INFRASTRUCTURE VICTORIA

March 2023

Measuring home price differences

How features, location and infrastructure affect Melbourne's home prices

Modelling report

About us

Infrastructure Victoria is an independent advisory body with 3 functions:

- preparing a 30-year infrastructure strategy for Victoria, which we review and update every 3 to 5 years
- advising the government on specific infrastructure matters
- publishing research on infrastructure-related issues.

Infrastructure Victoria also helps government departments and agencies develop sectoral infrastructure plans.

Infrastructure Victoria aims to take a long-term, evidence-based view of infrastructure planning and inform community discussion about infrastructure provision.

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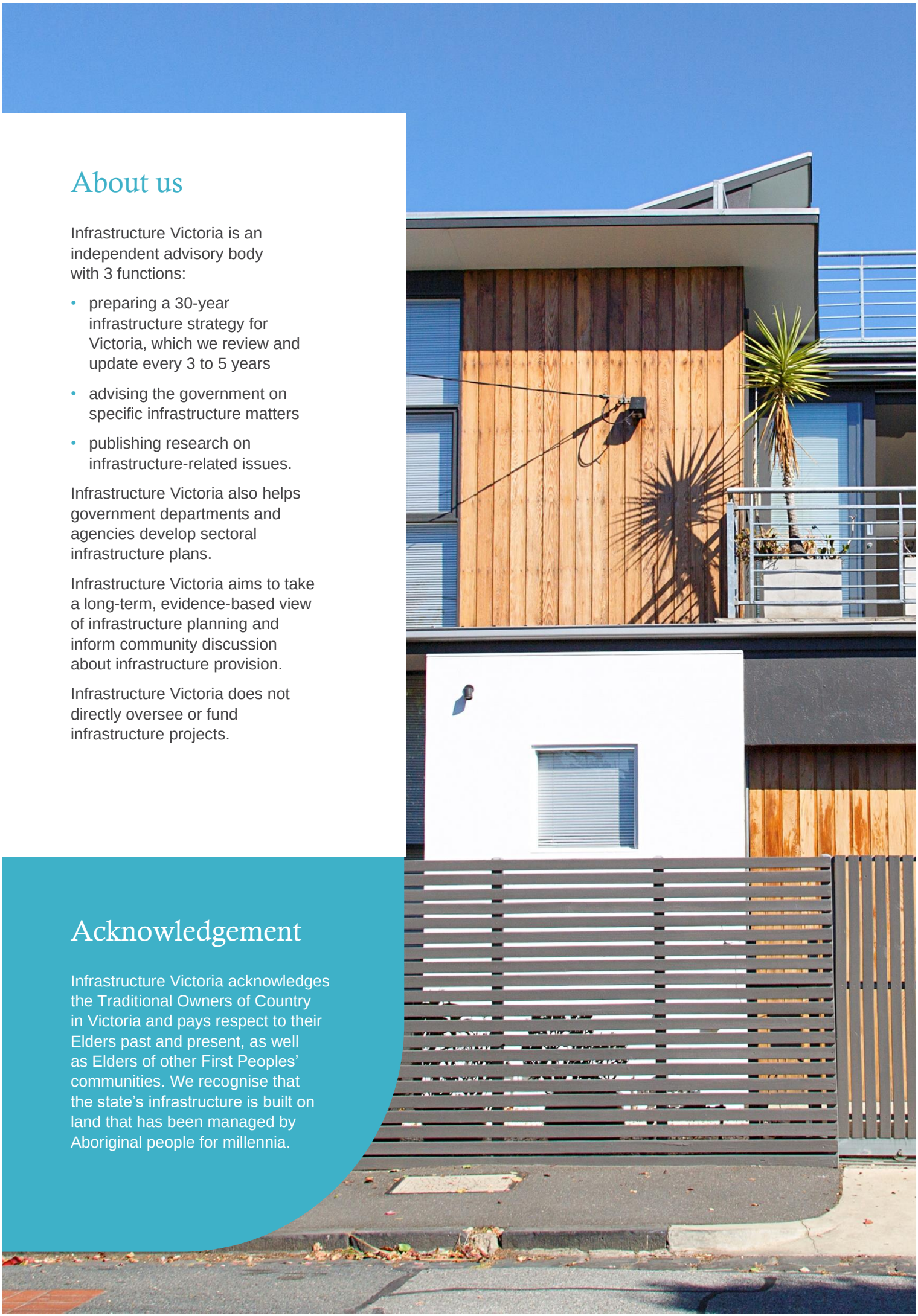


Acknowledgement

Infrastructure Victoria acknowledges the Traditional Owners of Country in Victoria and pays respect to their Elders past and present, as well as Elders of other First Peoples' communities. We recognise that the state's infrastructure is built on land that has been managed by Aboriginal people for millennia.

Contents

Summary

Infrastructure Victoria developed new price models to examine how people value different features when choosing a home, like bedrooms, car spaces and being close to public transport.

We also examined what type of homes are affordable to moderate income households and in which parts of Melbourne. We did this as part of a larger research project to identify a suite of policy options for the Victorian Government to consider that can offer more choices for people to buy homes in established suburbs rather than greenfield areas.

We used a specific modelling approach called a hedonic price model. This approach allowed us to better understand people's preferences for dwelling and location features and the type of homes they could afford. It gives insights about the drivers of housing demand, housing affordability and the alternative home types that could substitute for houses in new suburbs, known as greenfield areas, at similar market prices.

This research fills existing gaps about the home types and spatial areas that are affordable for moderate income households in Melbourne. It also comprehensively evaluates the economic value of proximity to many types of infrastructure.

Substitutable home types at similar prices as houses in growth areas

We used home sales data between January 2017 and June 2022 to understand the features of Melbourne homes. For all of Melbourne, detached houses in our data set had an average of 3.5 bedrooms, 1.8 bathrooms, 2 car spaces, on around 600m^2 of land.

We investigated potentially substitutable home types for a typical house in growth areas. We used our property market data to identify the typical home bought in these suburbs. This is a detached house with 4 bedrooms, 2 bathrooms, 2 car spaces and land size of around 600m^2. For a similar price, someone could buy:

- a smaller home in many outer suburbs
- a townhouse in some middle suburbs
- an apartment in most inner suburbs or the eastern middle suburbs.

Moderate income households can only buy larger homes in a narrow list of suburbs

This analysis forms part of a larger Infrastructure Victoria research project. The project seeks to identify the most important dwelling, locational or community attributes for households when making their residential location decisions to live in Victoria's greenfield locations, and the trade-off decisions they make.

We chose to investigate housing affordability for moderate income households, as these households are the predominant buyers of new homes built in the new housing estates on the fringes of Melbourne. We used a Victorian Government definition of moderate income household. A 2021 Order under the *Planning and Environment Act 1987* defines a moderate income household annual income as being between $88,021 and $132,030, in Melbourne for the period July 2021 to June 2022.[1]

We divided Melbourne into spatial zones representing the inner, middle, outer and growth areas. We found that in June 2022, a household earning $88,021 yearly, and keeping their mortgage repayments to less than 30% of their income to avoid housing stress, could afford:

- a small, detached house in some growth suburbs
- a townhouse in growth areas or some outer suburbs
- an apartment in the outer suburbs, or some middle suburbs (but usually only 2-bedrooms).

However, this household could not afford to buy a 2-bedroom or 3-bedroom apartment or townhouse almost anywhere in the inner suburbs.

A household earning $132,030 yearly, and keeping their mortgage repayments to less than 30% of their income, could afford:

- a detached house in most outer or growth suburbs
- a townhouse in many western, northern and southern middle suburbs
- an apartment in many inner suburbs, or the eastern middle suburbs.

Infrastructure proximity affects home prices

Home prices in growth suburbs are much cheaper than similar homes in established suburbs, on average. We examined the residential property value premium of proximity to 10 individual types of infrastructure to find out how being close to good infrastructure affects home prices.

After controlling for other variables, we generally found homes sold for significantly higher prices when they were close to:

- metropolitan activity centres
- major activity centres
- metropolitan train stations
- tram stops
- hospitals
- secondary schools.

We generally found homes sold for significantly lower prices when they were close to:

- cemeteries
- police stations
- landfill sites
- arterial roads or freeways.

Combined economic value of infrastructure proximity

We also determined the combined economic value from all 10 infrastructure types for houses and townhouses.

We found a strong spatial difference in the economic value of infrastructure proximity, as reflected in market prices. Proximity benefits (economic value) from infrastructure lie mostly in inner Melbourne. Middle suburbs, including in the south, west and north, also show property price premiums related to their infrastructure proximity. However, in the outer suburbs and growth areas, infrastructure proximity produces low or negative effects on property prices. These spatial differences are generally consistent for both houses and townhouses. This shows that inner and middle suburbs have better access to infrastructure, and this makes homes in these suburbs more expensive. Further, it means that people may trade-off good infrastructure access to find an affordable home to buy.

We aim to inform evidence-based discussions about housing affordability and infrastructure investment options in Melbourne. We used this information to inform potential policy options that can influence growth area housing demand and offer people better choices for homes in established suburbs.

Introduction

Providing different types of infrastructure in Melbourne's growth areas has high costs.[2] The Victorian Government aspires to accommodate some of Melbourne's new housing in the city's established suburbs, where existing infrastructure can be used more effectively, which reduces the need to build new infrastructure.[3] Encouraging new home-building in established suburbs can not only deliver cost efficiencies but can also offer better amenity and protect valuable farming and environmental land.[4]

Greenfield areas

We use the term 'greenfield' to describe land rezoned for urban development, primarily from farming land, either in metropolitan Melbourne or in the outer edges of regional towns and cities in Victoria. Greenfield housing estates in Victoria are typically characterised by low density, detached and often large houses in new suburbs. The homes are usually less than 10 years old.

Plan Melbourne 2017-2050 lists a housing objective that "Melbourne provides housing choice in locations close to jobs and services."[5] It also presents an aspirational scenario for established areas to accommodate 70% of all new homes built in Melbourne.[5] But established suburbs in Melbourne are not producing enough new homes to achieve this proportion. In 2013, two-thirds of Melbourne's new homes were built in established suburbs. By 2021, less than half were. Housing affordability in established suburbs is also a significant policy concern for the Victorian Government.[6]

Infrastructure Victoria instigated a research project, using qualitative and quantitative methods, identify the most important dwelling, locational or community attributes for households when making their residential location decisions to live in Victoria's greenfield locations, and the trade-off decisions they make. The primary research question of this project is:

> What would be the necessary pre-conditions for a proportion of households living in greenfield suburbs to have chosen a different residential location?

This report is one component of the larger research project. It examines the drivers of housing demand, housing affordability and what alternative home types could be substitutes for greenfield houses at similar market prices.

The specific questions we investigate in this report are:

1. What are the main dwelling and location characteristics that influence property prices? Do prices vary for different home types, for example, whether the home is a house, townhouse or unit?
2. What type of properties are affordable to moderate income households and in which areas?
3. What are the substitutable home types in established suburbs, at similar a sale price, for a typical house in growth areas?
4. Does a home with closer access to infrastructure sell for a higher price than a home without access? If so, what is the premium?

To answer these questions, Infrastructure Victoria used a hedonic price modelling method. This method allows us to attribute different price effects to different home features and characteristics. Other researchers use this method extensively to analyse the property market. For example, it has been used to explore the effect of dwelling features and locations on property prices and housing demand.[7,8,9,10] Internationally, the hedonic price modelling approach has been used to analyse housing affordability.[11,12,13,14] Researchers also use this method to estimate the capitalisation into house prices of local infrastructure and amenities such as green space, schools, shopping centres and transportation facilities.[15,16,17,18,19,20, 21,22]

Policy makers use hedonic price methods to evaluate policy change effects, or to derive non-market valuations for public goods. The Victorian Government accepts values derived from a hedonic price model as inputs for a cost benefit analysis.[23] Our research questions are also suited to a hedonic price approach.

Before starting this analysis, we analysed an industry data survey of new home buyers in greenfield estates.[24] Based on about 10,000 survey responses, it showed that the majority (62%) of new home buyers in greenfield estates between 2016 and 2021 had household incomes between $60,000 and $120,000. Those figures were not adjusted for wages or inflation. The most comparable income level defined by the Victorian Government was the 'moderate income range' between $88,021 and $132,020 for the year to June 2022, given changes in incomes and prices since.

This report fills knowledge gaps about the home types and spatial zones that are affordable for moderate income households in Melbourne. It also comprehensively evaluates the price effects of proximity to many types of infrastructure in Melbourne.

Method

This section has 3 subsections that discuss the details of our study area, the model specification, and the data we used.

Study area

The study area is Melbourne, Victoria in Australia. We defined 13 spatial zones for the greater Melbourne area, based on the intersection of 3 spatial categorisations:

- The Plan Melbourne regions, which reflect movement corridors in greater Melbourne.
- The Department of Environment, Land, Water and Planning categorisation of inner, middle, outer and growth areas, which reflects 'functional urban areas' based on built form and accessibility.
- Melbourne's urban growth boundary, which reflects the long-term limits of urban development.

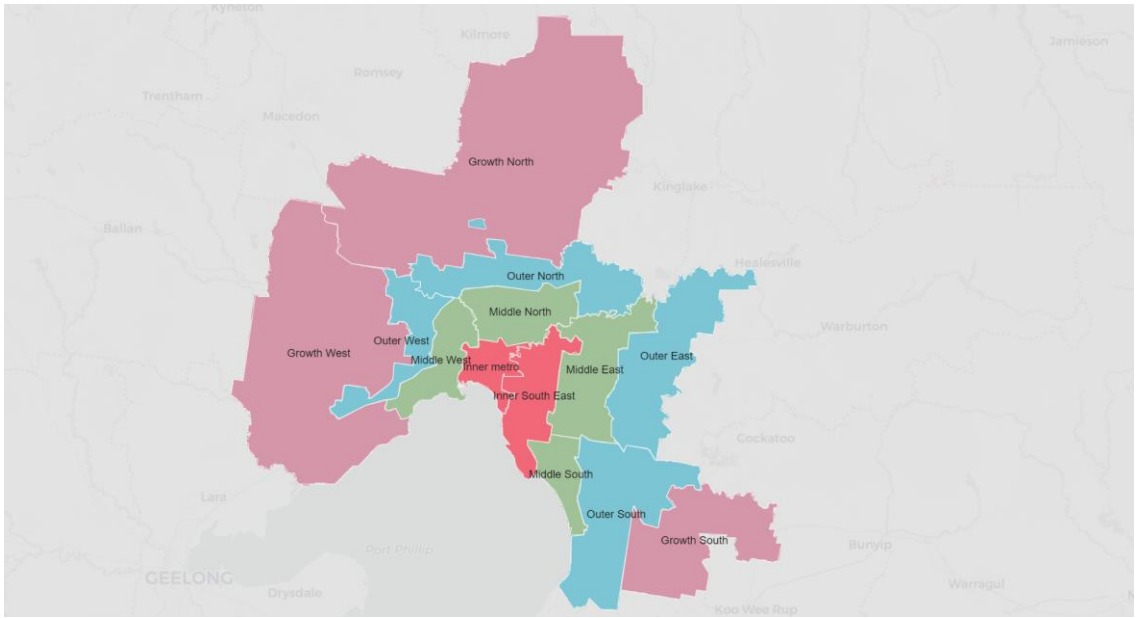
We used the intersections of the above 3 spatial categories to construct 13 spatial zones for Melbourne, as shown in Figure 1. We excluded areas of environmental significance from the spatial zones, such as the Yarra Valley, the Dandenong Ranges, most of the Mornington and Bellarine peninsulas, as these areas are not appropriate for more housing. The spatial zones are generally consistent with the spatial zones used in the Centre for International Economics' housing demand report, which was commissioned in parallel with this study.[25]

The growth west, growth north and growth south zones are 'growth areas', which predominantly produce new homes in greenfield estates. Zoning in these parts of Melbourne allows new suburban estates to be built on previously non-urban land.

The other zones are established areas of Melbourne. We further categorise:

- inner metro and inner south east as 'inner areas'
- middle east, middle north, middle south and middle west as 'middle areas'
- outer east, outer north, outer south and outer west as 'outer areas'.

Figure 1: Melbourne spatial zones used in this study



Source: Infrastructure Victoria and The Centre for International Economics

Model specification

Our hedonic price model expresses total property prices as a function of dwelling attributes, plus a random error term to represent characteristics that are not captured in the model. To answer the main research questions, the specific model we used for the analysis includes:

- dwelling-specific attributes
- time-specific variables that control for the general rise and fall in house prices
- location-specific variables that control for spatial effects
- property-specific variables that control for repeated sales of the same properties over time
- infrastructure proximity variables to indicate the distance from each home to selected infrastructure types.

We built separate models for houses, townhouses and units. We did this because the data variables available for each type were slightly different, and it allowed us to detect any differences in the price effects for different home types. In accordance with our data source, a ‘house’ includes homes categorised as fully detached houses, terrace houses and semi-detached duplexes. A ‘townhouse’ includes townhouses and villas (a villa is a single storey semi-detached townhouse), and a ‘unit’ includes units and apartments.

For our house model, we include the dwelling-specific attributes of:

- number of bedrooms
- number of bathrooms
- number of car spaces
- land area
- floor area.

For our townhouse model, we included the dwelling-specific variables of:

- number of bedrooms
- number of bathrooms
- number of car spaces
- land area.

