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NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

Big city life?

Challenges and trade-offs for Auckland city

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About NZIER

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Authorship

This paper was prepared at NZIER by Dr. Kirdan Lees. It was quality approved by John Ballingall.

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Context for this report

Auckland is on the move. Economic growth is outpacing most regions and people continue to flow into the city. This is putting pressure on the shape of Auckland city and the form of housing and transport infrastructure. So it's not surprising that Auckland is revising its planning for the city.

We were asked by three clients, Treasury, the Ministry of Transport and the Reserve Bank of New Zealand to:

1. Help inform debate by comparing Auckland to Australian cities, leveraging existing work.
2. Use a simple economic structure as a starting point to illuminate the trade-offs from improving transport infrastructure, lifting construction productivity and extending the urban limit.
3. Identify touch points for future specialised study likely to provide the most impact.

Key points

A surging Auckland provides opportunities and challenges

- Auckland has the opportunity to become a big, globally connected city from where New Zealand firms can grow generating and adapting new ideas and selling these ideas to the world. Auckland is set to grow fast.
- But the very growth that helps power the Auckland economy challenges how we live, through rising housing costs and longer commutes.
- Policymakers can use a suite of policies such as providing better transport infrastructure, improving construction productivity and lifting the supply of well-located land to improve outcomes – making Auckland a great place to live and lifting economic growth.
- Understanding how these policies affect economic and social outcomes needs a clear analytical framework. We present one framework, a monocentric model where all employment is located in the CBD, that focuses on the big picture trade-offs that arise from where families choose to locate.

Auckland's geography intensifies demands on well-located land

- Auckland's twin harbours – Manukau and the Waitemata – make Auckland very narrow relative to most cities including our Australian peers.
- Compared to other cities of the same population size that means Auckland will experience more intense demand for land close to the city centre.
- Narrow geography means Auckland cannot sustain a much larger population without sacrificing living standards under current policy settings.
- That heightens the need to get infrastructure and other urban policies right to provide outcomes comparable to other similar big cities.

Rising incomes and growing populations shape the city in different ways

- Auckland's population growth and income growth will outpace the rest of New Zealand.
- Population growth is expected to push Auckland city to two million people by 2031. That increases demand for well-located land, pushing up the cost of housing. Expect smaller houses and density to intensify.
- Incomes are set to grow too – per capita real income hits $119,000 by 2031 – but this has a different impact. On its own, income growth incentivises families to use relatively cheaper land further out from the city to build bigger houses.

Better transport infrastructure reduces housing costs

- Commuting to work in the city imposes a cost on moving to the suburbs. Each kilometre away from the city centre increases the cost of the commute by a chunky $738 dollars a year according to our calculations.

- When transport infrastructure improves, all else equal, the supply of well-located land increases and the price of land falls everywhere.
- Families can either move to the suburbs, taking advantage of bigger homes built with the additional well-located land, or stay put and benefit from cheaper rents since the price of land is now lower in the central city.
- Financing transport infrastructure improvements is costly. Over time, such changes transform land use promoting improved housing outcomes. The business case for new infrastructure needs to include this transformation.

Lifting building productivity improves outcomes – expect larger houses

- Building a house in New Zealand is more costly than building a similar size home in Australia. That suggests the possibility of unlocking productivity improvement.
- If housing productivity was 15 percent higher families would be 1.4 percent better off mostly through bigger or better located housing.

Extending the Metropolitan Urban Limit will lift welfare significantly

- We show the current Metropolitan Urban Limit (MUL) constrains the availability of well-located land and pushes up house prices.
- Moving the MUL out improves land supply and decreases housing costs. Families across the city benefit from reduced housing costs – even though commuting costs increase for some. The net impact on all families from expanding the MUL is always positive.
- The benefits can be material. Within our framework and set of assumptions on the cost of commuting and housing, extending the amount of land available by 22 percent makes each family a chunky $860 a year better off – including their transport costs.

