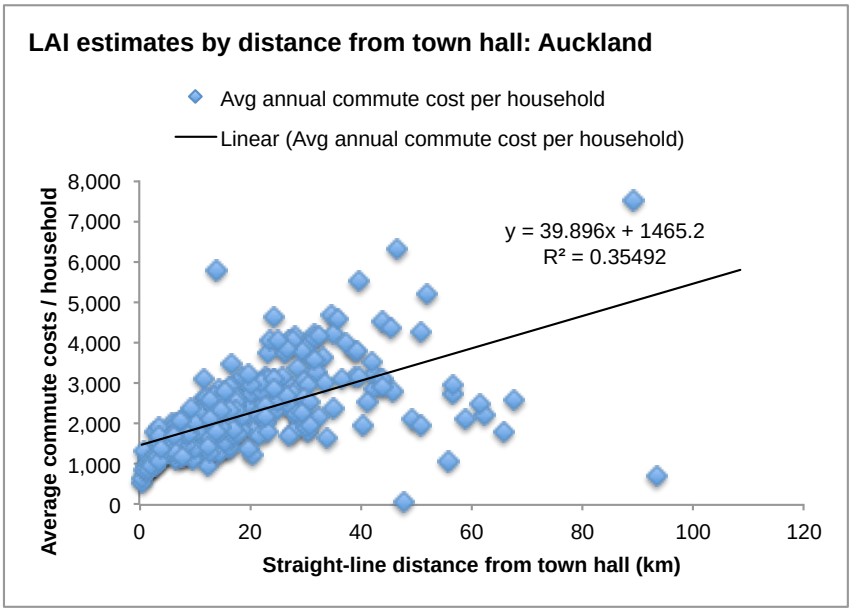
A.1 Auckland Region LAI variables and estimates