For the unit model, we excluded the land area variable. Our data set did not have separate land areas for units, and most units are not sold with separately titled or individual land. We excluded the floor area variable for both the townhouse and unit models due to data quality issues.

We also included distances from each home to centre of Melbourne in the models to control for proximity to the city centre (we used the distance to the intersection of Elizabeth and Bourke streets).

We used quarterly dummy variables to control for the effect of time. This means we created a dummy variable for each 3-month period our data set covered. We then coded each home sale to the corresponding time period. Doing this means we can control for general rises and falls in property prices.

We used spatial fixed effects to control for unobserved variables and spatial dependencies, and to avoid biased and inconsistent estimates of the model parameters.[26,27] We set the spatial fixed effects at Statistical Area Level 2 (SA2). Since there are repeat sales of the same proprieties, to control for potentially biased estimates of standard errors produced by repeat sales data, the models also included property-specific random effects.

We included 'distance' variables for each infrastructure type to estimate the effect of proximity to infrastructure or services. We used Haversine distance in this study to calculate the nearest distance from each home to the selected infrastructure. Haversine distance is calculated based on the Haversine formula, which gives minimum distance between 2 points on a sphere by using latitude and longitude.[28] This measurement accounts for the curvature of the earth, and is often used to calculate large distances, such as in navigation.[29]

Based on consultations and feedback from internal and external stakeholders, and data availability, we included the following specific infrastructure types in our analysis:

- metropolitan train stations (excluding V/Line stations)
- hospitals
- major activity centres
- landfill sites
- police stations
- metropolitan tram stops
- metropolitan activity centres
- cemeteries
- secondary schools
- arterial roads (including freeways).

Metropolitan activity centres

Metropolitan activity centres are higher-order centres intended to accommodate a diverse range of jobs, activities and homes for a regional catchment that are well served by public transport. These centres are intended to undertake a major service delivery role, including for government, health, justice and education services, and retail and commercial opportunities.[30]

Major activity centres

Major activity centres are a suburban focal point for services, jobs, homes, public transport and social interaction. They have different attributes and cater for different functions, with some serving larger subregional catchments.[30]

Formally, we can write our hedonic price model mathematically as:

$$\ln p_{ijt} = \alpha + \boldsymbol{\beta}' \mathbf{x}_{it} + \boldsymbol{\delta}' \mathbf{d}_{it} + \boldsymbol{\gamma}' \mathbf{r}_{ij} + \varphi_{ij} + \varepsilon_{ijt} \qquad \text{Equation (1)}$$

Where:

- p_{ijt} is the observed sale price of the home i, in area j, at time t
- x_{it} is a vector of dwelling-specific attributes (for example, the number of bedrooms, distance to the city centre, and proximity to select infrastructure)
- d_{it} is a dummy variable vector that takes the value 1 if the home i sold at time t, and is otherwise 0
- r_{ij} is a dummy variable vector that takes the value 1 if the home i sold in location j, and is otherwise 0
- φ_{ij} is a zero mean property-specific random error term
- ε_{ijt} is a zero mean observation-specific random error term.

We estimate the parameters of $\boldsymbol{\beta}'$, $\boldsymbol{\delta}'$ and $\boldsymbol{\gamma}'$. Specifically:

- $\boldsymbol{\beta}'$ are estimates of the implicit price of different dwelling and location attributes
- $\boldsymbol{\delta}'$ are estimates we can use to create a property price index
- $\boldsymbol{\gamma}'$ are estimates of the spatial effects.

The specific functional form of a hedonic price model must fit that particular data set.[31] As such, we used the Box-Cox method to test alternative model specifications.[30] We found that a log-linear model was the most appropriate functional form, and therefore we used this in our models.

Due to the nature of the data, we applied log transformation to the following explanatory variables:

- land area
- floor area
- distance to the city centre.

Data we used

We obtained property sale prices and primary property characteristics, including geocodes, from PropTrack.[32] We obtained the geocodes of the above 10 selected infrastructure types from publicly available Victorian Government data.[33,34,35] We used the geocodes of each property and infrastructure site to calculate the nearest distance from each home to the infrastructure of interest.

The sample in this study includes 344,869 properties sold from January 2017 to June 2022 in Melbourne. To exclude rural properties from the sample, we restricted the sample to:

- single homes with land area less than 4100m^2 for houses
- land area less than 700m^2 for townhouses
- fewer than 6 bedrooms for units.

We give summary information on the data set in Table 1. Appendix D shows extra summary information on the data set, for inner, middle, outer and growth areas.

Table 1: Model variables and descriptive statistics

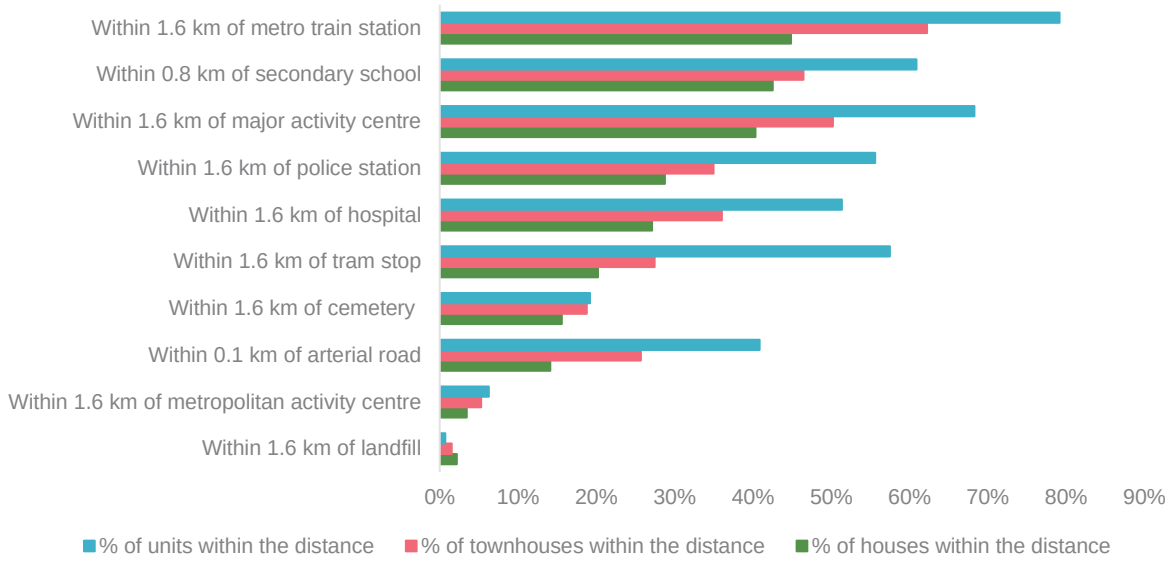
Variable	House		Townhouse		Unit	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Dependent variable						
Property sale price (AU$ '000)	1072.92	853.83	832.00	382.49	611.1	410.87
Explanatory variables						
Number of bedrooms	3.51	0.78	2.90	0.69	2.01	0.68
Number of bathrooms	1.80	0.70	1.89	0.63	1.31	0.49
Number of car spaces	2.04	1.12	1.60	0.59	1.11	0.58
Land area (m^2)	635.10	363.88	213.43	106.43	—	—
Floor area (m^2)	185.02	77.44	—	—	—	—
Distance to city centre (km)	22.73	11.78	17.50	9.44	13.08	10.90
Nearest distance to metro train station (km)	2.56	2.92	1.67	1.48	1.26	1.70
Nearest distance to hospital (km)	3.66	3.21	2.86	2.56	2.17	2.19
Nearest distance to metropolitan activity centre (km)	7.88	4.57	7.29	4.14	7.39	3.82
Nearest distance to major activity centre (km)	2.10	1.24	1.80	1.09	1.43	1.10
Nearest distance to cemetery (km)	3.60	2.05	3.26	1.87	3.01	1.64
Nearest distance to landfill (km)	9.52	5.74	9.00	5.13	10.12	4.33
Nearest distance to secondary school (km)	1.01	0.63	0.92	0.51	0.75	0.45
Nearest distance to police station (km)	2.41	1.30	2.13	1.13	1.60	1.02
Nearest distance to tram stops (km)	11.26	10.16	6.68	7.49	4.66	7.55
Nearest distance to arterial road (km)	0.50	0.51	0.35	0.39	0.23	0.28

Source: Infrastructure Victoria

Figure 2 shows the proportions of properties, by house, townhouse and unit, located within selected distances of each infrastructure type.

Units are located closer to our selected infrastructure types, on average, than townhouses and houses. For example, about 45% of houses are within 1.6km of a metropolitan train station, compared with about 80% of units. Similarly, about 68% of units are within 1.6km of a major activity centre, but only about 40% of houses are this close. About 60% of units are within 1.6km of a tram stop, while this distance only includes about 20% of houses. About 40% of units are within 100m of an arterial road, but less than 15% of houses are within the same distance.

Figure 2: Proportions of homes located near infrastructure



Source: Infrastructure Victoria

Results

This section includes 5 subsections. The first presents results from the base models. We used these results to calculate housing affordability for moderate income households (in the second subsection) and affordable substitute for growth areas (in the third subsection). The fourth subsection presents results from the second set of price models that include infrastructure proximity variables, and the last subsection summarises the resulting economic values of infrastructure proximity.

Our model calculates the price effects of each home feature

Table 2 shows the summary regression results for our house, townhouse and unit models. As the sample is large, implicit attribute values are precise estimates. Table 2 also shows the statistical significance at conventional levels.

We conducted a multicollinearity test using the variance inflation factor for each of the 3 models. We detected no significant multicollinearity. The implicit attribute values for standard dwelling attribute variables are largely as we expected. For example, more bedrooms, bathrooms, car spaces, a larger land area and floor area, and closer proximity to the city centre, all are associated with higher sales prices.

On average, 3-bedroom houses sold for 46.5% more than 1-bedroom houses, after controlling for the other variables in our model. Prices for 3-bedroom townhouses were 35.8% higher than 1-bedroom townhouses, and 3-bedroom units are 62.8% more expensive than 1-bedroom units.

Prices are higher by 8.7% for a second bathroom in a house or townhouse. The rise is higher for units. A second bathroom in a unit is associated with 12.3% higher prices. Compared with zero car spaces, 2 car spaces are associated with 33.7% higher unit values, but only 7.8% and 5.3% higher prices for townhouses and houses, respectively. Being 1% further from the city centre was reflected in 0.4% lower house values and 0.3% and 0.2% lower townhouse and unit prices, respectively.

Table 2: Base model results

	House		Townhouse		Unit	
	Estimate	**Standard Error**	**Estimate**	**Standard Error**	**Estimate**	**Standard Error**
(Intercept)	12.4003***	0.0195	13.0315***	0.0312	12.8442***	0.0160
Bedrooms						
2 bedrooms	0.3786***	0.0115	0.2464***	0.0145	0.4036***	0.0025
3 bedrooms	0.4650***	0.0114	0.3584***	0.0146	0.6280***	0.0037
4 bedrooms	0.5480***	0.0114	0.4705***	0.0148	0.7380***	0.0086
5 bedrooms or more	0.5990***	0.0115				
Bathrooms						
2 bathrooms	0.0867***	0.0012	0.0868***	0.0024	0.1227***	0.0023
3 bathrooms	0.2012***	0.0020	0.1673***	0.0036	0.5109***	0.0090
4 bathrooms or more	0.4319***	0.0035				
Car spaces						
1 car space	0.0235***	0.0021	0.0342***	0.0081	0.1875***	0.0034
2 car spaces	0.0534***	0.0020	0.0775***	0.0081	0.3366***	0.0042
3 car spaces	0.0657***	0.0025	0.1373***	0.0096	0.5339***	0.0088
4 car spaces or more	0.0784***	0.0024				
log(land area)	0.2618***	0.0013	0.1364***	0.0021		
log(floor area)	0.0425***	0.0012				
log(distance to city centre)	-0.4160***	0.0071	-0.3139***	0.0132	-0.1546***	0.0070
Quarters fixed effects	***		***		***	
Spatial fixed effects	***		***		***	
Observations	208,477		40,957		95,435	
R^2	0.87		0.82		0.62	
Significance level:						
'*' 5%						
'**' 1%						
'***' 0.1%.						

Source: Infrastructure Victoria

Housing affordability for moderate income households

Our second aim is to evaluate housing affordability for moderate income households in different spatial zones in Melbourne. According to the 2021 Order under the *Planning and Environment Act 1987*, the annual income range of a moderate income household is between $88,021 and $132,030 in Melbourne for the 2021-22 financial year.[36]

A common housing affordability measure is the ratio of housing costs to gross household income, also known as the housing affordability ratio.[37] This report aligns with that measure. Specifically, we define housing affordability in this project as the most expensive home type that is affordable for moderate income households, based on their gross household income, and the modelled average price for that home type in an area.

In general, housing affordability has been declining since the 1980s in Australia.[38] This section investigates the affordability for moderate income households to buy a home in Melbourne.

Average market prices for selected home types

To investigate housing affordability, we needed to estimate property market prices. We used our price model results to estimate average property market prices for different home types.

Property prices can be very different depending on the home's features and location. We selected 7 typical home types for estimating market prices. We then calculated the most expensive of these 7 home types that were affordable for moderate income households for each SA2. An SA2 is about the size of a large suburb. Table 3 lists the details of these 7 selected home types and our rationale for selecting them. We mostly selected home types with 3 or more bedrooms, as these may be suitable for households with children. Households with, or expecting to have, children are a substantial proportion of greenfield homebuyers.

Table 3: Home types selected for this analysis

Home type	Number of bedrooms	Number of bathrooms	Number of car spaces	Land size	Selection rationale
House	4	2	2	600m^2	A typical house in Melbourne's growth areas
House	3	2	2	550m^2	A typical house with 3 bedrooms and 2 bathrooms in established areas.
House	3	1	2	600m^2	A typical house in established areas.
Townhouse	3	2	2	200m^2	A typical townhouse with 3 bedrooms and 2 bathrooms in established areas.
Townhouse	3	1	1	200m^2	A typical townhouse with 3 bedrooms and 1 bathroom in established areas.
Unit	3	1	1	NA	A typical unit in established areas with 3 bedrooms.
Unit	2	1	1	NA	A typical unit in established areas with 2 bedrooms.

Source: Infrastructure Victoria

Housing affordability for moderate income households

Using our price model, we estimated the average prices for these 7 selected home types listed in Table 3 in each Melbourne SA2 for the second quarter of 2022. This allowed us to estimate the average market price of each. Given our moderate income range, we calculated their home loan borrowing power at both the upper and lower end of this range. This allows us to analyse housing affordability by determining the most expensive home type a household can afford at a given income.

We separately analysed housing affordability for a household with a yearly income of $88,021, and one with an income of $132,030, to accommodate the relatively large moderate income range. Housing stress is typically described as lower-income households that spend more than 30% of gross income on housing costs. In this report, we describe a household that could buy a particular home type 'without housing stress' if they spent less than 30% of their gross household income on their housing loan repayments.[39]

We defined a household as in 'housing stress' if they used their maximum borrowing power, but this exceeded 30% of their gross household income. The interest rate we used was 4.53%, which was offered by Commonwealth Bank of Australia (CBA) in June 2022. We calculated a household's maximum borrowing power using the CBA online home loan calculator.

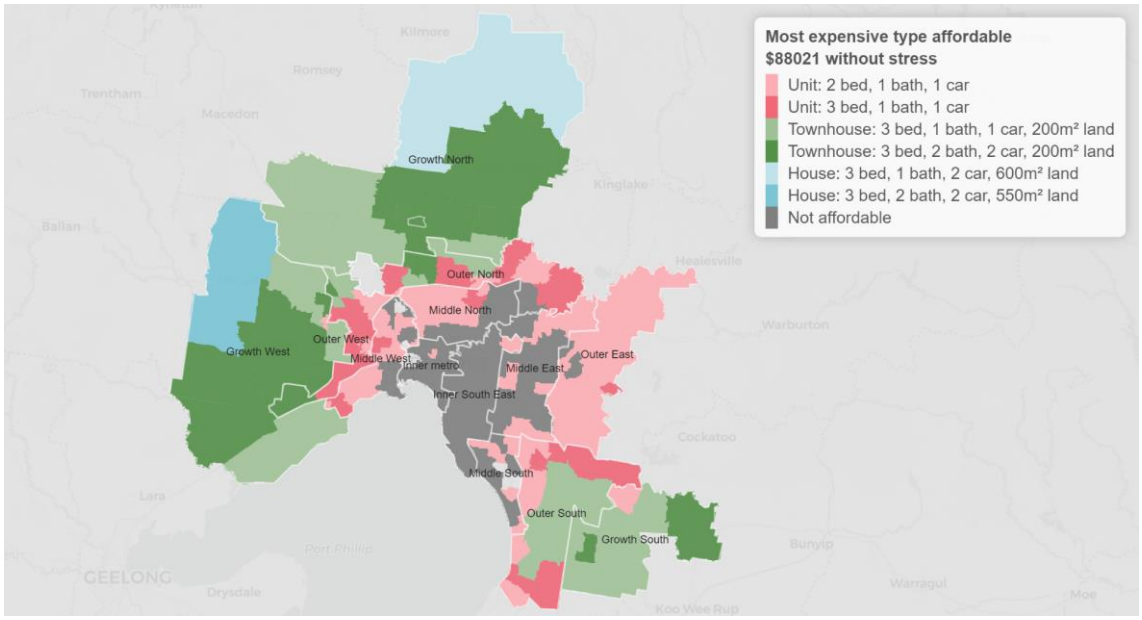
Our model estimates that the 7 home types listed in Table 3 follow an identical order from the most expensive to the least expensive at average market prices for each SA2. For example, in every SA2, the estimated average price of a townhouse with 3 bedrooms, one bathroom, one car space and 200m^2 of land is always more expensive than a unit with 3 bedrooms, one bathroom and one car space.