Using many policy levers makes for better outcomes

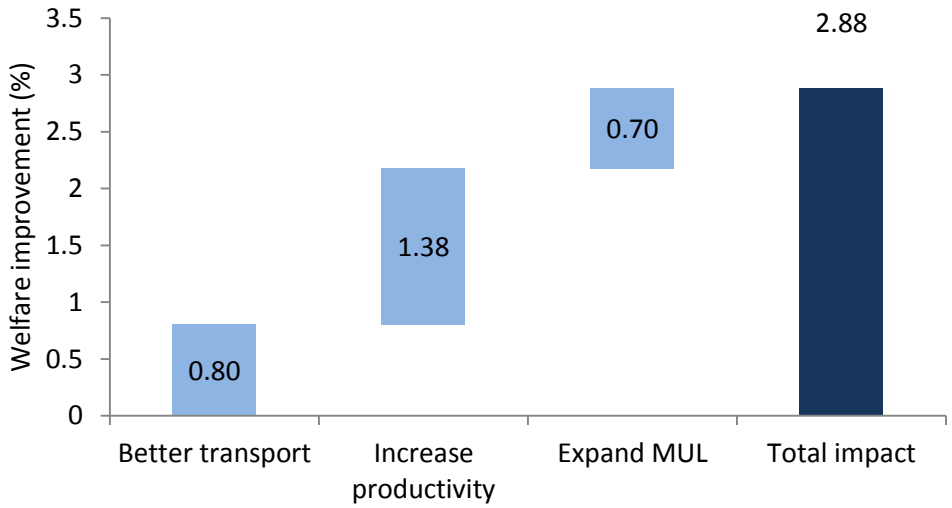
- Policy settings need to adjust and respond to population growth and rising incomes that impact on the city shape in different ways.
- Some policies are easier to implement than others. We might expect to have picked the low-hanging fruit for efficient, low cost transport infrastructure projects. But a careful assessment of the trade-offs across policy options needs to account for interactions between housing and transport.
- Figure 1 shows the impact of three key policy changes:

    1. a 2 percent improvement in transport infrastructure
    2. a 15 percent increase in housing construction productivity
    3. a 22 percent increase in land area within the MUL.

  Some policy interventions may prove less costly than other interventions.
- Adjustment along many dimensions, including transport infrastructure, produces better outcomes rather than just using a single policy lever.

Figure 1 Marginal impact of key policy levers on family welfare

Improvement over policy status quo



Source: NZIER

Policy adjustment is needed to get Auckland humming

- A thriving Auckland needs to provide people with well-located land that allows people the opportunity to work within or close to the city centre that drives Auckland's growth.
- Policymakers have generally identified the right set of levers – extending the urban boundary, reducing urban planning restrictions and improving productivity in the housing sector. Continuing to look closely at the costs of imposing height restrictions will also help.
- But the facilitating role of transport infrastructure – both public and private – means there appear to be opportunities to make housing cheaper.
- Auckland's rapid population growth and challenging geography suggest coordinated adjustments across a number of policies are needed to deliver a world-class city to live and to work.

A role for further research

- Our work uses a single spatial framework that helps isolates the trade-offs across a range of policies. Extending the range of policies to include the impact of height restrictions would be a useful exercise.
- Testing the implications of these policies in extensions to the model would make policy advice more robust.
- Our analysis suggests extending the model to accommodate a polycentric city where employment occurs at many locations within the city looks like a prime candidate for enriching our framework.
- Auckland's strong migration inflows are dependent on Auckland's high desirability as a place to live and work. Allowing for populations to choose across cities with better employment opportunities, cheaper houses and better commuting flows would be a useful extension to our work.

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1. Introduction

Building a city that provides a great place to live and work

Cities are attractive to many firms since they provide the opportunity to sell into a market where firms cluster together, scale up and share ideas to fuel economic growth.