A.1.1 Underlying variables

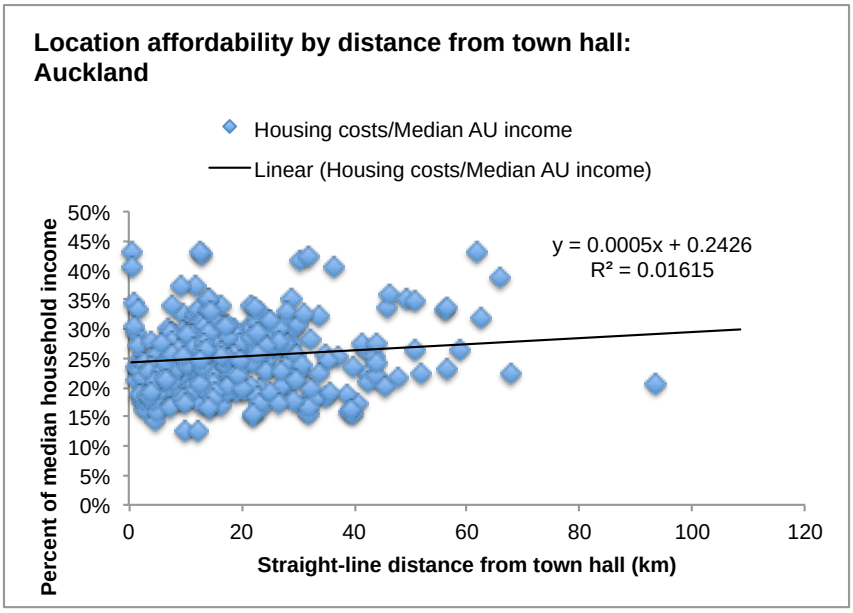


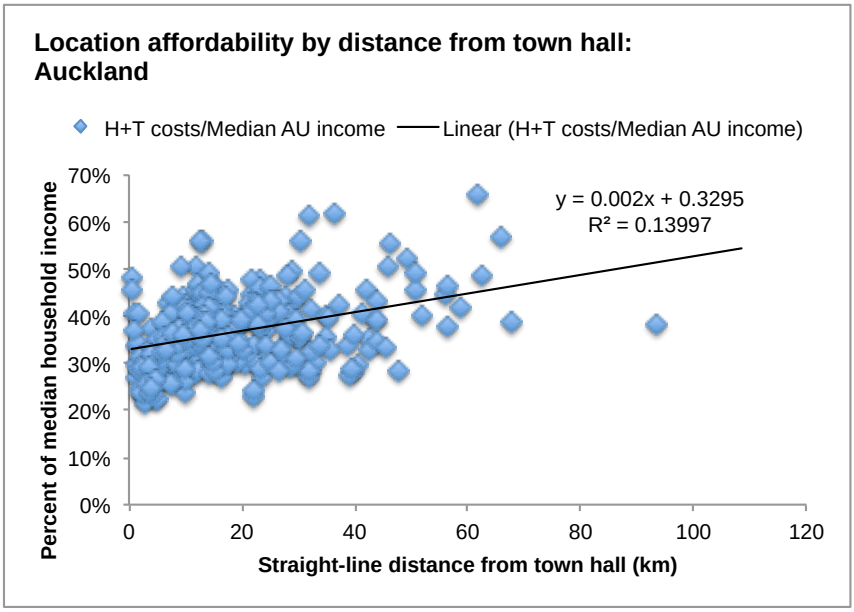






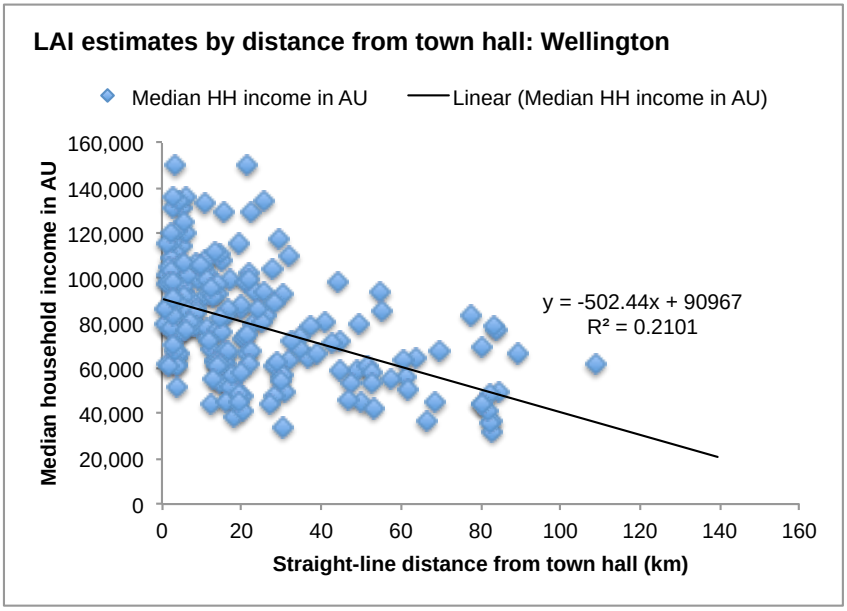
A.1.2 Main estimates