Figures 3A and 3B show the most expensive home type that is affordable, at our modelled average price, for a moderate income households earning $88,021 each year, with and without housing stress, in each SA2. Appendix A (Table A1) also shows the results aggregated from SA2s to the larger spatial zones.

Figure 3A shows that if a household earned $88,021 each year, and kept their mortgage repayments less than 30% of their gross household income, they could not buy any of our selected home types at the average price in most inner areas of Melbourne. In a very few inner areas, they could afford an average-priced 2-bedroom unit. In the middle suburbs, they could only afford a 2-bedroom or 3-bedroom unit at the average price. Moving further away from Melbourne's central areas, in the outer east, the most expensive home type these households could afford is still an average-priced unit. In the other outer areas, this household could afford either a unit or a townhouse, depending on the specific SA2. Households with this income level can only afford an average-priced house on the very outer edge of the northern and western growth areas.

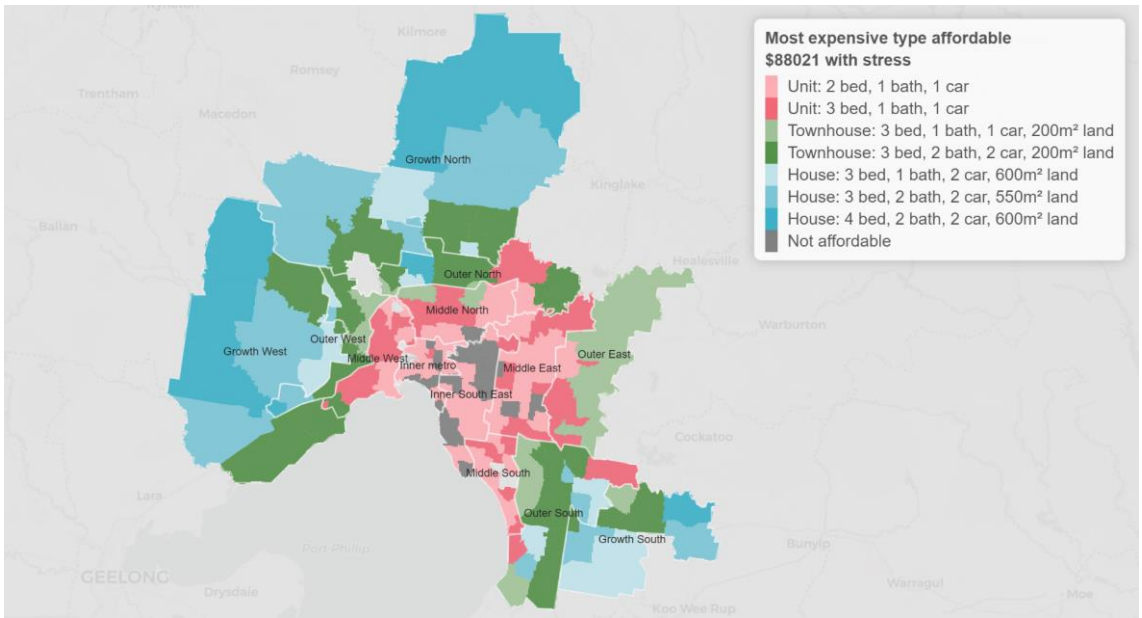
Some households will borrow more than the 30% of gross income traditionally used to measure housing stress. If a moderate income household range earning $88,021 maximises their borrowing capacity beyond 30%, they will be in 'housing stress', but can still secure a home loan. This amount varied depending on a household's income but was typically around 37% in June 2022. Even in this case, Figure 3B shows they cannot afford any of our selected home types in much of inner Melbourne. But in some inner locations they could afford average-priced 2-bedroom or 3-bedroom units. In the southern and eastern middle suburbs, the most expensive home type they could afford is still a unit, but in parts of the northern and western middle suburbs, they could afford average-priced townhouses. The growth areas are still the only places they could afford an average-priced house.

Figure 3A: Homebuying options for a household earning $88,021, without housing stress



Source: Infrastructure Victoria

Figure 3B: Homebuying options for a household earning $88,021, with housing stress



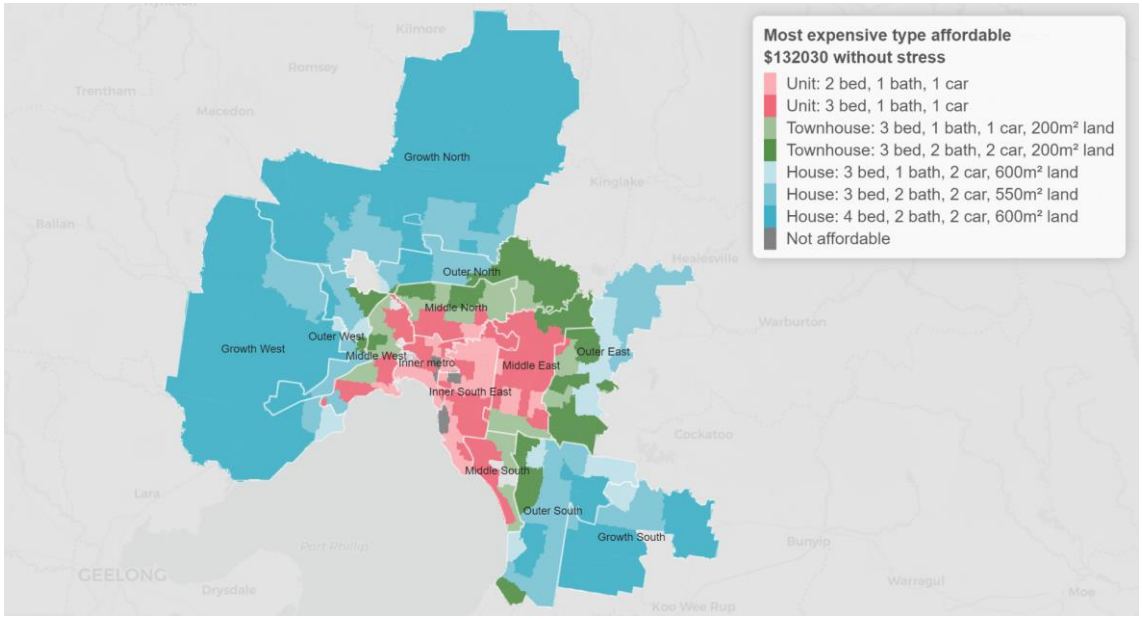
Source: Infrastructure Victoria

Figures 4A and 4B show the affordable options for a moderate income household earning $132,030 each year. They show the results for each SA2. Table A2 in Appendix A shows the aggregated results by spatial zones. Figure 4A shows that the most expensive of our 7 home types these households could afford in June 2022, at the average modelled price and without exceeding 30% of their gross income. These homes are units in inner areas and townhouses in the most of middle areas. The household could afford either townhouses or houses in outer and growth areas depending on the specific SA2.

Figure 4B shows that if this household maximised their borrowings to levels allowed by banks, exceeding 30% of their income, they can buy a wide variety of home types at average prices. On the outer edge of inner areas, they could afford a 3-bedroom townhouse. But in most inner areas, the most expensive home type they could afford is still an average-priced unit. In the middle areas, the most expensive home type they

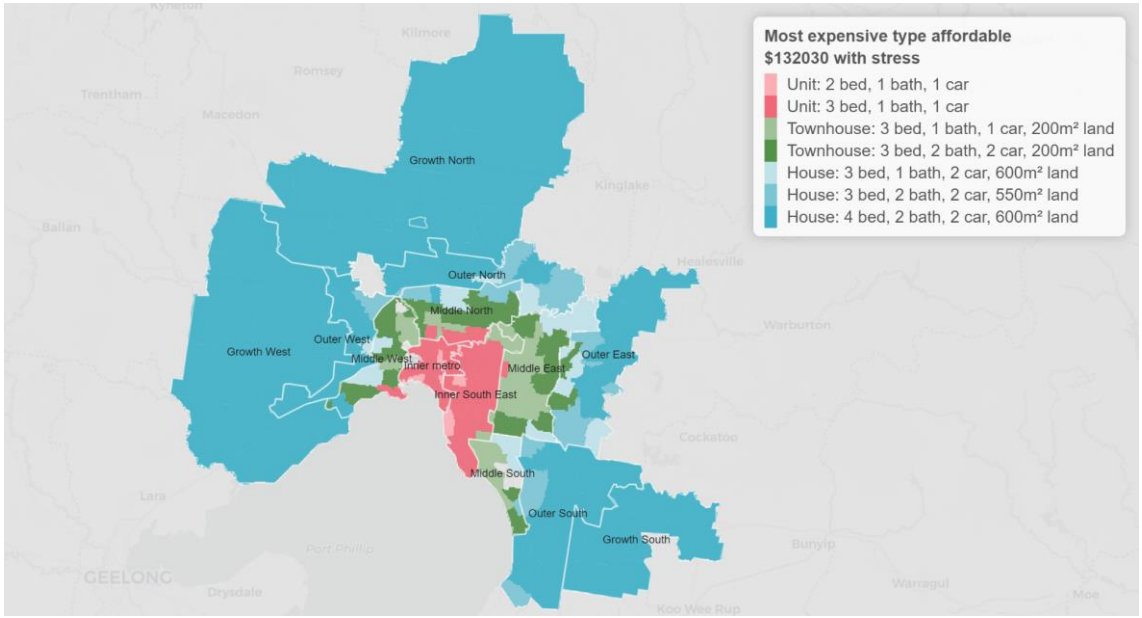
could afford now includes detached houses in a few places. In outer and growth areas, they could afford 4-bedroom houses.

Figure 4A: Homebuying options for a household earning $132,030, without housing stress



Source: Infrastructure Victoria

Figure 4B: Homebuying options for a household earning $132,030, with housing stress



Source: Infrastructure Victoria

In summary, Melbourne's growth areas are the only places a moderate income household earning $88,021 each year could buy a detached home in June 2022, if they bought an average-priced house of its type and spent less than 30% of their income on mortgage repayments. If this household wanted to live closer to central Melbourne, they could only afford a townhouse in the established outer suburbs or unit in the middle suburbs. They could not afford an averaged-priced 2-bedroom apartment in virtually any inner suburb. If they maximised their borrowing beyond 30% of their income, their detached house options extended to few SA2s in established outer suburbs, or a small averaged-price 2-bedroom unit in selected inner suburbs.

A moderate income household earning $132,030 had a few more options. They could buy an averaged-price detached home in the established outer suburbs and still pay their mortgage with less than 30% of their income in June 2022. If they maximised their borrowings, they could afford a 3-bedroom house in a few SA2s in the middle suburbs. If they wished to live any closer to the central city, they could only afford an average-priced townhouse in the middle suburbs, or an apartment in the inner suburbs.

We conducted 2 sensitivity tests (Appendix B), using the lowest and highest interest rate since 2008. These show that housing affordability is sensitive to interest rates. The higher the interest rate, the fewer affordable housing options. At an interest rate of 9.6%, a household earning $88,021 had few options to own a home. A household earning $132,030 was in a better position at this interest rate, but the inner areas remained largely unaffordable, and they could only buy a 4-bedroom house in the growth areas.

We also examined affordability changes in a hypothetical scenario where prices for townhouses and units in Melbourne's established areas were 10% lower (Appendix C). The main housing affordability improvement for moderate income households was an extra bedroom in some areas. The price drop only produced a change in their affordable home types in a few areas (for example, from a unit to a townhouse). A household earning $88,021 still could not afford an average-priced townhouse in inner areas.

We also considered a second hypothetical scenario of 10% higher prices for properties in growth areas (Appendix C). Households on the lower income ($88,021) showed a more drastic reduction in their home buying options, such as no longer being able to afford a detached home in some growth areas.

Affordable substitutes for growth area houses

We wanted to identify potentially substitutable home types for a typical house in growth areas. We define a 'substitutable home type' as one that has a lower market price than a typical growth area home.

From our property market data, the typical growth area home sold since 2017 is a detached house with 4 bedrooms, 2 bathrooms, 2 car spaces and a land size around 600m^2. This is a measure of all homes sold in our defined growth areas, whether newly developed or resold. While new estates typically have smaller blocks, at around 400m^2,[40] our sales data indicates that the average size lot actually bought in growth areas averaged 600m^2 (with the median only slightly lower, at 570m^2). We estimated its average price to be around $780,000 at June 2022.

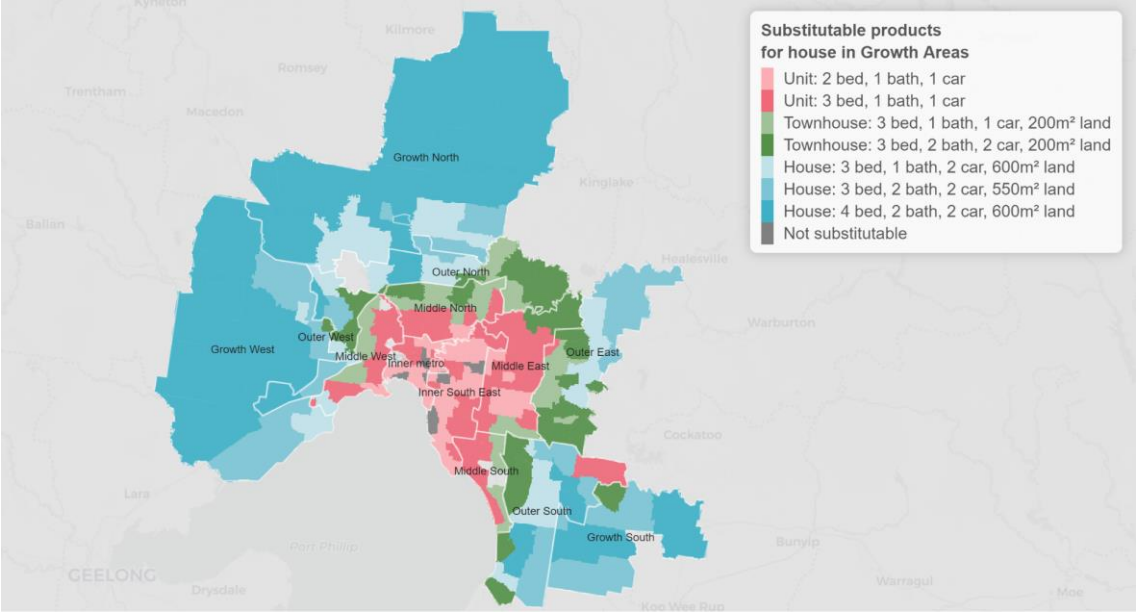
In this subsection, we calculate the most expensive home type with an average price below $780,000 in each SA2. We considered the same options as in Table 3.

Figure 5 shows the most expensive substitutable home types for this typical growth area home in each SA2, at our modelled prices. Table A3 in Appendix A shows the same results aggregated into larger spatial zones.

In summary, our results show that:

- Some parts of inner Melbourne had no affordable substitutes for growth area houses from our list of typical homes, at their average modelled price in June 2022.
- In most inner areas, the only substitutable home types were units, mostly 2-bedroom units.
- For a majority of SA2s in the eastern middle suburbs, the most expensive substitutable home types were also units, but included 3-bedroom units. In a few SA2s in this area, townhouses were also substitutable.
- For the rest of the middle suburbs, potentially substitutable home types included units for SA2s nearer the city centre, or townhouses for those further away.
- In most established outer suburbs, townhouses or smaller houses sold at price substitutable for the typical growth area house. Prices in the outer south and east are somewhat higher than in the north and west.

Figure 5: Substitutable home types for a growth area house (4 bed, 2 bath, 2 car, 600m² land)



Source: Infrastructure Victoria

Price effects of infrastructure proximity

Another of our objectives is to investigate the residential property value premium of proximity to infrastructure. More specifically, to investigate the research question:

> 'Does a home with access to infrastructure sell for a higher price than a home without access? If so, what is the premium?'

To answer this question, we constructed 10 variables indicating whether a home was near selected infrastructure types. They are listed in Table 1. We included these extra independent variables in a second version of our hedonic price model, as described by Equation (1).

We transformed these 10 extra independent variables into dummy variables, each indicating whether a home was located within a certain distance of each infrastructure type. In general, we examined the effect of a home being located within 1.6km from each infrastructure type. This is approximately equal to a 20-minute walk at a steady walking pace. This choice reflects the Plan Melbourne direction to create a city of 20-minute neighbourhoods. We transformed most of the infrastructure proximity variables into dummy variables coding for whether a home was within 1.6km or not of each infrastructure type. We made 2 exceptions:

- The secondary school dummy variable codes for a home being within 800m of a secondary school. We chose this distance because a very high proportion of homes are with 1.6km of a secondary school. Using the larger distance would not produce a meaningful distinction between homes.
- The arterial road dummy variable codes for a home being within 100m of an arterial road or freeway. Again, the vast majority proportion of homes are with 1.6km of an arterial road. We also hypothesise that the price effects dissipate rapidly, as the noise, pollution and privacy effects of major roads are highly localised.