To attract the right people cities need to provide families with a desirable place to live and a desirable place to live not too far from work.

Auckland probably has the scale to grow into a more globally competitive city. But Auckland faces two key challenges: rapid population growth and a narrow geography, limited by Auckland's twin harbours, reducing the availability of well-located land close to the city.

These challenges bite more for Auckland than other cities. Australia's coastal cities also face land constraints, but these constraints are not as extreme. Land availability should constrain our aspirations for shorter commuting times and better housing outcomes. Equally we should not be surprised at the intensity of debate.

But conversely, the geography that makes it more difficult to build a liveable city heightens the gains from policies that improve Auckland's urban structure. The benefit from relaxing these constraints, through good urban planning and policy, is likely to be higher than for other cities. Good planning can mitigate the problems that dominate residents' thoughts: soaring house prices, stultifying commuting times, and increasing angst about building higher in the inner-city.

Those soaring house prices

The cost and location of housing are critical factors in providing families with an attractive place to live and work.

Many demand factors have increased the cost of housing in New Zealand such as:

- cheap and widespread access to credit
- increasing population
- favourable tax treatment of housing relative to other assets
- changing demographics.

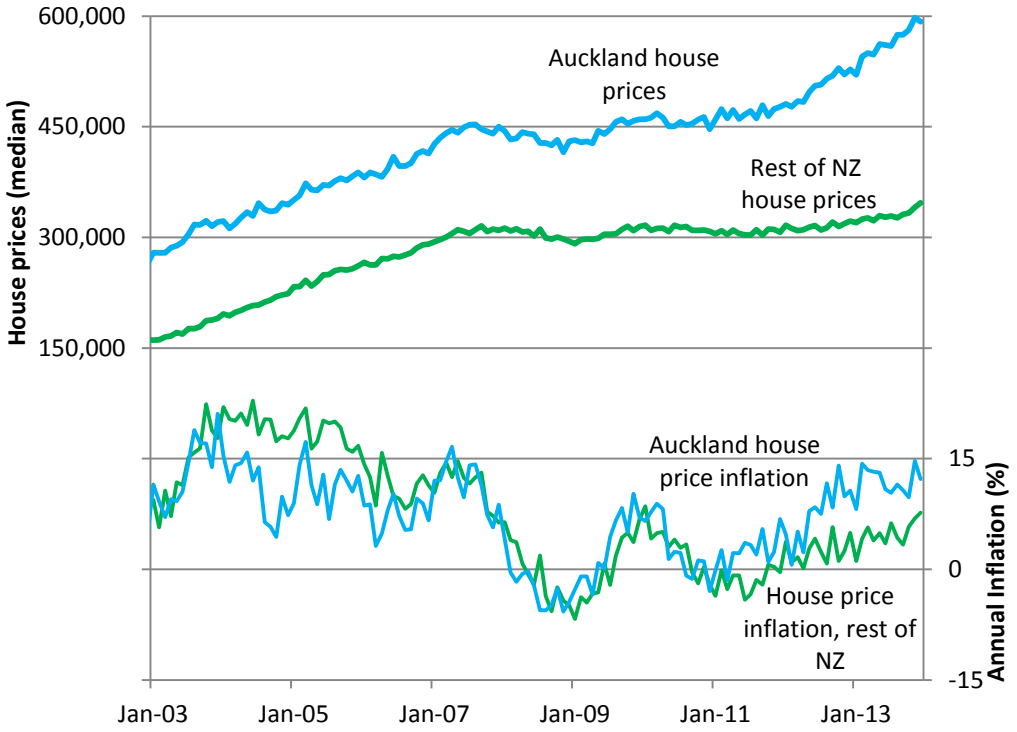
But there are supply-side issues that clearly matter too, including:

- the availability of land within the urban limit
- planning requirements that restrict the height of new buildings
- increasing regulation and the availability of financing for new construction.