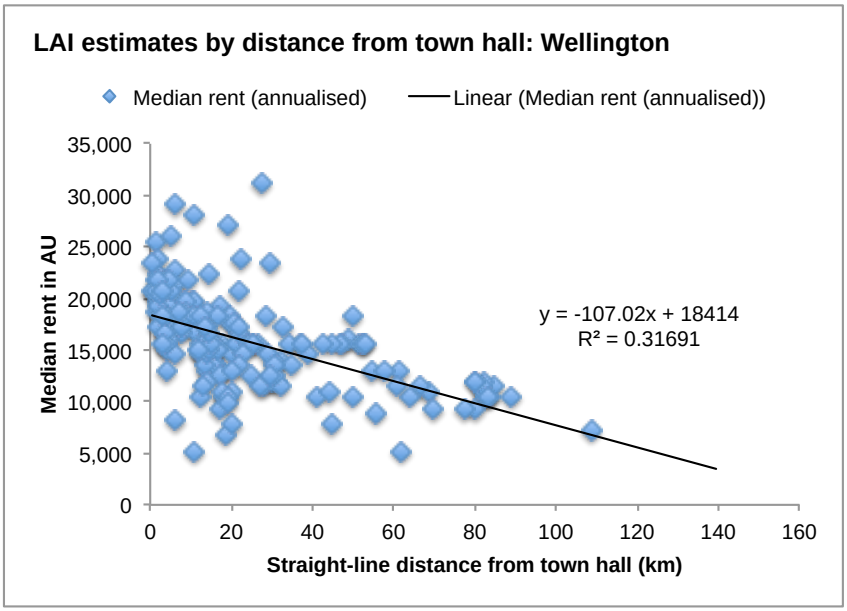


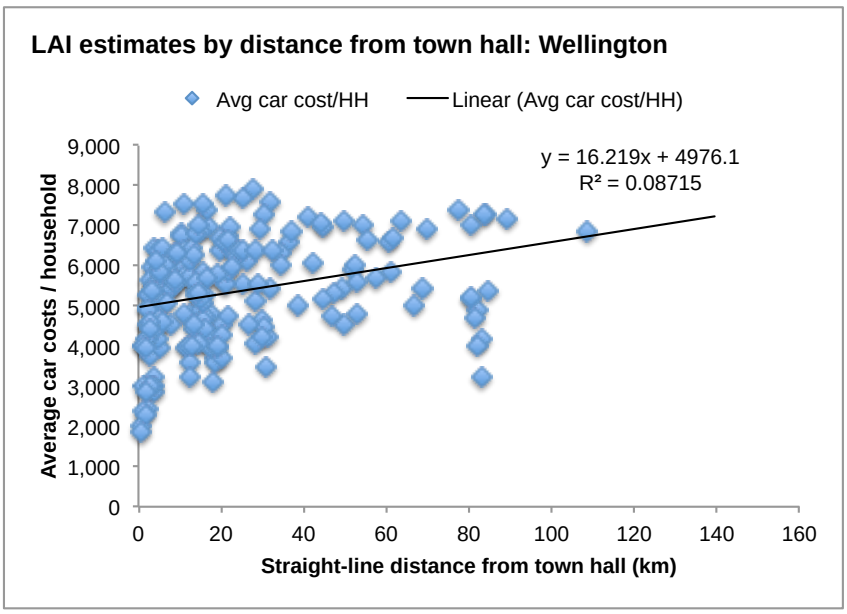


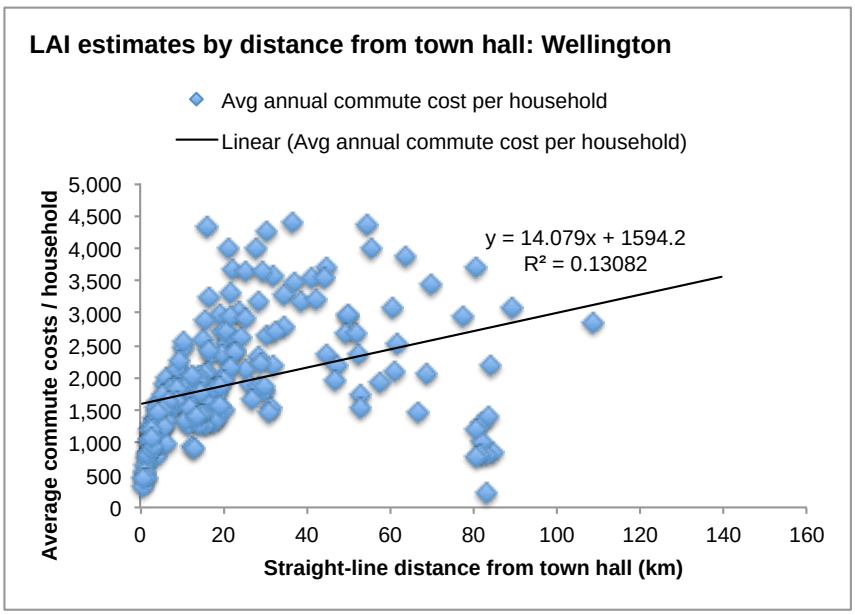
A.2 Wellington Region LAI variables and estimates