Table 4 shows the results of this second version of our price model. We conducted a multicollinearity test using the variance inflation factor and detected no significant multicollinearity. Comparing Table 4 with Table 2 shows the coefficient estimates for home features are largely consistent between models (for example, the coefficients for the number of bedrooms, bathrooms, or car spaces). We performed an analysis of variance test to compare the 2 sets of models. The results show that the models that include infrastructure variables have a statistically significant better model fit, which means they can explain the house price variations better, even though the model estimates for dwelling characteristics are consistent in the 2 sets of models.

We designed the previous base model to analyse housing affordability (Table 2). That model does not include infrastructure proximity variables, because it aims to estimate the average impacts from all infrastructure in an SA2, and that model design made the average market price more representative for spatial areas and home types.

In our second set of models (results shown in Table 4), we included infrastructure proximity variables to analyse the effects of proximity to each infrastructure type on property prices. We are primarily interested in the coefficients on the proximity to infrastructure variables, shown in the bottom half of Table 4.

A positive coefficient means infrastructure proximity is associated with higher property values. The larger the coefficient, the larger the effect on property prices.

To explain the meaning of the coefficients, we can use metropolitan train station proximity as an example. We follow the Kennedy approach to the interpretation of the dummy variable coefficients.[41] Table 4 shows the coefficient for 'within 1.6km of metropolitan train station' is 0.0215. This means a home located within 1.6km of a metropolitan train station appears to add 2.17% to the sale price of house, on average in Melbourne, after controlling for other variables. We calculated this as follows:

$$exp(0.0215 - (0.5 * 0.01^2)) - 1) * 100 = 2.17\%$$

Similarly, townhouse prices are 2.91% higher.

Among the 10 selected infrastructure types, being within 1.6km of a metropolitan activity centre has the highest positive association with sale prices. House prices near these centres are 4.2% higher, after controlling for other variables. The next largest effect is for metropolitan train stations, selling for 2.17% higher prices. Proximity to tram stops, major activity centres, hospitals and secondary schools are positively associated with higher house prices by 1.77%, 0.97%, 0.94%, and 0.61% respectively.

For townhouses, being located within 1.6km of a metro train station has the biggest positive association (2.92%), followed by tram stops (1.28%), hospitals (1.21%) and being within 800m of a secondary school (0.79%).

Compared with units located further away from infrastructure, units closer to infrastructure generally have negative associations with sale prices. We don't have a strong explanation for this discrepancy. But Figure 2 shows that units normally have good accessibility to almost all our chosen infrastructure variables.

One hypothesis is that units located further away from infrastructure could be a scarcer product, for which apartment buyers are willing to pay more. For example, units further away from infrastructure might be in quieter and more private neighbourhoods, and therefore could be more valuable. Current zoning polices and planning regulations in Victoria specifically tend to locate unit and apartment developments near infrastructure.[42] These policies aim for medium and high-density housing developments have appropriate infrastructure. These planning policies can mean that most units are close to infrastructure by design, to maximise the use of that infrastructure.

These planning policies can concentrate the supply of units close to infrastructure, but restrict the supply of units that are further away from it. If the supply of apartments located further away from infrastructure is constrained, the market can build too few units in these places to meet market demand. This makes it difficult to use real market data to analyse the 'true' demand and willingness to pay for infrastructure proximity for units.

A further possibility is that, despite the care we took to estimate appropriate hedonic models, and control for possible sources of variance, confounding variables that correlate with proximity to infrastructure could be affecting our model. For example, we did not have data to indicate whether streets were quiet and private. If the infrastructure proximity was negatively correlated with quiet and private street, then our infrastructure proximity variable might be detecting the value of 'quiet and private streets', rather than the value of being located away from infrastructure. The infrastructure proximity implicit prices would then capture both the pure value of the infrastructure proximity attribute, and part of the unmeasured neighbourhood attribute, and hence reduce the accuracy of the estimated economic value of infrastructure proximity.

Similarly, our data set did not include information for the size of apartments, other than the number of bedrooms (unlike houses and townhouses). If infrastructure proximity correlates with the average size of units and apartments, then our infrastructure proximity value can capture both the value of infrastructure proximity and part of the unmeasured unit size attribute. This might be the case if units located further away from infrastructure tend to be older, larger apartments, compared with newer, smaller apartments built under more recent planning policies.

Missing variables are more likely to exist for the unit model compared with the house and townhouse models, judged by the relatively low R^2 for the unit model (as shown by Table 4). For a missing variable to invalidate the basic findings, the missing variable would have to be both highly correlated with the infrastructure proximity variables and uncorrelated with all other variables. We have no evidence that such a bias exists, but we acknowledge the potential for there to be some attributes that are not accounted for.

Of all our variables, the arterial road variable had the largest negative association with property prices, whether houses, townhouses or units. We included proximity to freeways in the variable. Being located within 100m of an arterial road was associated with 4.5% lower house prices, and 3.9% and 4.8% lower townhouse and unit prices, respectively. Landfill sites also have a consistent negative association with prices for all the home types.

Houses and townhouses located within 1.6km of a police station sold for less, on average, than those further away, after controlling for other variables. Proximity to cemeteries similarly had a negative association with townhouses prices, but did not show significant effects for houses and units.

Hospitals and secondary schools had similar associations. Being closer to either hospitals or secondary schools was positively associated with houses and townhouses prices by about 1%.

Table 4: Model results including infrastructure proximity variables

	House		Townhouse		Unit	
	Estimate	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
(Intercept)	12.3191***	0.0204	12.9584***	0.0339	12.9092***	0.0191
Bedrooms						
2 bedrooms	0.3759***	0.0114	0.2514***	0.0144	0.4004***	0.0025
3 bedrooms	0.4626***	0.0113	0.3633***	0.0145	0.6195***	0.0037
4 bedrooms	0.5450***	0.0114	0.4743***	0.0148	0.7270***	0.0086
5 or more bedrooms	0.5959***	0.0115				
Bathrooms						
2 bathrooms	0.0869***	0.0012	0.0869***	0.0024	0.1279***	0.0023
3 bathrooms	0.2006***	0.0019	0.1665***	0.0036	0.5172***	0.0090
4 or more bathrooms	0.4302***	0.0035				
Car spaces						
1 car space	0.0238***	0.0021	0.0340***	0.0080	0.1883***	0.0034
2 car spaces	0.0544***	0.0020	0.0770***	0.0081	0.3357***	0.0042
3 car spaces	0.0668***	0.0024	0.1381***	0.0095	0.5335***	0.0088
4 or more car spaces	0.0803***	0.0024				
Land area	0.2615***	0.0013	0.1347***	0.0021		
Floor area	0.0429***	0.0012				
Distance to city centre	-0.3929***	0.0073	-0.2903***	0.0139	-0.1547***	0.0071
Within 1.6km of metro train station	0.0215***	0.0014	0.0288***	0.0031	-0.0187***	0.0040
Within 1.6km of hospital	0.0094***	0.0014	0.0121***	0.0026	-0.0086**	0.0028

	House		Townhouse		Unit	
	Estimate	SE	Estimate	SE	Estimate	SE
Within 1.6km of metropolitan activity centre	0.0412***	0.0033	0.0089	0.0067	-0.0329***	0.0079
Within 1.6km of major activity centre	0.0097***	0.0013	0.0025	0.0027	-0.0073*	0.0034
Within 1.6km of cemetery	0.0028	0.0015	-0.0122***	0.0030	-0.0060	0.0033
Within 1.6km of landfill	-0.0215***	0.0037	-0.0304**	0.0095	-0.0267*	0.0131
Within 0.8km of secondary school	0.0061***	0.0010	0.0079***	0.002	-0.0148***	0.0023
Within 1.6km of police station	-0.0117***	0.0013	-0.0124***	0.0027	0.0038	0.0029
Within 1.6km of tram stop	0.0176***	0.0028	0.0128**	0.0044	-0.0041	0.0068
Within 0.1km of arterial road	-0.0462***	0.0013	-0.0392***	0.0020	-0.0495***	0.0020
Quarters fixed effects	***		***		***	
Spatial fixed effects	***		***		***	
Observations	208,477		40,957		95,435	
R^2	0.87		0.83		0.63	
Significance level:						
'*' 5%						
'**' 1%						
'***' 0.1%.						

Source: Infrastructure Victoria

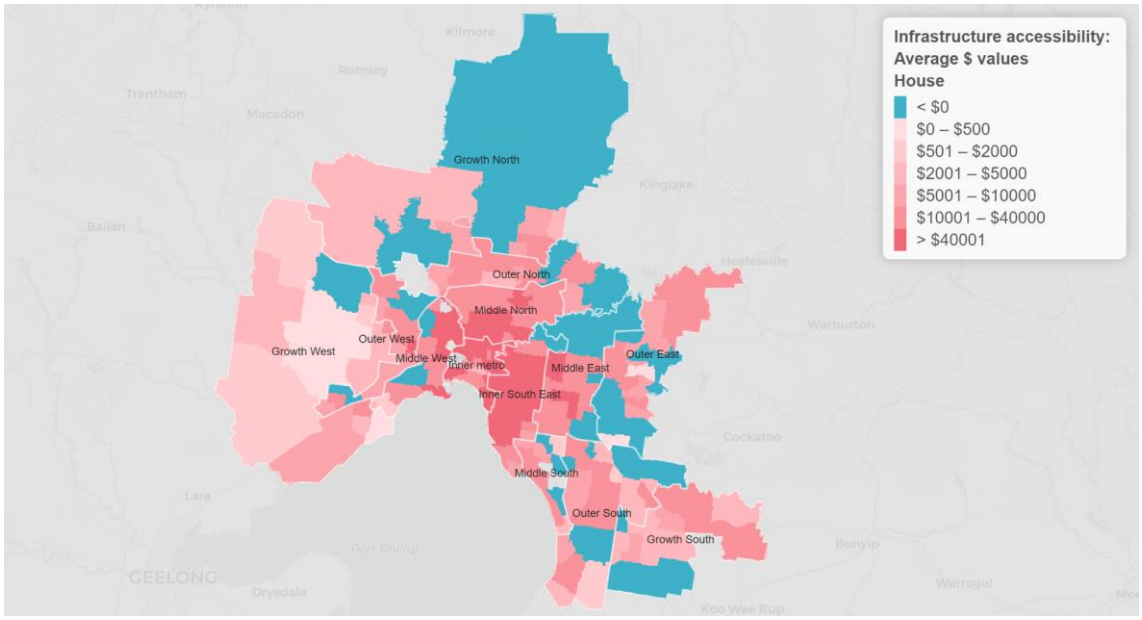
Combined price associations with infrastructure proximity

Based on Table 4, we can derive the implicit market value of proximity to each infrastructure type. Evaluated at the sample median price ($959,182 for house; $796,111 for townhouse and $555,298 for units), we can calculate the implicit values of proximity to each infrastructure type. These implicit values are a measure of economic value capitalised into property prices. Using the estimated implicit values for infrastructure proximity and distances from each house and townhouse to individual infrastructure, we calculated the combined economic value from all 10 infrastructure types for each house and townhouse included in the study. We then averaged this combined 'infrastructure proximity value' for all the houses, and all townhouses, in each SA2. Figures 6A and 6B show the average combined economic value of infrastructure proximity for houses and townhouses in each SA2.

Figures 6A and 6B show a strong spatial differences in the economic value of infrastructure proximity. Proximity benefits (economic value) from infrastructure lie mostly in inner Melbourne. Middle suburbs, including in the south, west and north, also show property price premiums related to their infrastructure proximity. However, in the eastern middle suburbs, the outer suburbs, and growth areas, infrastructure proximity produces low or negative effects on property prices. These spatial differences are generally consistent for both houses and townhouses.

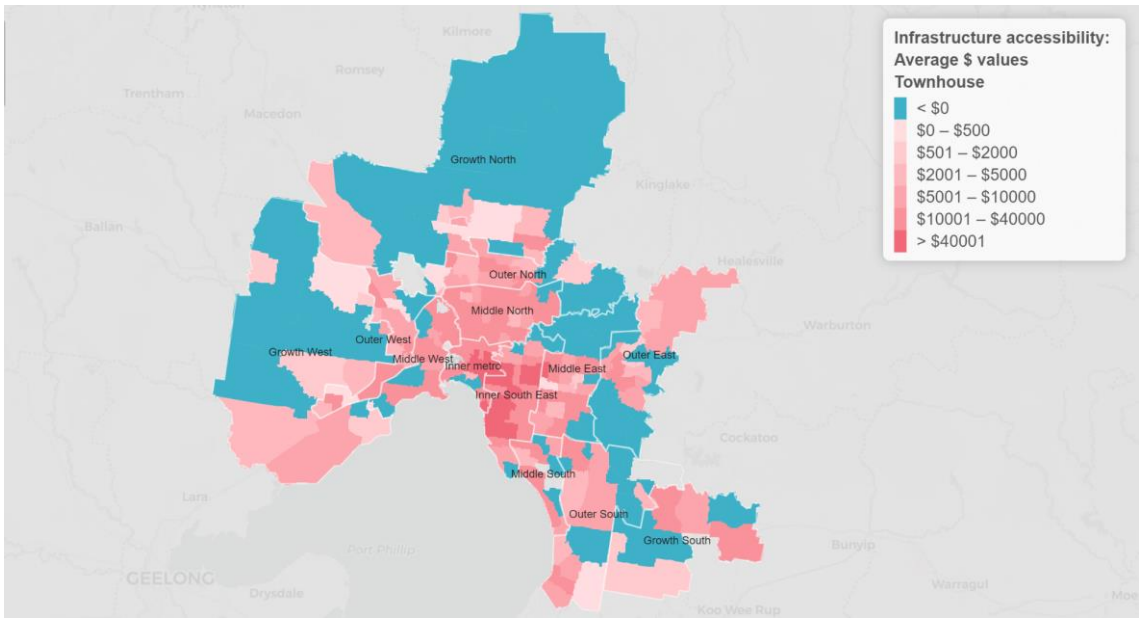
In other words, based on this measure, property prices are relatively unaffected by close proximity to infrastructure in the outer suburbs and growth areas. Inner areas receive the highest price premiums from infrastructure proximity. This means access to infrastructure is one factor making homes in inner and middle suburbs more expensive. Low to moderate income households seeking more affordable homes must trade-off infrastructure access by choosing to live in outer suburbs or growth areas.

Figure 6A: Combined economic value of infrastructure proximity for houses, on average, by SA2



Source: Infrastructure Victoria

Figure 6B: Combined economic value of infrastructure proximity for townhouses, on average, by SA2

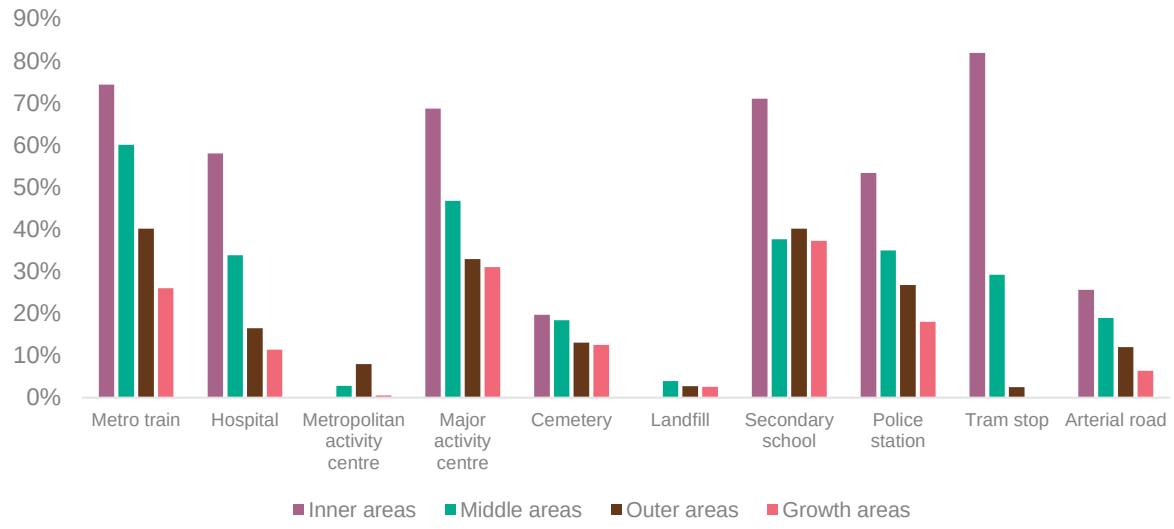


Source: Infrastructure Victoria

Figures 7A and 7B show the differences in each area's access to infrastructure. They show the proportions of houses and townhouses located near infrastructure for the inner, middle, outer and growth suburbs. The percentages show proximity at the distances listed in Table 4.