A.2.1 Underlying variables

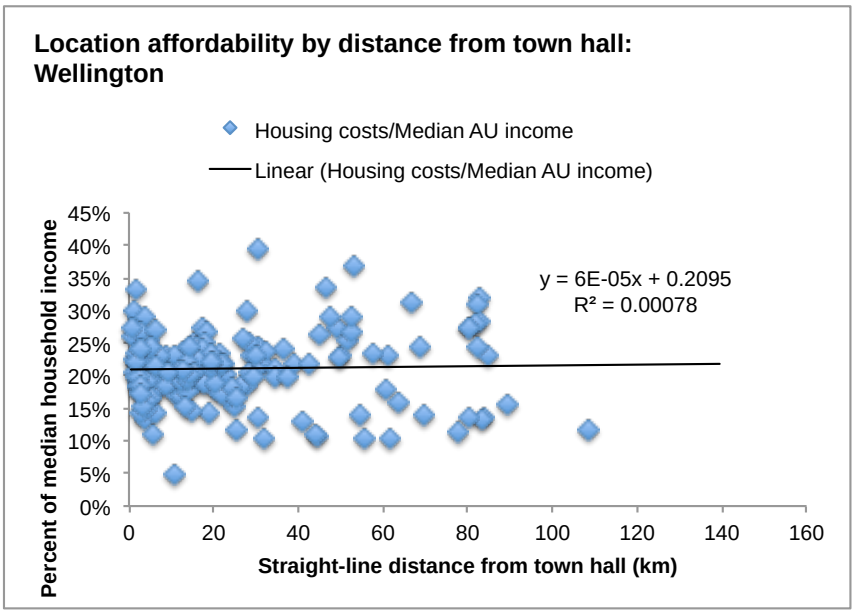


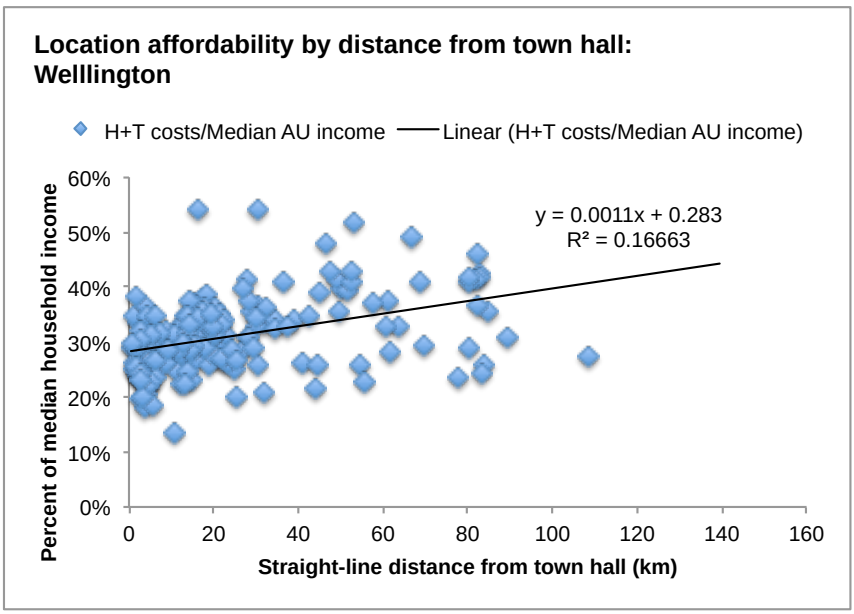

LAI estimates by distance from town hall: Wellington
Median rent (annualised)
Linear (Median rent (annualised))
Median rent in AU
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
y = -107.02x + 18414
R² = 0.31691
0
20
40
60
80
100
120
140
160
Straight-line distance from town hall (km)


LAI estimates by distance from town hall: Wellington
Avg car cost/HH
Linear (Avg car cost/HH)
Average car costs / household
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
y = 16.219x + 4976.1
R² = 0.08715
0
20
40
60
80
100
120
140
160
Straight-line distance from town hall (km)


LAI estimates by distance from town hall: Wellington
Avg annual commute cost per household
Linear (Avg annual commute cost per household)
Average commute costs / household
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
y = 14.079x + 1594.2
R² = 0.13082
0
20
40
60
80
100
120
140
160
Straight-line distance from town hall (km)

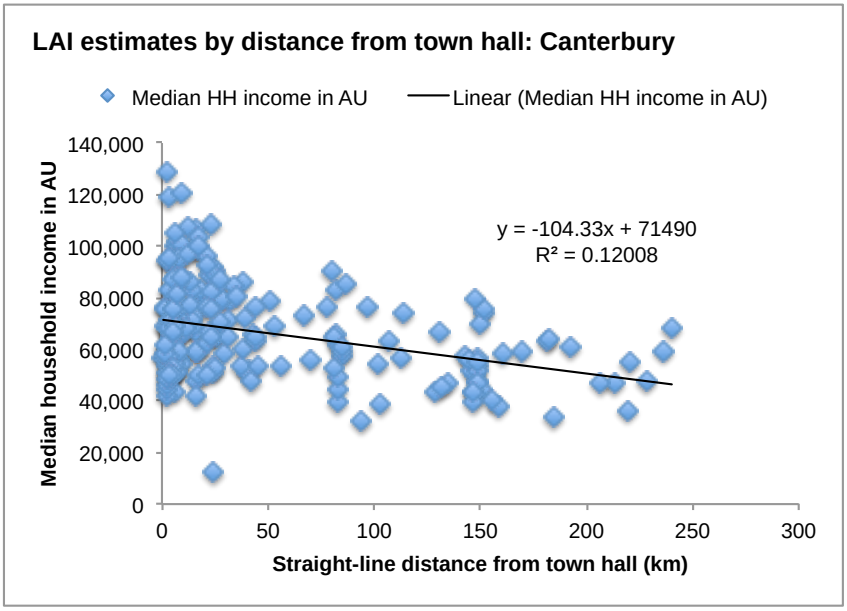
A.2.2 Main estimates

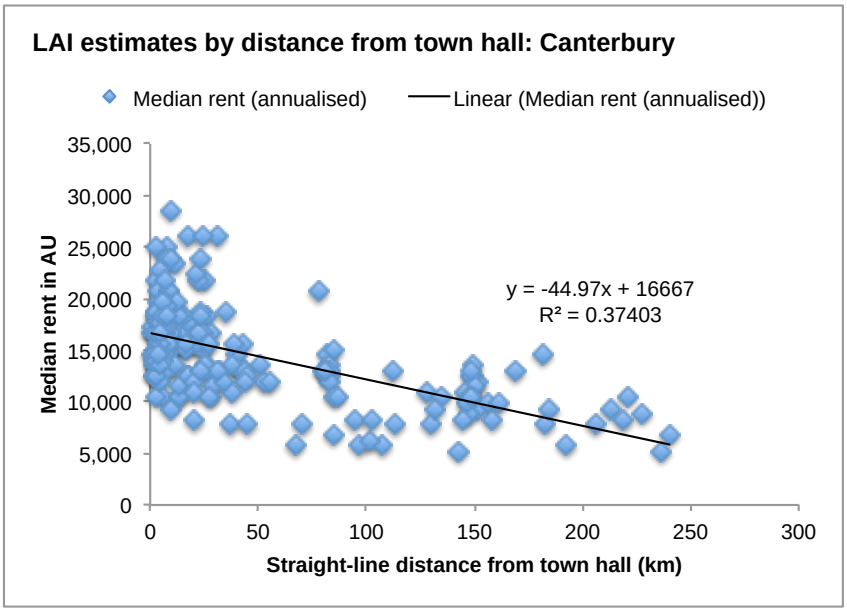


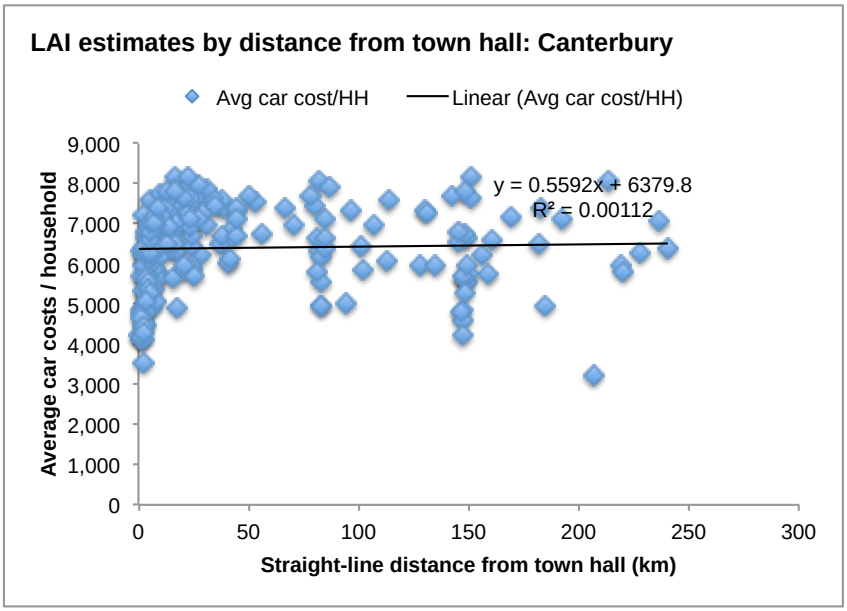


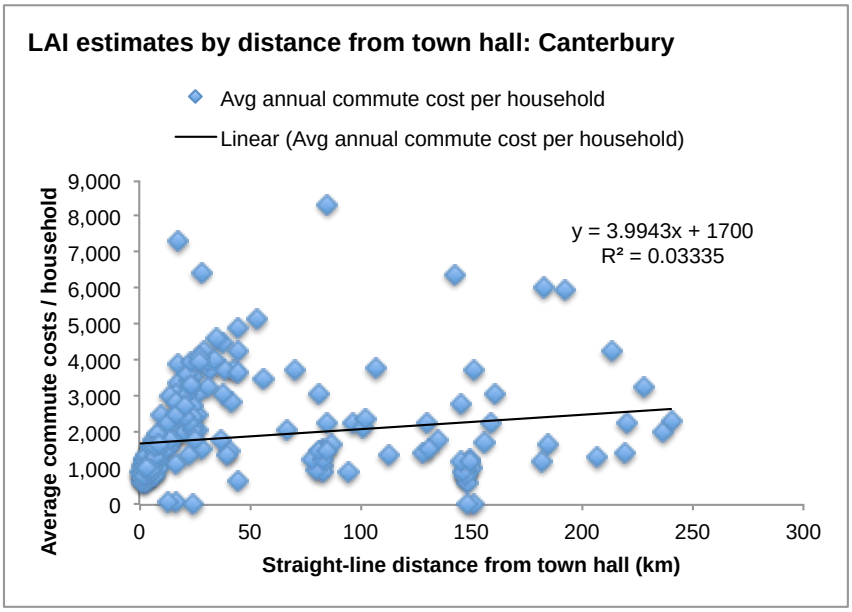
A.3 Canterbury Region LAI variables and estimates