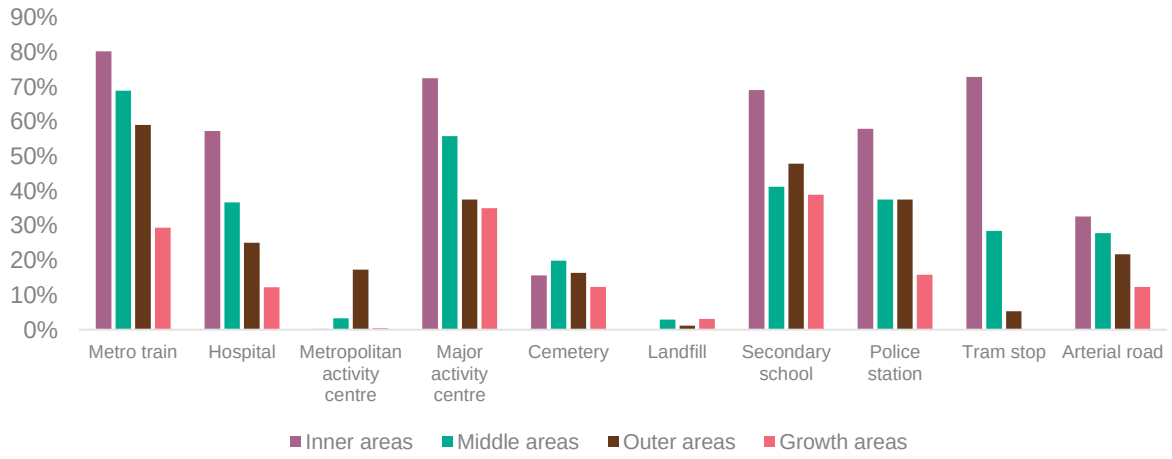
Figure 7A shows that, in general, houses in inner areas have better access to each of the 10 selected infrastructure types, followed by houses in middle and outer areas. Houses in growth areas are usually not close to infrastructure. Figure 7B confirms a similar story for townhouses. It shows that townhouses in inner areas are usually close to infrastructure. Townhouses in growth areas are not.

Figure 7A: Proportions of houses near infrastructure by spatial zones



Source: Infrastructure Victoria

Figure 7B: Proportions of townhouses near infrastructure by spatial zones



Source: Infrastructure Victoria

Conclusions

Dwelling features and location influence property prices

For this report, we used real market data to explore housing characteristics relationships with property prices. We built separate hedonic price models for Melbourne houses, townhouses and units. Our modelling results show that more bedrooms, bathrooms, car spaces, and places closer to the central Melbourne are all associated with higher sales prices for all home types. Data limitations meant our townhouse model could not include floor area, and our unit model could not include floor area or land area. But for home types with relevant data, we also confirmed that a larger land or floor area leads to higher sales prices.

We also confirmed that dwelling features and locations are associated with different prices of houses, townhouses and units. For example, the value of 3-bedroom houses is 46.5% higher than 1-bedroom houses. Prices for 3-bedroom townhouses are 35.8% higher than 1-bedroom townhouses, and 3-bedroom units are priced 62.8% higher than 1-bedroom units. Prices are 8.7% higher for a second bathroom in a house or townhouse. But the proportionate price difference for units is higher, by 12.3%. Compared with no car spaces, 2 car spaces is associated with a 33.7% higher price for a unit, but only 7.8% and 5.3% higher prices for townhouses and houses, respectively.

Moderate income restricts affordable home choices

We selected 7 typical home types in Melbourne, with different features and spatial areas, to investigate housing affordability for moderate income households.

We examined the circumstances in June 2022 for a household whose annual gross income is $88,021 (Figure 3A). Based on the prevailing home loan interest rate, and the average estimated prices of different home types, if that household spent less than 30% of their gross household income on a home loan repayment, then:

- For most Melbourne inner areas, they could not afford any of the 7 selected home types at their average prices.
- For the Melbourne middle suburbs, the most expensive average-priced home type they could afford was a 2-bedroom or 3-bedroom unit.
- In Melbourne's outer east, the most expensive home type this household could afford was still a unit, and nowhere in the outer eastern suburbs could they afford an average priced townhouse or house.
- In the northern, southern and western outer areas, this household could afford either units or townhouses, depending on the specific SA2.
- The only places this household could afford an average-priced detached home were at the outer edge of the northern and western growth areas, but not in the southern growth area.

This moderate income household, with a yearly gross income of $88,021, also had the option of stretching to their borrowing limit, but would exceed 30% of their income on mortgage repayments in June 2022 (Figure 3B). If they took on this extra debt, they could afford an average-priced 2-bedroom or 3-bedroom unit in certain inner Melbourne areas. They could similarly afford an average-priced townhouse in certain northern and western middle suburbs. But they still could not buy an average-priced detached home outside the growth areas.

A household at the upper end of the moderate income scale, with a yearly gross income of $132,030, had a few more options, while still keeping their mortgage repayments under 30% of their income in June 2022 (Figure 4A). They could afford an averaged-priced unit in most parts of inner Melbourne, including 3-bedroom units in certain suburbs. In the middle suburbs, they could generally afford an average-priced

townhouse. They could afford either average-priced townhouses or detached houses in the outer suburbs and growth areas, depending on the SA2.

If this household, earning a yearly gross income of $132,030, stretched to their borrowing limit in June 2022, beyond 30% of their income, their options increased (Figure 4B). They could buy an average-priced 3-bedroom apartment in most inner suburbs. At the edges of inner Melbourne, they could buy an average-priced townhouse. They could buy an average-priced townhouse in the middle suburbs, and buy an average-priced 3-bedroom house in a few select middle areas. In the outer and growth suburbs, they could buy larger properties, extending to an average-priced 4-bedroom houses in many places.

In summary, if a moderate income household strongly preferred a detached house in June 2022, Melbourne's growth areas were the only places they could consistently buy one, at the average price, without spending more than 30% of their income on mortgage repayments. Being at the higher end of the income range, or more extensive borrowing, could extend this to some established outer suburbs or bought them a larger home.

Moderate income households wanting to live closer to central Melbourne were generally restricted to average-priced units in inner or middle areas, and some suburbs remained out-of-reach altogether. Being at the higher end of the income range, or more extensive borrowing, added the possibility of buying an average-priced townhouse in some middle suburbs, or given options for a larger unit in more places.

We conducted sensitivity tests to explore the effects of different interest rates on our housing affordability results. Appendix B presents the results from 2 sensitivity tests, using the historically lowest and highest interest rates since 2008. We also examined 2 hypothetical scenarios of property price changes and their effects on housing affordability for moderate income households. Appendix C presents the detailed methods and results of these scenarios.

Units in established suburbs cost as much as growth area houses

This research investigated potentially substitutable home types for a typical growth area house. We found a standard home in growth areas had 4 bedrooms, 2 bathrooms, and 2 car spaces, and an average 600m^2 block of land. We used our price model to estimate the home types in other parts of Melbourne that would have sold at a similar average price in June 2022. Our results show that:

- In most inner areas, the only substitutable home types were average-priced 2-bedroom units. In a few places in inner Melbourne, none of our selected home types were substitutable at the average price.
- In most middle suburbs, the largest substitutable home type was an average-priced 3-bedroom unit. In a few areas, especially those farthest north, south or west, an average-priced townhouse was substitutable.
- In the established outer suburbs, townhouses were usually substitutable for a typical growth area house. In some places, especially established north and west outer suburbs farthest from the centre of Melbourne, an average-priced 3-bedroom home was substitutable.
- Generally, no other parts of Melbourne have 4-bedroom houses available at a market price similar to growth areas.

Proximity to infrastructure influences property prices

This research demonstrates that proximity to infrastructure has a significant relationship with property prices. People pay more for houses that are located within 1.6km of metropolitan train stations, hospitals, metropolitan activity centres, major activity centres, tram stops, and within 800m of secondary schools. Townhouse prices are similarly higher when located near metropolitan train stations, hospitals, secondary schools and tram stops. However, our model estimated that people generally pay less for units located closer to most types of infrastructure.

Of the 10 infrastructure types we investigated, houses near a metropolitan activity centre exhibited the largest positive association with average prices, showing 4.2% higher average prices, after controlling for other variables. However, only a small proportion of properties were this close to a metropolitan activity centre. This was followed by metropolitan train stations (2.2% higher prices).

For townhouses, being within 1.6km of a metropolitan train station showed the largest positive association with prices (2.9% higher). This was followed by tram stops (1.3%), hospitals (1.2%) and secondary schools (0.8%). Arterial roads have the largest negative association with prices, for all home types. Being located within 100m of an arterial road or freeway is associated with 4.5% lower average house prices, 3.9% lower average townhouse prices, and 4.8% lower unit prices.

In summary, this research found:

- Being located within 1.6km of a metropolitan activity centre is associated with a 4.2% higher average price for a house.
- Being located within 1.6km of a metropolitan train station is associated with a 2.2% higher average price for a house and a 2.9% higher average price for a townhouse.
- Being located within 1.6km of a tram stop is associated with a 1.8% higher average price for a house, and a 1.3% higher average price for a townhouse.
- Being located within 1.6km of a hospital or major activity centre are each associated with about a 1.0% higher average price for a house.
- Having a secondary school nearby (within 800m) is associated with about a 0.6% higher average price houses and a 0.8% higher average price for townhouses.
- If there is a cemetery within 1.6km of a townhouse, it sells on average for 1.2% less than one further away.
- Properties located within 1.6km of a landfill site exhibit 2.1% lower average house prices, 3.0% lower average townhouse prices, and 2.6% lower average unit prices. However, this applies to only a small percentage of Melbourne's homes.
- Homes located within 100m of an arterial road or freeway have 4.5% lower average house prices, 3.9% lower average townhouse prices, and 4.8% lower average unit prices.

Using this information on our 10 infrastructure types, we further investigated the combined economic value of proximity to infrastructure. We calculated the implicit price effect of all 10 infrastructure types in combination on each home in our sample and averaged these in each SA2.

Our results show a strong spatial difference in Melbourne in the economic value of infrastructure proximity. Specifically, positive price effects are highest in inner Melbourne. Melbourne's middle suburbs also generally experience positive price premiums associated with infrastructure proximity, although not as high as in the inner suburbs. But in Melbourne's outer suburbs and growth areas, the price premiums associated with infrastructure proximity are low or even negative. These differences are generally consistent, regardless of whether we model prices for houses or townhouses.

Appendix A. Housing affordability by spatial zones

This appendix shows the most expensive home types affordable in each spatial zone, from our selection of 7 home types (Table 3). We found that in these larger areas, several home types could be the most expensive type affordable, unlike the single type computed for each SA2.

The following tables show 2 options for each spatial zone. The first option shows the most expensive home type that is affordable in every SA2 in the spatial zone, at the average modelled price. This means it is available everywhere in that spatial zone. The second option shows the most expensive home type that is available in a least one SA2 in that zone. In other words, it shows the most expensive type available anywhere in that zone, even if it is only one suburb, at the average modelled price.

For example, in Table A1 in the growth north zone, the second row shows the most expensive home type affordable for a household earning $88,021, who spends less than 30% of their income on their mortgage. It shows that this household could afford a 3-bedroom, 1-bathroom, 1 car space townhouse on 200m^2 of land anywhere in the growth north zone, at the average modelled price in June 2022. It also shows that in at least one suburb in the zone, the same household could afford a detached home with 3 bedrooms, 1 bathroom and 2 car space on 600m^2 of land.

Table A1: Homebuying options for a household earning $88,021, by spatial zone

Spatial zone	Most expensive type affordable $88021 without stress		Most expensive type affordable $88021 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Townhouse: 3 bed, 1 bath, 1 car, 200m² land,	House: 3 bed, 1 bath, 2 car, 600m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Unit: 2 bed, 1 bath, 1 car,	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Inner south east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Middle east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Middle north	Not affordable	Unit: 3 bed, 1 bath, 1 car	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle south	Not affordable	Unit: 2 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car
Middle west	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Outer east	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Outer north	Not affordable	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 2 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Outer west	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Table A2: Homebuying options for a household earning $132,030, by spatial zone

Spatial zone	Most expensive type affordable $132030 without stress		Most expensive type affordable $132030 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 3 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Inner south east	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle east	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land
Middle north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Middle south	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 3 bed, 2 bath, 2 car, 550m² land
Middle west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer east	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer north	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Table A3: Substitutable home types for a growth area house (4 bed, 2 bath, 2 car, 600m² land)

Spatial zone	Substitutable home types for growth area house (4 bed, 2 bath, 2 car, 600m² land)	
	Everywhere	Anywhere
Growth north	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not substitutable	Unit: 3 bed, 1 bath, 1 car
Inner south east	Not substitutable	Unit: 3 bed, 1 bath, 1 car
Middle east	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Middle north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Middle south	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land
Outer east	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Outer north	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Appendix B. Housing affordability sensitivity tests on interest rate variations

For our main analysis, we used the prevailing interest rate in June 2002. The rate was 4.53%, offered by Commonwealth Bank of Australia at this time. This appendix shows the results of our interest rate sensitivity tests. These test the effects on housing affordability under different interest rate conditions. We chose the lowest and highest market interest rates between January 2008 and June 2022 for the tests.

We still used the average modelled prices for our 7 home types at June 2022 for our sensitivity tests. Changes in interest rates affect home prices. This test does not model those responses. Rather, we explore what effect a different interest rate would have on our findings, had the prices remained the same.

Housing affordability sensitivity test – lower interest rate

Our first interest rate sensitivity test recalculated the results using a low interest rate. We used the historically lowest interest rate since 2008. This was 2.19% offered by CBA in March 2022. This sensitivity test explores the changes in affordability from our previous analysis if the interest rate was lower (about half).

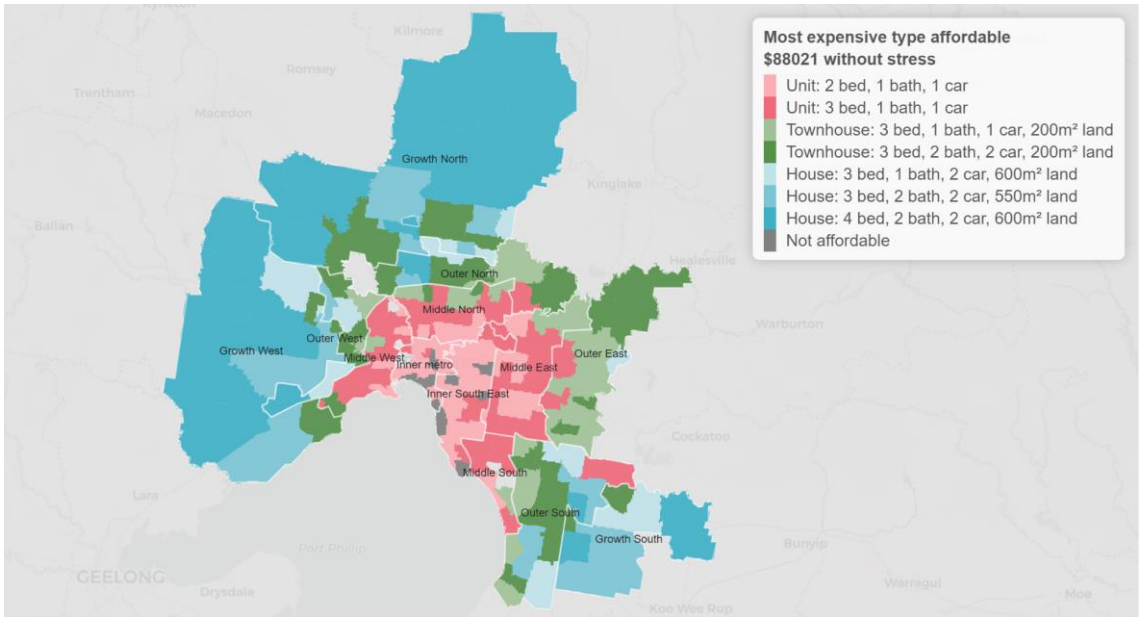
Figures B1 and B2 show affordability at SA2 level for a household earning $88,021, at this lower interest rate. At this rate, the maximum borrowing power for a household earning $132,030 is less than 30% of their income. This means we only show the affordability results for this household in a single map (Figure B3).

Table B1 shows aggregated results at spatial zone levels. At both ends of the moderate income range, aggregating results to spatial zones produced the same affordable home types, regardless of whether the household exceeded 30% of their income, often because their borrowing limit was below this. For this reason, Table B1 present results for both income levels in a single table.

Even with a much lower interest rate, housing affordability for moderate income households does not change markedly. If these households prefer a detached house, most places affordable for households at the lower end of the range are in the growth areas, plus some SA2s in the established outer suburbs. At the higher end of the moderate income range, households can afford a detached house in both outer and growth areas, as well as few SA2s in the middle suburbs.