A.3.1 Underlying variables

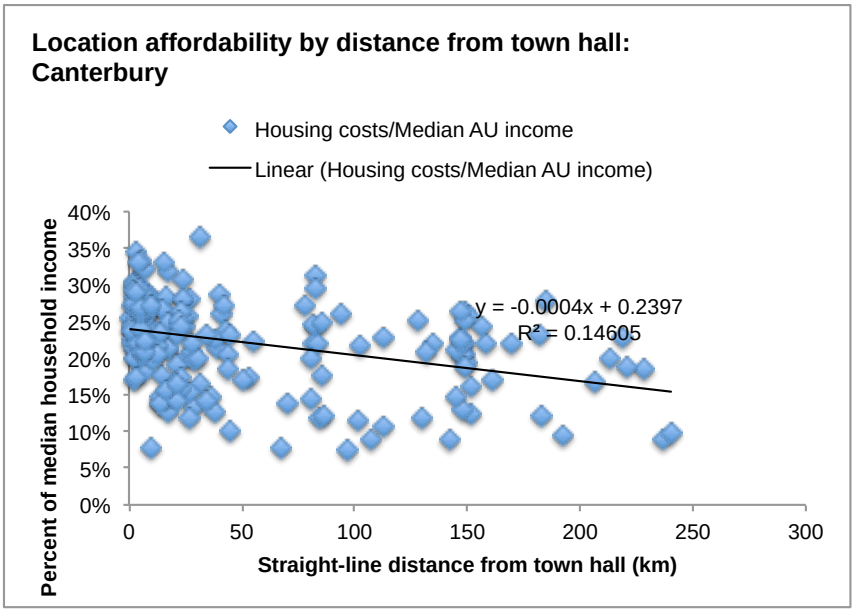


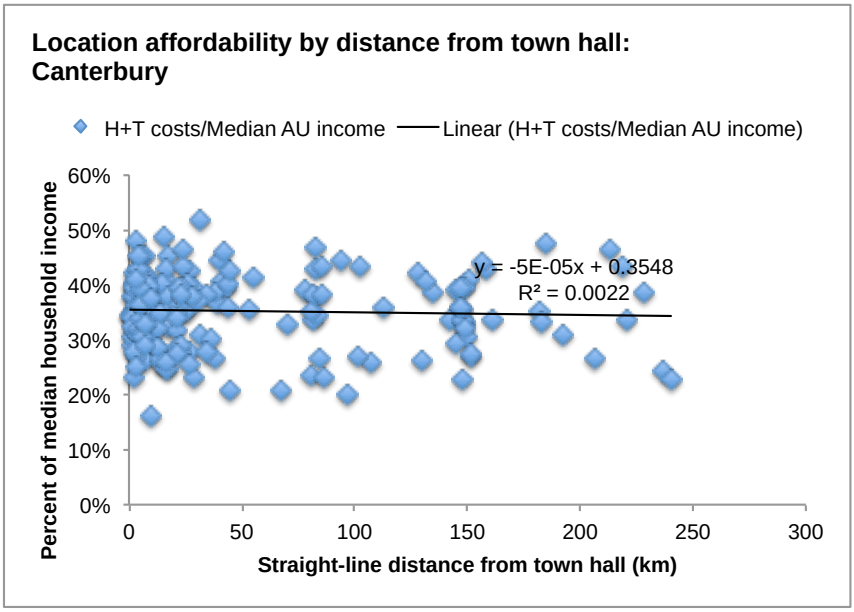






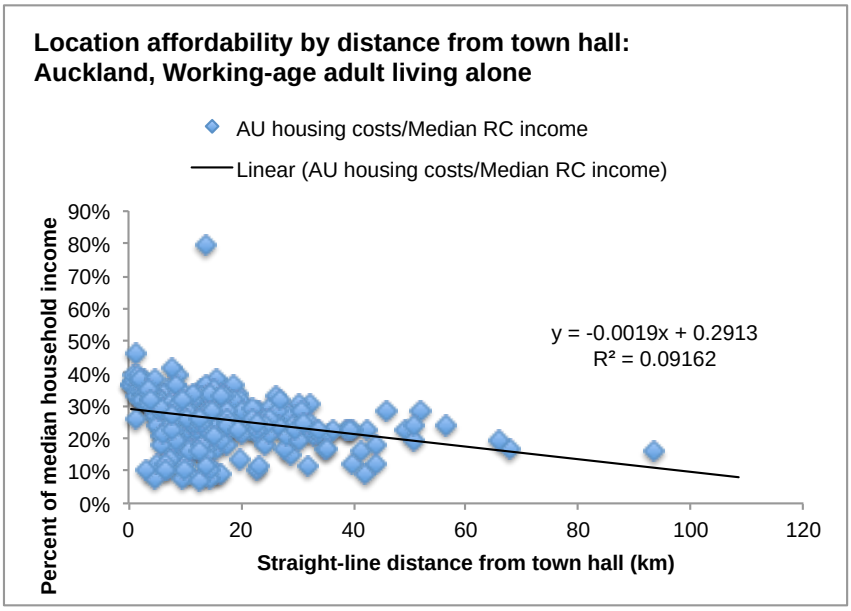
A.3.2 Main estimates

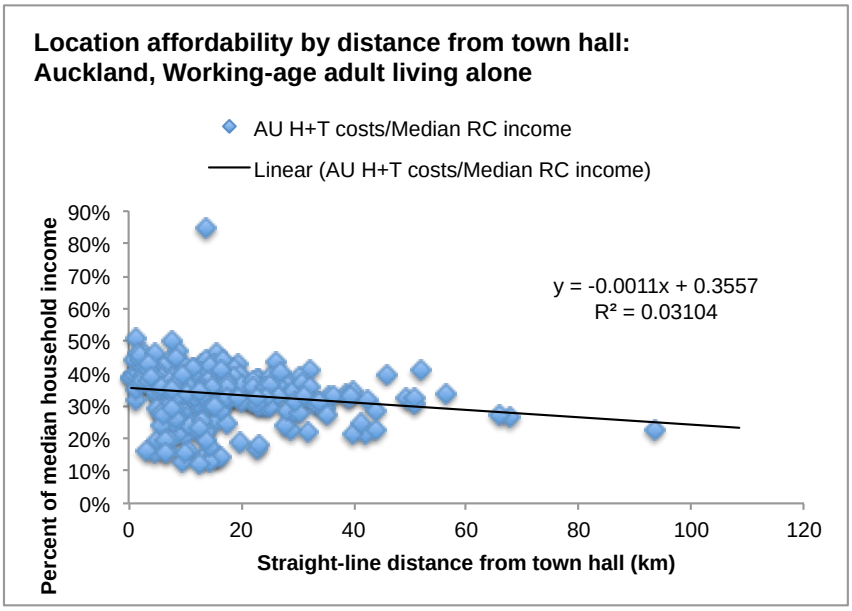




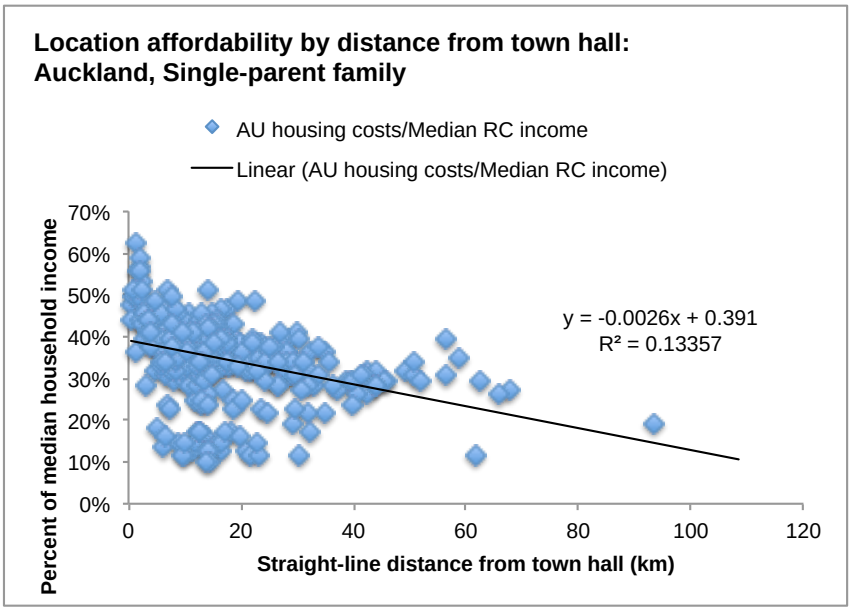
A.4 Main LAI estimates for selected regional average household types in Auckland