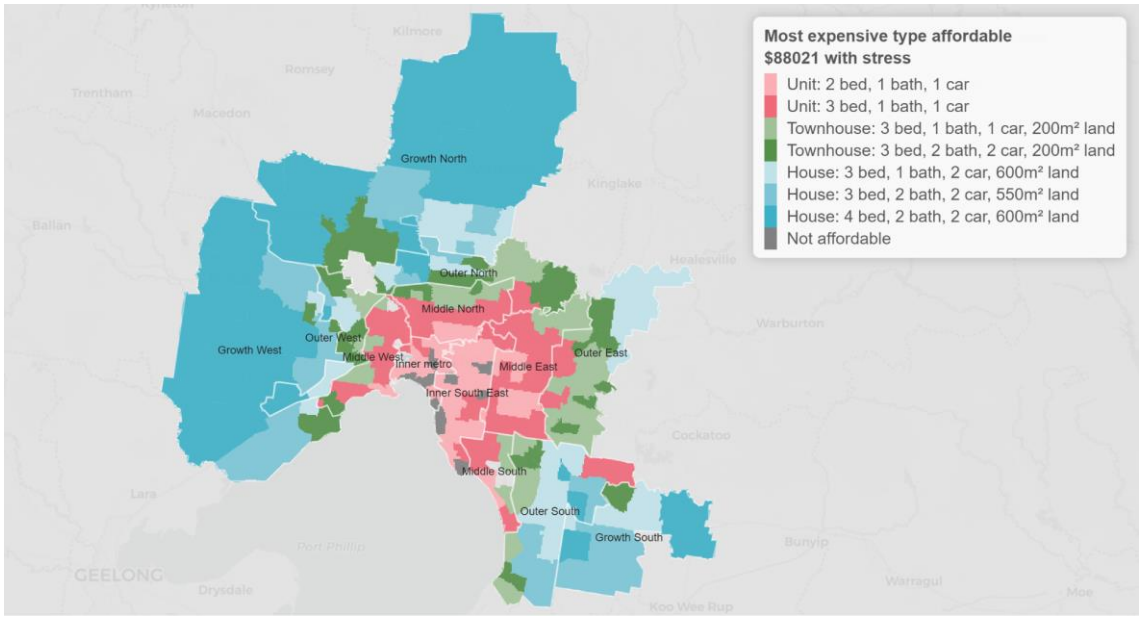
If households at the lower end of the moderate income range want to live close to the centre of Melbourne, they only had a few buying options in June 2022. They could buy a unit in inner areas, or a unit or townhouse in middle areas. At the upper end of the income range, households could buy a unit or townhouse in inner areas, or a unit, townhouse or house in middle areas, depending on the suburb.

Figure B1: Homebuying options for a household earning $88,021, without housing stress, at a lower interest rate



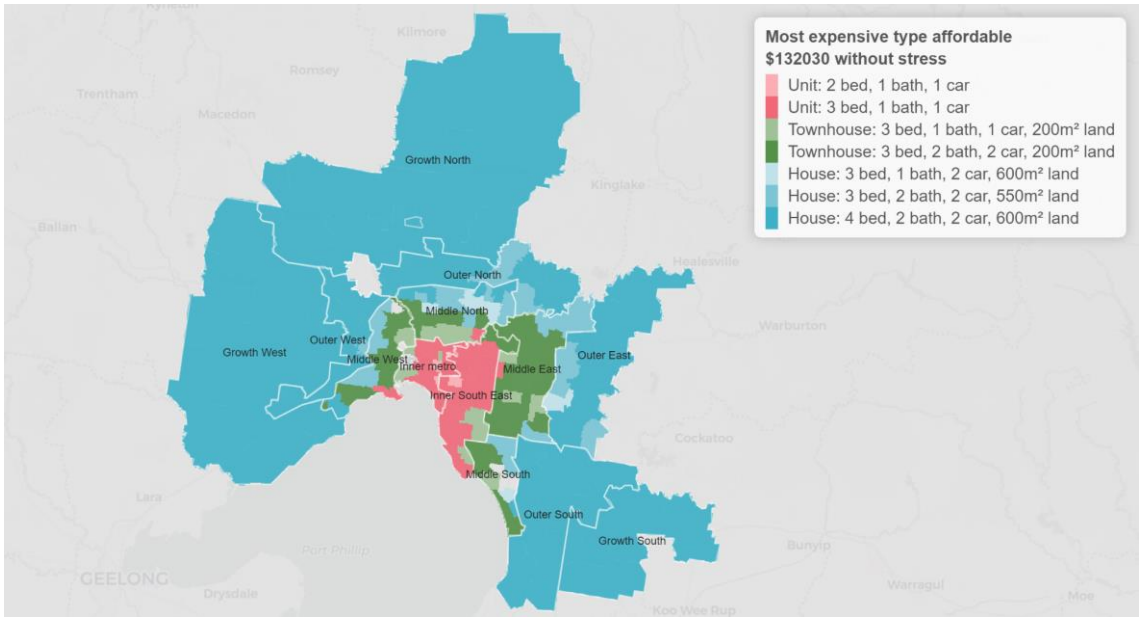
Source: Infrastructure Victoria

Figure B2: Homebuying options for a household earning $88,021, with housing stress, at a lower interest rate



Source: Infrastructure Victoria

Figure B3: Homebuying options for a household earning $132,030, without housing stress, at a lower interest rate



Source: Infrastructure Victoria

Table B1: Homebuying options for moderate income households, at a lower interest rate, by spatial zone

Spatial zone	Most expensive type affordable $88021		Most expensive type affordable $132030	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Inner south east	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Middle east	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Middle north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Middle south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Middle west	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer east	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer north	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer west	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Housing affordability sensitivity test – higher interest rate

Our second sensitivity test explores the effect of high interest rates. We chose to use the highest interest rate in the market since 2008 for the test. This was 9.58%, offered by CBA in July 2008. As before, we still use the average modelled price for each of our 7 home types in each SA2. This sensitivity test explores the changes in affordability from our previous analysis if the interest rate was higher (about twice as high).

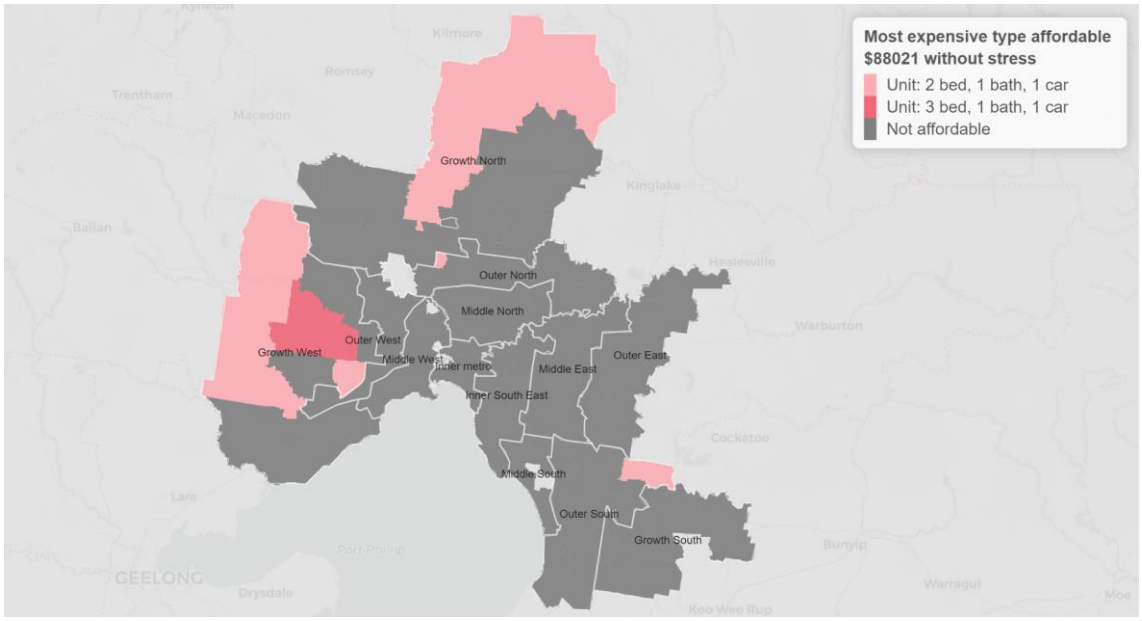
Figures B4 and B5 show affordability at SA2 level for a household earning $88,021, at this higher interest rate. With this doubled interest rate, affordable home buying options drastically reduce for this household. They cannot afford any of our detached home types anywhere in Melbourne, at the average modelled price. They can only afford a townhouse if they pay more than 30% of their income in mortgage repayments, and even then only in the suburbs furthest from Melbourne's centre. If they keep their mortgage repayments below 30%, they can only afford a small unit in a few growth area suburbs.

Figures B6 and B7 show housing affordability for a household earning $132,030 each year. At this higher interest rate, they can no longer afford any of our home types in a large part of the inner areas. If they kept their mortgage repayments below 30% of their income, they could not afford a detached home anywhere in Melbourne, at the average modelled price, except for Melton. If they stretch to their borrowing limit, they can afford to buy a small home in more parts of the growth areas, mostly in the north and west.

Tables B2 and B3 also show the aggregated results by spatial zones, for both income levels.

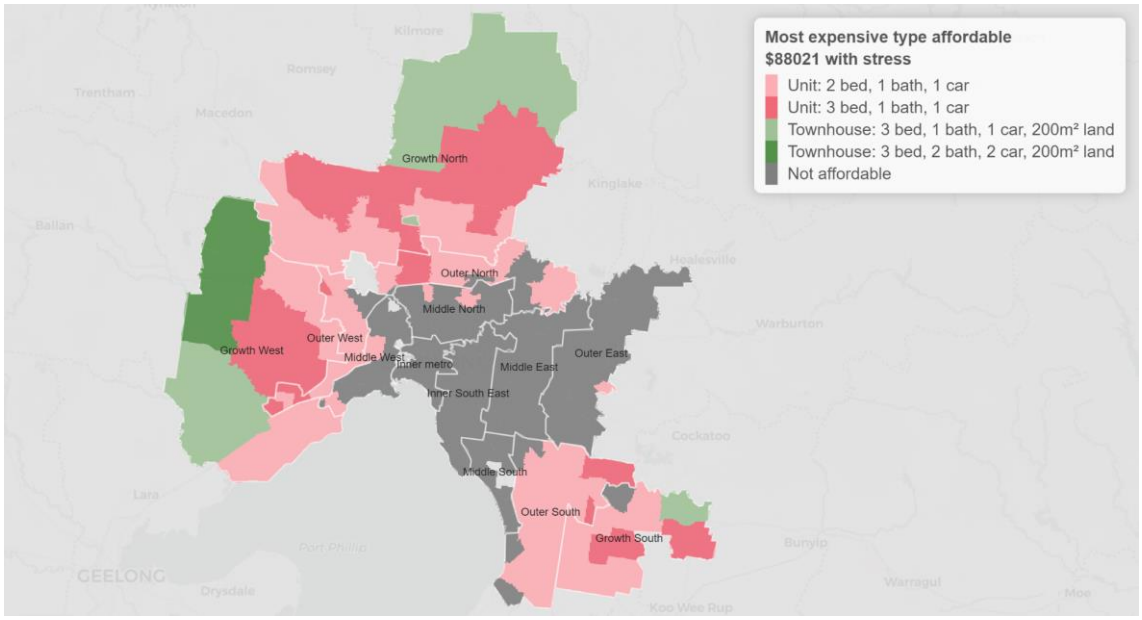
If the interest rate doubled to 9.58%, moderate income households wanting to buy a home anywhere near the centre of Melbourne in June 2022 had very few options. They could afford a 2-bedroom unit in a few select middle suburbs. If a household at the upper end of the income range maximised their borrowing limit, they could afford a 3-bedroom unit in a few middle suburbs.

Figure B4: Homebuying options for a household earning $88,021, without housing stress, at a higher interest rate



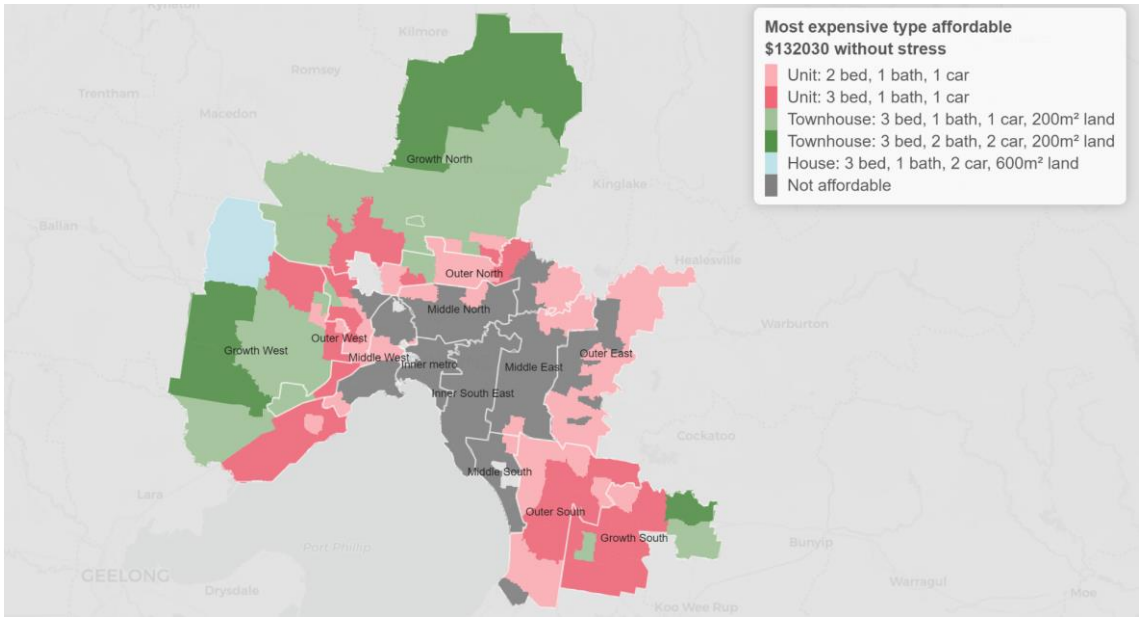
Source: Infrastructure Victoria

Figure B5: Homebuying options for a household earning $88,021, with housing stress, at a higher interest rate



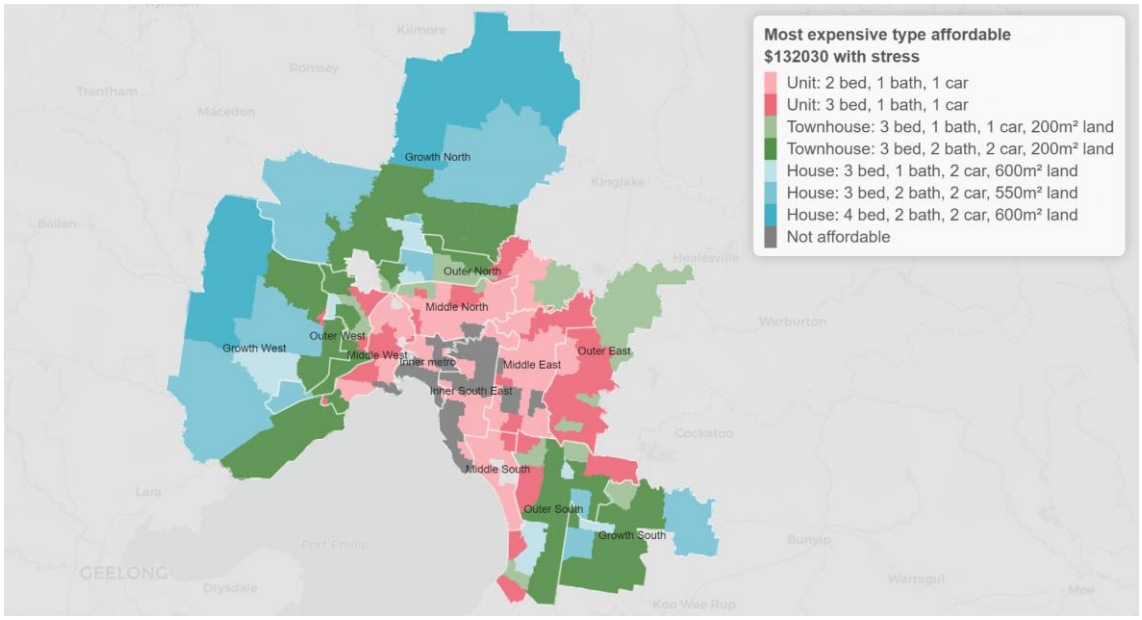
Source: Infrastructure Victoria

Figure B6: Homebuying options for a household earning $132,030, without housing stress, at a higher interest rate



Source: Infrastructure Victoria

Figure B7: Homebuying options for a household earning $132,030, with housing stress, at a higher interest rate



Source: Infrastructure Victoria

Table B2: Homebuying options for a household earning $88,021, at a higher interest rate, by spatial zone

Spatial zone	Most expensive type affordable $88021 without stress		Most expensive type affordable $88021 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Not affordable	Unit: 2 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Growth south	Not affordable	Not affordable	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Growth west	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Inner metro	Not affordable	Not affordable	Not affordable	Not affordable
Inner south east	Not affordable	Not affordable	Not affordable	Not affordable
Middle east	Not affordable	Not affordable	Not affordable	Not affordable
Middle north	Not affordable	Not affordable	Not affordable	Unit: 2 bed, 1 bath, 1 car
Middle south	Not affordable	Not affordable	Not affordable	Not affordable
Middle west	Not affordable	Not affordable	Not affordable	Unit: 2 bed, 1 bath, 1 car
Outer east	Not affordable	Not affordable	Not affordable	Unit: 2 bed, 1 bath, 1 car
Outer north	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Outer south	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Outer west	Not affordable	Not affordable	Not affordable	Unit: 3 bed, 1 bath, 1 car

Source: Infrastructure Victoria

Table B3: Homebuying options for a household earning $88,021, at a higher interest rate, by spatial zone

Spatial zone	Most expensive type affordable $132030 without stress		Most expensive type affordable $132030 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 3 bed, 2 bath, 2 car, 550m² land
Growth west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Not affordable	Not affordable	Unit: 2 bed, 1 bath, 1 car
Inner south east	Not affordable	Not affordable	Not affordable	Unit: 2 bed, 1 bath, 1 car
Middle east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Middle north	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle south	Not affordable	Unit: 2 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car
Middle west	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Outer east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Outer north	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Outer south	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Outer west	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land

Source: Infrastructure Victoria

Our 2 sensitivity tests used the lowest and highest interest rates since 2008. They show that housing affordability is sensitive to interest rates. Higher interest rates impair housing affordability. For an interest rate of 9.6%, a household on $88,021 could afford very few of our home options anywhere in Melbourne in June 2022, at the average modelled price. A household earning $132,030 was in a better position, but the inner areas were largely unaffordable to them. If this household wanted to buy an average-priced 4-bedroom house, their only option was to buy in a growth area and pay more than 30% of their income in mortgage repayments.