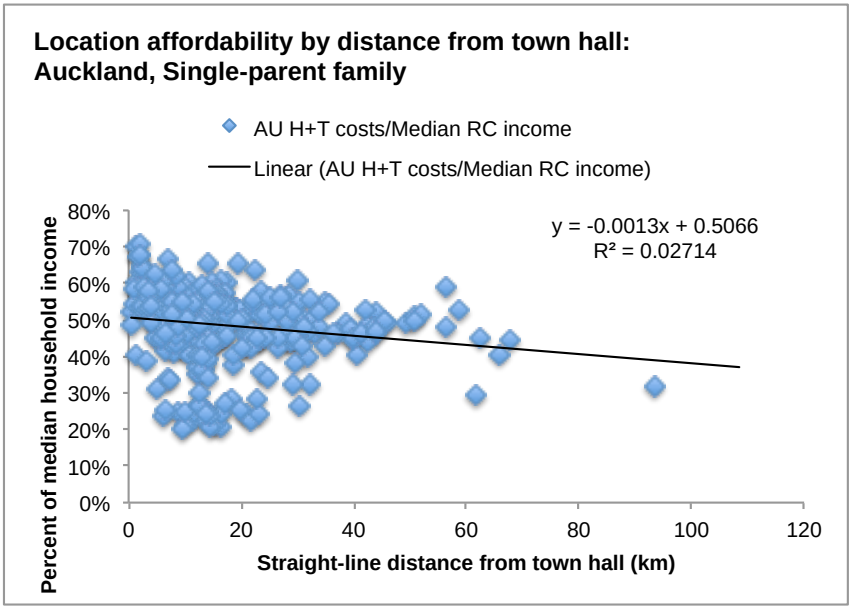
A.4.1 Working-age adult living alone



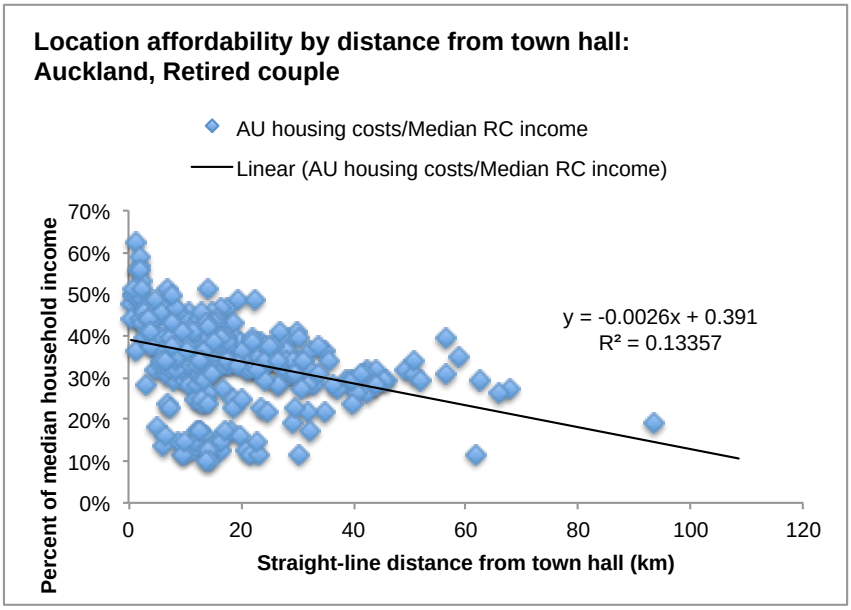


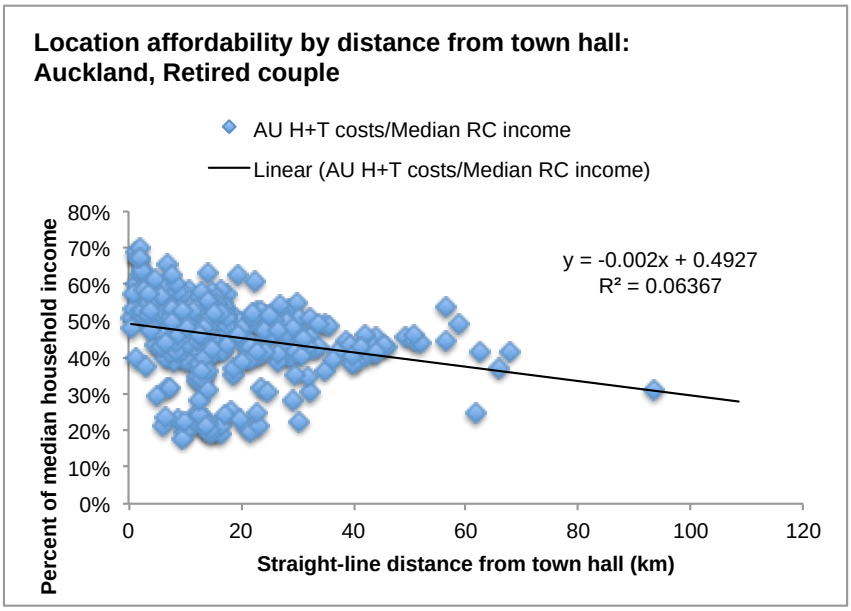
A.4.2 Single-parent family





A.4.3 Retired couple





APPENDIX B References

Adli and Raichev (2014), *Affordability in New Zealand*. Available online at http://affordability.org.nz/.

Arnott (1981), "Aggregate land rents and aggregate transport costs"

Auckland Transport (2013), "Community Transport Evaluation Report 2012/2013".

Australian Bureau of Statistics (2010), *Household Expenditure Survey 2009/2010*.

Bento, Cropper, Mobarak and Vinh (2005). The effects of urban spatial structure on travel demand in the United States. The Review of Economics and Statistics 87, No.3: 466-478.

Bram (2012), "To Buy or Not to Buy? The Changing Relationship between Manhattan Rents and Home Prices", Federal Reserve Bank of New York.

Brownstone and Golob (2009). The impact of residential density on vehicle usage and energy consumption. Journal of Urban Economics 65, no.1:91-98.

CE Delft (2008), *Handbook on estimation of external costs in the transport sector, volume 1.1*.

Center for Neighborhood Technology (2006), "The Affordability Index: A New Tool for Measuring the True Affordability of a Housing Choice", *Brookings Institute Urban Markets Initiative*.

Center for Neighborhood Technology (2011). Housing + transportation affordability in Washington, DC. Chicago: Center for Neighborhood Technology.

Centre for International Economics and Arup (2012), "Costs and benefits of alternative growth scenarios for Sydney", a report to NSW Department of Planning and Infrastructure.

Centre for International Economics and Arup (2014), "Auckland Cost of Growth Study", a report for Auckland Council [forthcoming].

Cervero (1992), "Land Market Impacts of Urban Rail Transit and Joint Development - Washington DC and Atlanta", *University of California Transportation Center Working Paper No. 135.*

Cervero and Kang (2009), "BRT Impacts on Land Uses and Land Values in Seoul"

Coleman, Andrew (2010), "Transport infrastructure, lock-out and urban form: Highway development in Auckland and the United States", *Policy Quarterly*, volume 6, No 4.

Currie and Senbergs (2007), "Exploring Forced Car Ownership in Metropolitan Melbourne", paper presented at the 30th Australasian Transport Research Forum.

European Commission (2003), "Household Budget Surveys in the EU, Methodology and recommendations for harmonisation".

Eurostat (2013), *National Accounts Statistics: Final consumption expenditure of households 2012*.

Demographia (2013), "Demographia World Urban Areas Report".

Donovan and Munro (2013). "Impact of urban form on transport and economic outcomes" NZ Transport Agency research report 513.

Douglass and Abley (2011), "Trips and parking related to land use", NZTA research report 453.

Ewing and Cervero (2010), "Travel and the Built Environment", *Journal of the American Planning Association* 76:3.

Fairgray (2013), "Auckland Retail Economic Evidence Base", Auckland Council Technical Report TR2013/046.

Glaeser and Gyourko (2002), "The Impact of Zoning on Housing Affordability", Harvard Institute of Economic Research Discussion Paper 1948.

Glaeser, Gyourko and Saks (2005a), "Urban Growth and Housing Supply", NBER Working Paper 11097.

Glaeser, Gyourko and Saks (2005b), "Why Have Housing Prices Gone Up" NBER Working Paper 11129.

Goodman, Buxton, et al (2010), "Planning reform, land release and the supply of housing", *Australian Housing and Urban Research Institute Positioning Paper No 126*.

Graham and Maré (2009), "Agglomeration Elasticities in New Zealand", Motu Working Paper 09-06.

Graham and Van Dender (2010), "Estimating the agglomeration benefits of transport investments: Some tests for stability", OECD/ITF Discussion Paper 2009/32.

Grimes, Holmes and Tarrant (2010), "New Zealand Housing Markets: Just a Bit-Player in the A-League?", Paper presented to LEANZ conference, Auckland.

Grimes and Liang (2007), "Spatial determinants of land prices in Auckland: does the MUL have an effect?" Motu Working Paper 07-09.

Grimes and Liang (2010) Bridge to somewhere: Valuing Auckland's Northern Motorway Extensions, *Journal of Transport Economics and Policy*, 44:3, pp 287–315.

Grimes and Young (2010), Anticipatory Effects of Rail Upgrades - Auckland's Western Line", Motu Working Paper 10-11.

Haas, Makarewicz, Benedict and Bernstein (2008), "Estimating Transportation Costs by Characteristics of Neighborhood and Household", *Transportation Research Record* no 2077.

Horner (2007). A multi-scale analysis of urban form and commuting change in a small metropolitan area (1990-2000). The Annals of Regional Science 41, no.2:15-332.

Hurst (2011), "How Does Light Rail Transit Affect Urban Land Use?"

International Monetary Fund (2014), *Global Housing Watch*. Available online at http://www.imf.org/external/research/housing/index.htm.

Jakob, Craig, and Fisher (2006), "Transport Cost Analysis: A Case Study of the Total Costs of Private and Public Transport in Auckland", *Environmental Science and Policy* vol 9.