Our 2 sensitivity tests only considered interest rate changes. They did not examine any property price changes in response to interest rate variations. Interest rates and property prices can change in opposite directions simultaneously. If this occurred, the results would be less extreme.

Appendix C. Effects of price changes on housing affordability

This appendix investigates 2 hypothetical scenarios of property price changes and explores their effects on housing affordability for moderate income households. The scenarios align with other work Infrastructure Victoria undertook in this research series. The 2 scenarios are:

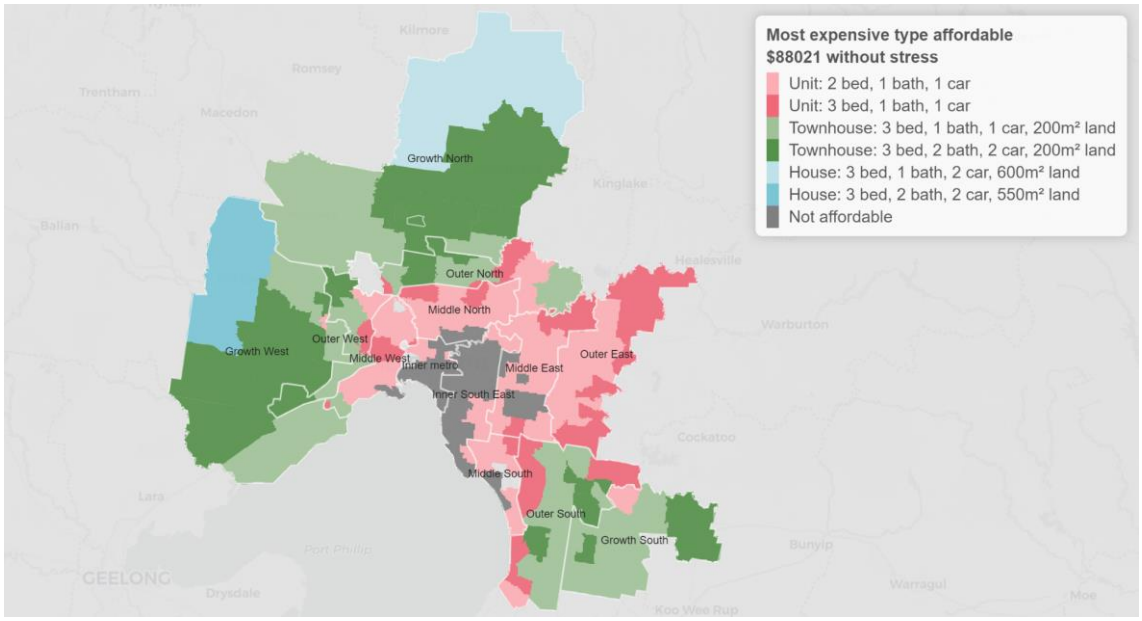
- 10% lower prices for townhouses and units in established areas
- 10% higher prices for all home types (including houses, townhouse and units) in growth areas.

Effects of 10% lower prices for established area townhouses and units

Our first price shock scenario examines the effect on housing affordability if prices for townhouse and unit prices in established areas were 10% lower. Figure C1 shows the most expensive of our 7 home types that are affordable for a household earning $88,021. The results are for the average modelled price in June 2022, and where the household kept their mortgage repayments below 30% of their income. Figure C2 shows the same analysis if that household stretched their repayments to their borrowing limit. Similarly, Figures C3 and C4 show the results for a household earning $132,020. Tables C1 and C2 show the aggregated results by spatial zones.

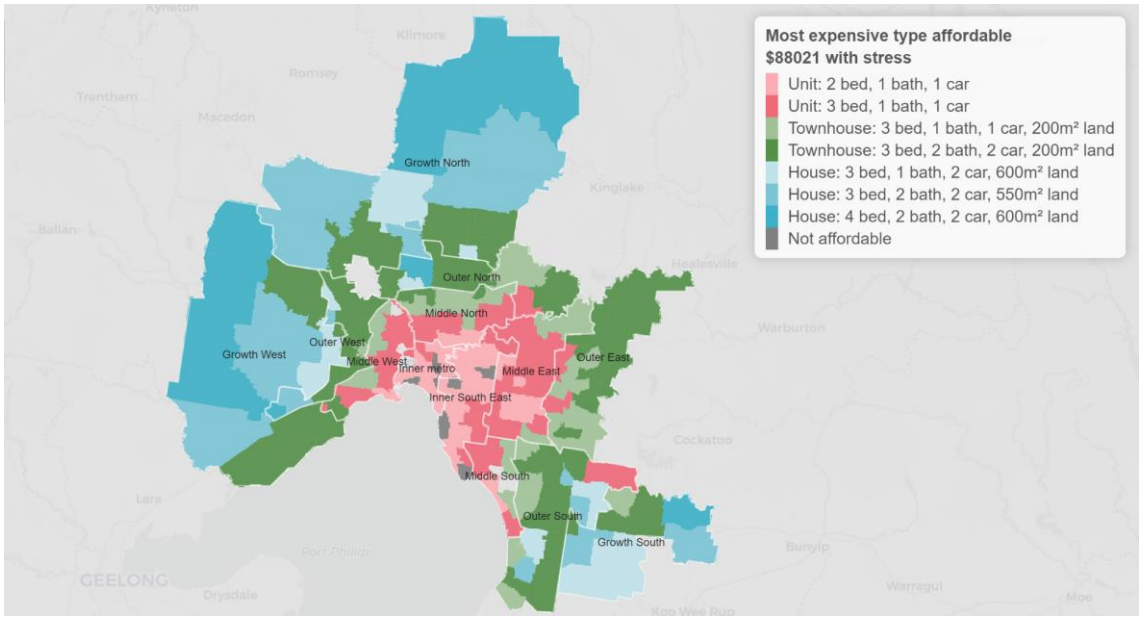
We compared the results from this scenario with 10% cheaper established area townhouses and apartments (Figures C1 and C2) with the baseline model (Figures 3A and 3B). Keeping mortgage repayments below 30% of lower-bound moderate income household, comparing Figure C1 with Figure 3A, the price drop only makes minor differences in affordability. For example, this household could buy one of our 7 home types at the average modelled price in a few more suburbs than in the baseline scenario. They could also buy a townhouse in a few western middle suburbs. If extending their borrowings to the limit (comparing Figure C2 with Figure 3B), they could also stretch to buy a home in an extra few suburbs and can buy a 3-bedroom townhouse in a few more middle suburbs.

Figure C1: Homebuying options for a household earning $88,021, without housing stress, with 10% lower prices for established areas townhouses and units



Source: Infrastructure Victoria

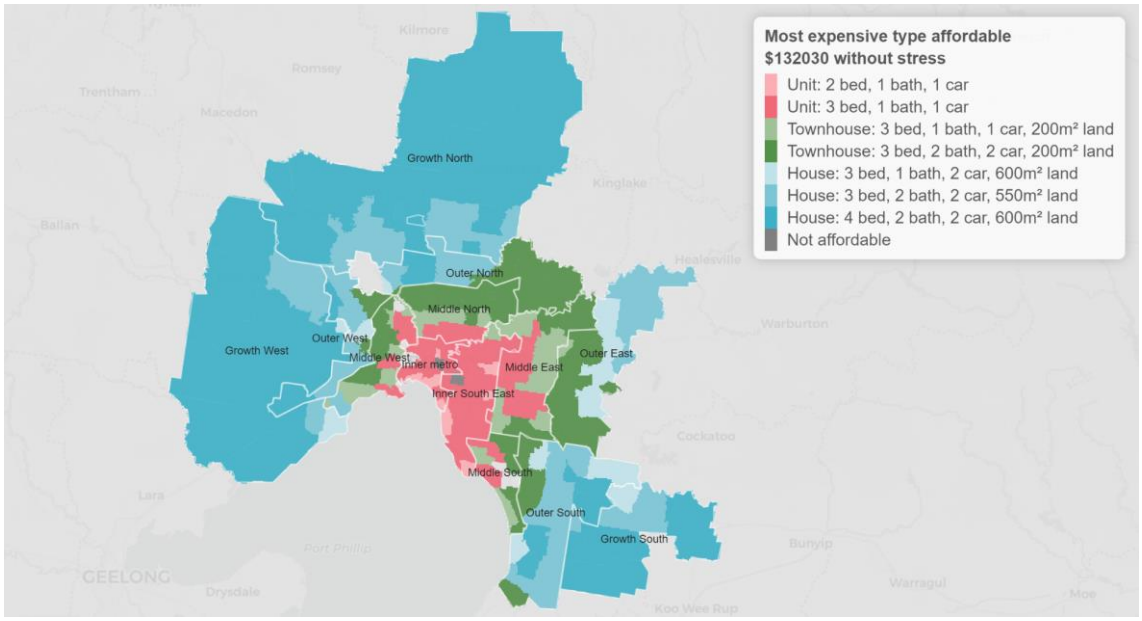
Figure C2: Homebuying options for a household earning $88,021, with housing stress, with 10% lower prices for established areas townhouses and units



Source: Infrastructure Victoria

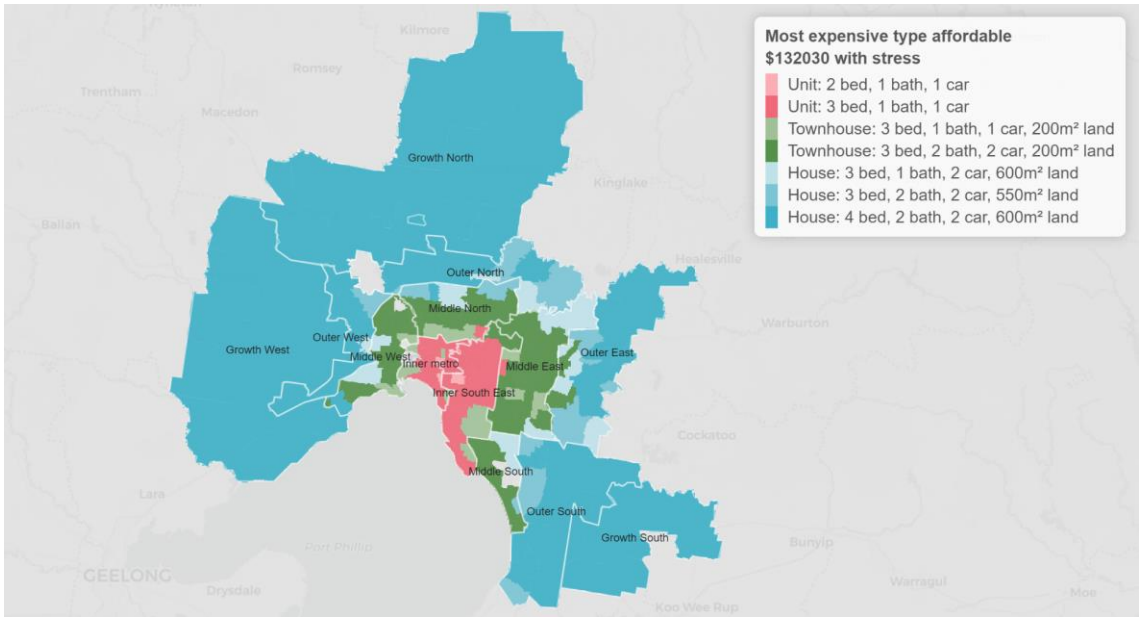
We repeated the same exercise for a household earning $132,020. We compared the results if we lower the price by 10% of established area townhouses and apartments (Figures C3 and C4) with the baseline scenario (Figures 4A and 4B). Similar to the lower end of the income range, this only makes a marginal improvement in the home types this household could afford. Their options to buy an average-priced 2-bedroom unit or 3-bedroom unit expand to a few more inner suburbs. They could similarly buy townhouses in more middle suburbs.

Figure C3: Homebuying options for a household earning $132,021, without housing stress, with 10% lower prices for established areas townhouses and units



Source: Infrastructure Victoria

Figure C4: Homebuying options for a household earning $132,021, with housing stress, with 10% lower prices for established areas townhouses and units



Source: Infrastructure Victoria

Table C1: Homebuying options for a household earning $88,021, with 10% lower prices for established areas townhouses and units, by spatial zone

Spatial zone	Most expensive type affordable $88021 without stress		Most expensive type affordable $88021 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 3 bed, 1 bath, 2 car, 600m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Inner south east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Middle east	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle north	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Middle south	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle west	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Outer east	Unit: 2 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Outer north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Outer west	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Table C2: Homebuying options for a household earning $132,030, with 10% lower prices for established areas townhouses and units, by spatial zone

Spatial zone	Most expensive type affordable $132030 without stress		Most expensive type affordable $132030 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Inner south east	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Middle east	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land
Middle north	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Middle south	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 3 bed, 2 bath, 2 car, 550m² land
Middle west	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer east	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 3 bed, 2 bath, 2 car, 550m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer north	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land

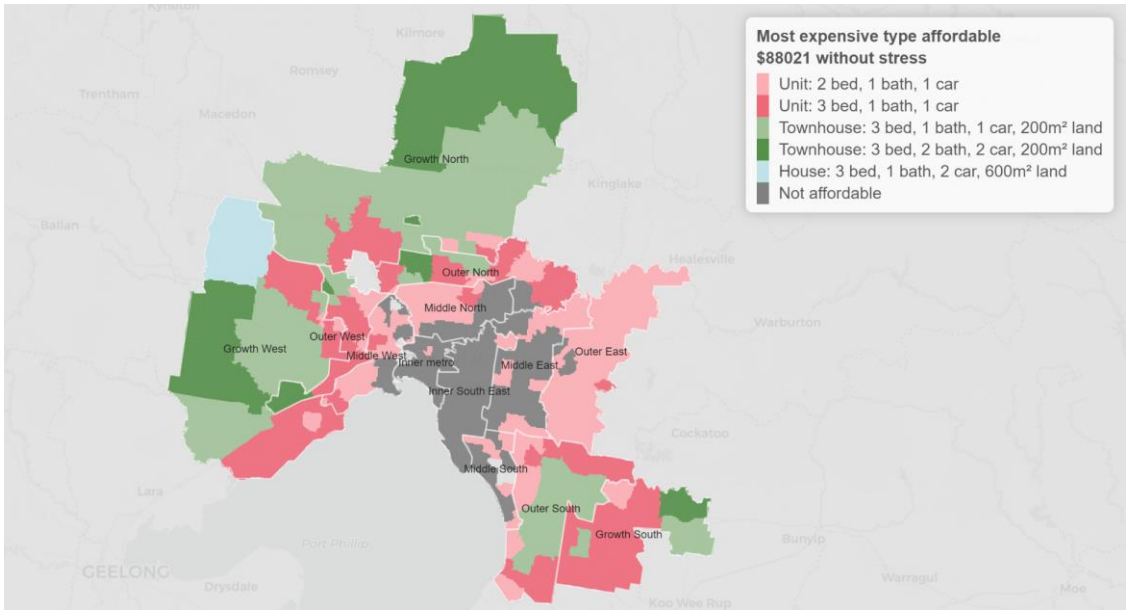
Source: Infrastructure Victoria

Effects of 10% higher prices for growth area homes

Our second price shock scenario examines the outcome if the prices for all the selected home types in growth areas were 10% higher. Figures C5, C6, C7 and C8 show the results for households earning $88,021 and $132,020, and whether they keep their mortgage repayments under 30%, or extend to their borrowing limit. Tables C3 and C4 show the aggregated results by spatial zones.

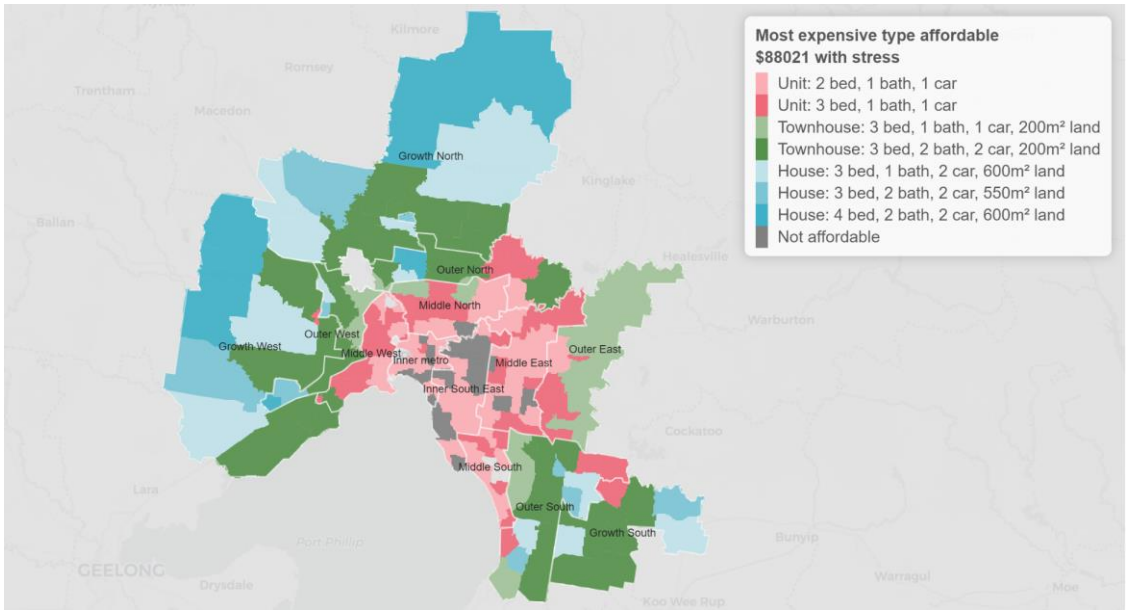
We compared the affordability outcome of 10% higher prices in growth areas for a household earning $88,021 (Figure C5 and C6), with the baseline scenario (Figures 3A and 3B). As expected, this reduces the affordability of our 7 home types in growth areas. This household could have bought a detached house in fewer places in the growth areas, and the size of the home they could buy is often smaller.

Figure C5: Homebuying options for a household earning $88,021, without housing stress, with 10% higher prices for growth area homes



Source: Infrastructure Victoria

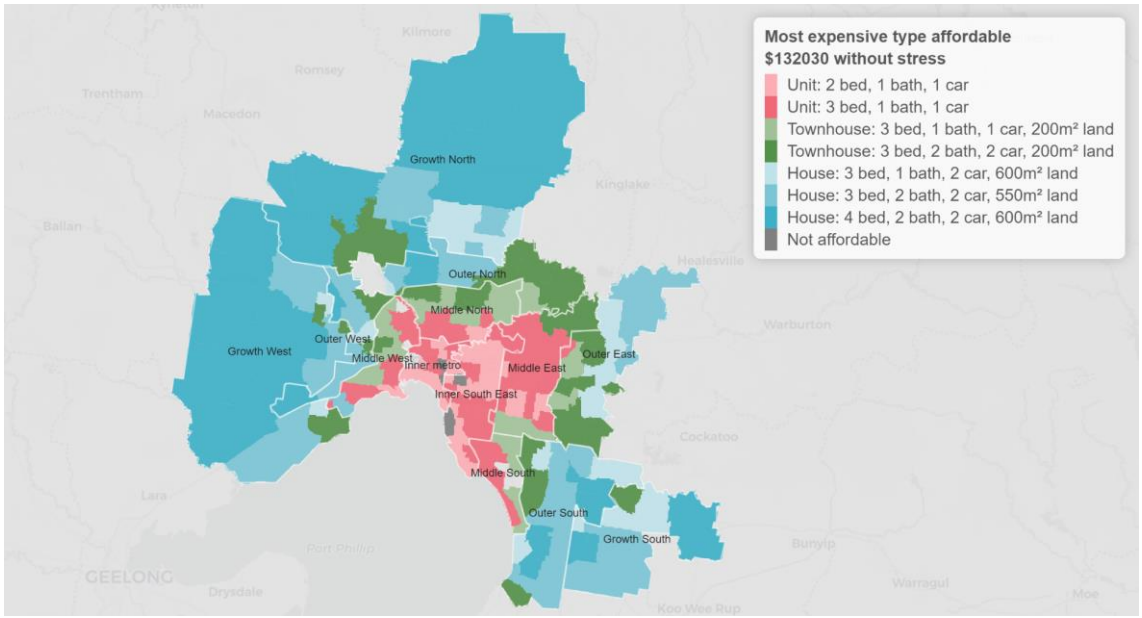
Figure C6: Homebuying options for a household earning $88,021, with housing stress, with 10% higher prices for growth area homes



Source: Infrastructure Victoria

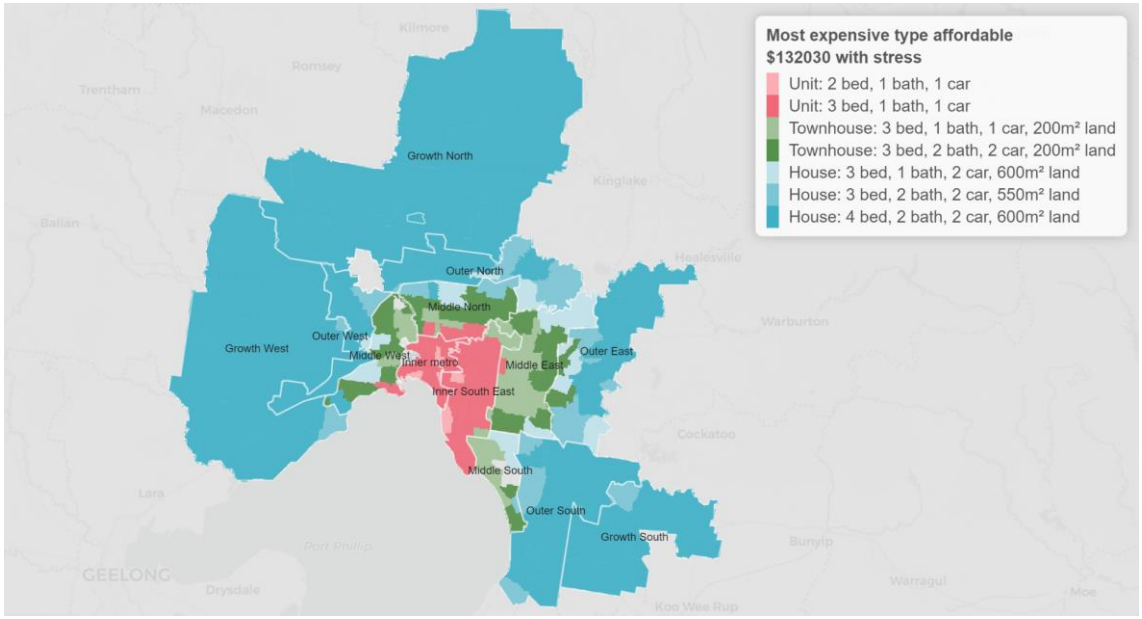
For a household earning $132,020, the general results are similar. They can buy large homes in fewer places. In some places where this household could buy a detached home in the baseline scenario, they could now only afford a townhouse. Even if they stretched to their borrowing limit, they could now only afford a 3-bedroom home in some growth suburbs where they could afford a 4-bedroom home in the baseline scenario.

Figure C7: Homebuying options for a household earning $132,030, without housing stress, with 10% higher prices for growth area homes



Source: Infrastructure Victoria

Figure C8: Homebuying options for a household earning $132,030, with housing stress, with 10% higher prices for growth area homes



Source: Infrastructure Victoria

In summary, if we assume 10% lower prices for townhouses and units in established areas in Melbourne, the homebuying options for moderate income households would improve in some places. Specifically, a household earning $88,021 could afford an average-priced 2-bedroom or 3-bedroom unit in some inner suburbs where they could not previously. They could also afford a townhouse in a few middle suburbs.

At the higher end of the moderate income range, a household earning $132,020 would also have a slight improvement in their affordable home options. In a scenario where established area townhouses and apartment are 10% cheaper, this household could afford to buy one of our 7 home types in more inner areas, including more suburbs where an average-priced 3-bedroom unit is affordable. They could similarly afford a townhouse in more inner suburbs.

In a scenario where growth area homes had 10% higher prices, the effects were more severe for lower-income households. A household earning $88,021 could afford a detached home in fewer places and could only afford a smaller home in many growth suburbs compared with the lower-priced baseline scenario.

Table C3: Homebuying options for a household earning $88,021, with 10% higher prices for growth area homes, by spatial zone

Spatial zone	Most expensive type affordable $88021 without stress		Most expensive type affordable $88021 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Growth west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Inner south east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Middle east	Not affordable	Unit: 2 bed, 1 bath, 1 car	Not affordable	Unit: 3 bed, 1 bath, 1 car
Middle north	Not affordable	Unit: 3 bed, 1 bath, 1 car	Not affordable	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle south	Not affordable	Unit: 2 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car
Middle west	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land
Outer east	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Outer north	Not affordable	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 2 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land
Outer west	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Table C4: Homebuying options for a household earning $132,030, with 10% higher prices for growth area homes, by spatial zone

Spatial zone	Most expensive type affordable $132030 without stress		Most expensive type affordable $132030 with stress	
	Everywhere	Anywhere	Everywhere	Anywhere
Growth north	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Growth west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Inner metro	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Unit: 3 bed, 1 bath, 1 car
Inner south east	Not affordable	Unit: 3 bed, 1 bath, 1 car	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land
Middle east	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 1 bath, 2 car, 600m² land
Middle north	Unit: 2 bed, 1 bath, 1 car	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Middle south	Unit: 3 bed, 1 bath, 1 car	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 3 bed, 2 bath, 2 car, 550m² land
Middle west	Unit: 2 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land	Unit: 3 bed, 1 bath, 1 car	House: 4 bed, 2 bath, 2 car, 600m² land
Outer east	Unit: 3 bed, 1 bath, 1 car	House: 3 bed, 2 bath, 2 car, 550m² land	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer north	Townhouse: 3 bed, 1 bath, 1 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer south	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 2 bath, 2 car, 550m² land	House: 4 bed, 2 bath, 2 car, 600m² land
Outer west	Townhouse: 3 bed, 2 bath, 2 car, 200m² land	House: 4 bed, 2 bath, 2 car, 600m² land	House: 3 bed, 1 bath, 2 car, 600m² land	House: 4 bed, 2 bath, 2 car, 600m² land

Source: Infrastructure Victoria

Appendix D. Summary information of data set by inner, middle, outer and growth areas

Table D4: Model variables and descriptive statistics by inner, middle, outer and growth areas for houses

Variable	Inner			Middle			Outer			Growth		
	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation
Property sale price (AU$ '000)	1900.0	2305.8	1527.6	1115.0	1212.8	502.9	700.0	753.3	261.7	600.0	630.5	210.6
Number of bedrooms	4.0	3.6	0.9	3.0	3.4	0.8	3.0	3.5	0.7	4.0	3.6	0.7
Number of bathrooms	2.0	2.0	0.9	2.0	1.7	0.8	2.0	1.7	0.6	2.0	1.9	0.5
Number of car spaces	2.0	2.0	1.1	2.0	2.0	1.1	2.0	2.1	1.2	2.0	2.1	1.0
Land area (m^2)	600.0	580.0	289.0	595.0	613.0	378.0	643.0	704.0	391.0	570.0	601.0	333.0
Floor area (m^2)	177.0	190.0	82.1	158.0	172.0	70.6	163.0	180.0	73.7	194.0	204.0	83.1
Distance to city centre (km)	10.4	10.2	4.1	14.2	14.5	6.0	27.1	27.5	8.4	33.7	33.3	10.5
Nearest distance to metro train station (km)	1.0	1.3	1.0	1.4	1.7	1.3	2.0	2.3	1.4	2.8	4.6	4.9
Nearest distance to hospital (km)	1.4	1.6	0.9	2.0	2.6	2.0	3.4	3.9	2.5	4.3	5.8	4.5
Nearest distance to metropolitan activity centre (km)	8.9	9.3	4.0	6.7	6.8	3.0	5.1	6.2	4.2	9.8	10.6	5.3
Nearest distance to major activity centre (km)	1.4	1.6	0.9	1.7	1.8	0.9	2.2	2.5	1.4	2.1	2.2	1.3

Variable	Inner			Middle			Outer			Growth		
	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation
Nearest distance to cemetery (km)	2.6	2.6	1.1	2.7	3.1	1.7	3.9	4.0	1.9	3.9	4.3	2.5
Nearest distance to landfill (km)	11.2	10.8	3.7	8.0	9.3	5.5	6.2	8.0	5.5	9.8	11.0	6.7
Nearest distance to secondary school (km)	0.7	0.7	0.4	0.9	1.0	0.6	0.9	1.0	0.5	1.0	1.1	0.9
Nearest distance to police station (km)	1.8	1.9	0.9	2.0	2.0	0.9	2.3	2.4	1.1	3.0	3.2	1.7
Nearest distance to tram stops (km)	0.7	1.4	1.7	2.8	4.0	4.3	11.8	13.9	8.3	23.2	21.9	8.2
Nearest distance to arterial road (km)	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.5	0.4	0.7	0.9	0.7

Source: Infrastructure Victoria

Table D2: Model variables and descriptive statistics by inner, middle, outer and growth areas for townhouses

Variable	Inner			Middle			Outer			Growth		
	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation
Property sale price (AU$ '000)	1239.9	1298.4	471.8	800.0	843.0	259.4	590.0	598.0	187.1	465.0	476.9	120.5
Number of bedrooms	3.0	3.1	0.7	3.0	2.9	0.7	3.0	2.8	0.6	3.0	2.9	0.6
Number of bathrooms	2.0	2.1	0.7	2.0	1.9	0.7	2.0	1.8	0.6	2.0	1.9	0.5
Number of car spaces	2.0	1.7	0.6	2.0	1.6	0.6	2.0	1.5	0.6	2.0	1.6	0.6
Land area (m^2)	242.0	250.0	124.4	191.0	212.0	107.9	186.0	203.0	91.3	171.0	183.0	74.7
Distance to city centre (km)	11.8	11.0	4.6	12.7	13.8	5.8	26.0	25.4	7.7	25.4	29.8	10.5
Nearest distance to metro train station (km)	1.0	1.3	1.0	1.1	1.4	1.1	1.3	1.8	1.4	2.8	3.1	2.6
Nearest distance to hospital (km)	1.5	1.6	0.9	1.9	2.4	2.0	2.8	3.5	2.5	4.5	5.6	4.0
Nearest distance to metropolitan activity centre (km)	10.2	10.0	4.4	6.4	6.6	3.2	4.4	5.0	3.3	9.6	10.3	4.8
Nearest distance to major activity centre (km)	1.3	1.5	0.8	1.5	1.7	0.9	2.2	2.4	1.5	2.0	2.1	1.1
Nearest distance to cemetery (km)	2.6	2.6	1.1	2.6	2.9	1.5	3.8	3.9	2.1	4.5	4.7	2.5
Nearest distance to landfill (km)	9.0	9.5	3.9	7.7	8.7	5.0	6.1	7.6	5.0	11.0	12.2	6.3
Nearest distance to secondary school (km)	0.7	0.8	0.4	0.9	0.9	0.5	0.8	0.9	0.5	1.0	1.1	0.7
Nearest distance to police station (km)	1.7	1.9	0.9	2.0	2.0	1.0	2.0	2.1	1.2	3.0	3.1	1.5

Variable	Inner			Middle			Outer			Growth		
	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation
Nearest distance to tram stops (km)	1.1	1.8	1.9	2.6	3.9	4.2	9.7	11.5	7.2	16.1	18.1	8.8
Nearest distance to arterial road (km)	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.6	0.8	0.7

Table D3: Model variables and descriptive statistics by inner, middle, outer and growth areas for Unit

Variable	Inner			Middle			Outer			Growth		
	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation
Property sale price (AU$ '000)	590.0	693.9	531.2	545.0	577.6	262.6	475.0	494.3	163.1	395.0	409.5	159.6
Number of bedrooms	2.0	1.8	0.6	2.0	2.0	0.7	2.0	2.3	0.6	2.0	2.4	0.6
Number of bathrooms	1.0	1.3	0.5	1.0	1.3	0.5	1.0	1.3	0.5	1.0	1.4	0.5
Number of car spaces	1.0	1.0	0.6	1.0	1.2	0.5	1.0	1.3	0.6	1.0	1.2	0.5
Distance to city centre (km)	5.0	6.0	4.4	12.3	12.9	6.6	27.3	27.4	7.7	36.3	35.2	10.7
Nearest distance to metro train station (km)	0.7	0.9	0.8	0.8	1.1	1.0	1.2	1.6	1.4	2.4	4.7	5.7
Nearest distance to hospital (km)	1.3	1.4	0.8	1.8	2.3	2.0	2.6	3.3	2.4	3.7	5.9	5.3
Nearest distance to metropolitan activity centre (km)	8.4	8.4	3.1	6.7	6.7	3.5	4.4	4.9	3.7	9.8	11.1	6.1

Variable	Inner			Middle			Outer			Growth		
	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median	Mean	Standard Deviation
Nearest distance to major activity centre (km)	0.9	1.0	0.6	1.3	1.5	1.0	2.2	2.4	1.5	1.7	1.9	1.5
Nearest distance to cemetery (km)	2.7	2.7	1.1	2.7	3.0	1.7	3.5	3.9	2.2	2.7	3.4	2.5
Nearest distance to landfill (km)	11.8	11.4	2.6	8.4	9.3	4.8	6.3	7.5	4.7	13.5	12.4	7.1
Nearest distance to secondary school (km)	0.5	0.6	0.4	0.8	0.9	0.5	0.8	0.9	0.5	0.9	1.0	0.6
Nearest distance to police station (km)	1.2	1.3	0.8	1.6	1.7	0.9	1.9	2.0	1.2	2.5	2.6	1.6
Nearest distance to tram stops (km)	0.2	0.6	1.1	1.9	3.5	4.5	11.2	13.2	8.0	25.0	23.3	8.6
Nearest distance to arterial road (km)	0.1	0.2	0.2	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.6	0.7

Endnotes

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