Kelly and Mares (2013), "Productive cities: Opportunity in a changing economy", Grattan Institute report 2013-05.

Krugman (1991), "Increasing Returns and Economic Geography", *Journal of Political Economy* 99:3.

Krugman (1994), "Urban Concentration: The Role of Increasing Returns and Transport Costs"

Kulish, Richards and Gillitzer (2011), "Urban Structure and Housing Prices: Some Evidence from Australian Cities", Reserve Bank of Australia Research Discussion Paper 2011-03.

Law and Meehan (2013), "Housing Affordability in New Zealand - Evidence from Household Surveys", Treasury Working Paper 13/14.

Lees (2014), "Big City Life: Challenges and Trade-offs for Auckland", NZIER working paper 2014/02.

Leggatt-Cook (2007), "Housing Demand, Supply and Affordability in the Auckland Region: A Review of Current Trends and Drivers", Auckland Regional Council Background Report.

Lipman (2006), "A Heavy Load- The Combined Housing and Transportation Burdens of Working Families", *Center for Housing Policy*.

Litman (2012), "Evaluating Transportation Land Use Impacts: Considering the Impacts, Benefits and Costs of Different Land Use Development Patterns", Victoria Transport Policy Institute working paper.

Litman (2013), "Smart Growth Savings: What We Know About Public Infrastructure and Service Cost Savings", Victoria Transport Policy Institute working paper.

Litman (2014), "Affordable-Accessible Housing in a Dynamic City", Victoria Transport Policy Institute working paper.

Luen (2014), "Residential building height regulations in Auckland: Understanding the effects and implications", Presentation at New Zealand Association of Economists 2014 conference.

Maré (2008), "Labour productivity in Auckland firms", Motu Working Paper 08-12

Mattingly and Morrissey (2013), "Housing and transport expenditure: Socio-spatial indictors of affordability in Auckland", *Cities* volume 38.

McCann and Shefer (2005), "Agglomeration, economic geography and regional growth", *Papers in Regional Science* 84:3.

McLaughlin (2011a), "Metropolitan growth policies and new housing supply: evidence from Australia's capital cities", *Australasian Journal of Regional Studies*, 17:1.

McLaughlin (2011b), "New housing supply elasticity in Australia- a comparison of dwelling types", *Annals of Regional Science* 48:2.

Ministry of Business, Innovation and Employment (2013), *Housing Affordability: Residential Land Availability in Auckland*.

Ministry of Business, Innovation and Employment (2014), *New Zealand Housing and Construction Quarterly: Open Data*.

Ministry of Transport (2013), "NZ Household Travel Survey 2009-2012: Comparing travel modes".

Ministry of Transport (2014), "The New Zealand Vehicle Fleet: Annual Fleet Statistics 2013". Available online at http://www.transport.govt.nz/research/NewZealandVehicleFleetStatistics.

MRCagney (2012), "The Economic Impacts of Minimum Parking Requirements: An Analysis of Dominion Rd, Takapuna, and Onehunga", a report to Auckland Council.

MRCagney (2013), "The Economic Impacts of Parking Requirements in Auckland", a report to Auckland Council.

Næss, P (2006), *Urban structure matters: residential location, car dependence and travel behaviour*.

New Zealand Productivity Commission (2012), *Housing affordability inquiry*.

New Zealand Transport Agency (2013), *Economic Evaluation Manual*.

O'Fallon and Wallis (2012), "Living in intensified urban environments: residential self-selection and travel behavior", NZ Transport Agency research report 468.

Organization for Economic Cooperation and Development (2013a), *Taxing Energy Use – A Graphical Analysis*. Available online at http://www.oecd.org/tax/tax-policy/taxingenergyuse.htm.

Organization for Economic Cooperation and Development (2013b), *OECD Economic Outlook, Volume 93*.

Polkinghorne, John (2014), "Household Spending on Transport Fuels in Auckland".

Portland Bureau of Planning and Sustainability (2013), "Cost of Onsite Parking + Impacts on Affordability".

Quigley and Raphael (2005), "Regulation and the High Cost of Housing in California", *American Economic Review* 95:2.

Quigley (2007), "Regulation and Property Values in the United States- The High Cost of Monopoly", UC Berkeley Program on Housing and Urban Policy working paper W06-004.

Statistics New Zealand (2012), "Gross Domestic Product: September 2012 quarter (summary of revisions)", available online at http://www.stats.govt.nz/browse_for_stats/economic_indicators/GDP/GrossDomesticProduct_HOTPSep12qtr/Revisions.aspx.

Statistics Canada (2012), *Survey of Household Spending 2012*.

Statistics New Zealand (2013a), *New Zealand Census 2013*.

Statistics New Zealand (2013b), *New Zealand Household Economic Survey 2012/13*.

Statistics New Zealand (2013c), "Rental affordability 1998-2012: Regional distributions", working paper.

Trubka, Newman and Bilsborough (2008), "Assessing the Costs of Alternative Development Paths in Australian Cities", Curtin University Sustainable Policy Institute.

United Kingdom Office for National Statistics (2012), *Living Costs and Food Survey 2012*.

United States Bureau of Labour Statistics (2013), *Consumer Expenditures Survey 2013*.

US Department of Housing and Urban Development and Department of Transportation (2013), "Housing and Transportation Affordability Initiative: Data and Methodology"

Vance and Hedel (2007). The impact of urban form on automobile travel: disentangling causation from correlation. Transportation 34, no.5: 575-588.

Venables (2007), "Evaluating Urban Transport Improvements - Cost-Benefit Analysis in the Presence of Agglomeration and Income Taxation", *Journal of Transport Economics and Policy*, Volume 41.

Venables (2010), "Productivity in cities: self-selection and sorting".

Wallis and MRCagney (2011), "Auckland Passenger Transport Performance Benchmark Study", a report to Auckland Council.

Zheng (2013), "The effect of Auckland's MUL on land prices", *Productivity Commission Research Note*.