House prices grew strongly in Auckland and the rest of New Zealand across the mid-2000s (see Figure 2). But after the Global Financial Crisis, growth in Auckland house prices has outstripped the rest of New Zealand.

Figure 2 Auckland house prices outpace the rest of New Zealand

REINZ, median monthly house prices weighted by sales



Source: REINZ

Auckland specific factors are likely to be important. Other researchers suggest that supply factors have driven up house prices pointing to urban planning restrictions.[1]

That drive time commute

Efficient transport infrastructure can help mitigate commuting costs. We highlight just how improvement in transport infrastructure can help determine the costs and quantity of well-located housing. Quality transport infrastructure has the potential to change how land is used. Many city problems – including soaring house prices – are influenced by quality transport infrastructure.[2]

Although not all work in Auckland is located in the city centre, families like well-located land that is close to the CBD. That reduces time spent commuting. So the price of land is higher closer to the city centre reflecting lower commuting costs that can also be reflected in wages.

1 See Grimes and Liang (2007) for example.

2 See Coleman (2010) who discusses the development of Auckland's motorway, Lowe (2013) and Kulish et al. (2012) who articulate the case to free up well-located land in Australia's main cities and Zheng and Kockelman (2013) who discuss urban sprawl in relation to two policies – congestion charges and urban boundaries.

How economics can help provide the big picture framework

High house prices and traffic congestion work against Auckland attracting productive capital and people to New Zealand. These factors matter for productivity: not just for Auckland but to help drive New Zealand's productivity.[3] And population pressures have only just begun – Auckland needs to plan for 500,000 new residents in the next 20 years.[4]

Economics can help frame alternative policies by using a number of different scenarios in a model that examines trade-offs. To do this we need a model that is simple enough to provide tractable outcomes but also sufficiently rich to capture the key aspects of the structure of cities. Any model needs to account for how families respond to different policies and prices and then allow these responses to in turn influence prices.

[3] See Skilling (2013) for example and Moretti (2003) who argues increasing human capital within cities has higher returns than the private returns to individuals.

[4] See Statistics New Zealand's Auckland local board population projections, November 2012.

2. Our simple economic model

Introducing the Alonso-Muth-Mills model

Our framework is a simple spatial model, the Alonso-Muth-Mills model, which draws out the key features of a city including the location, size and cost of housing within a city circle (see the Appendix for the mathematical outline).

The model begins with families who like consuming goods, living in better houses and favour living close to the city to reduce commuting time for family members that work in the city centre. Families budget income across these goods and activities.

When choosing where to live these families trade-off lower commuting times against bigger and better homes that are available in the suburbs. All families are identical and adjust behaviour like where to locate until no family has an incentive to change behaviour or location in response to the market price of housing. Families are indifferent between smaller houses located in the city centre and larger houses located in the suburbs.

Commercial firms are located in the city centre and housing developers build houses putting together capital and land. Developers bid up land closer to the city centre that can be rented at a higher price than the same sized plot in a location further out from the city centre. These developers rent housing back to the families (for simplicity, the developers are assumed to live out of town).

Land close to the city is more expensive, driving up the cost of housing but also increasing the height of dwellings and apartments close to the city-centre because of the need to increase yield. The extent of traffic infrastructure, the metropolitan urban limit and the relative value of land inside and outside the city boundary also help determine the size of the city.[5]

Putting together the firms, families and developers allows us to describe the city structure with a range of variables and trade-offs:

- the cost of a unit of housing (square metre) relative to costs in the city centre
- the cost of a unit of land relative to distance to the city centre
- the size of each house relative to distance to the city centre
- the average commuting time relative to distance to the city centre
- population density relative to distance to the city centre
- building height relative to distance to the city centre.

But first we need to define a range of inputs or parameters that include:

- how much each family prefers housing relative to consumption goods
- the cost to each family of commuting (including time cost)
- how efficiently developers transform capital and land into housing
- how much income each family earns
- the average commuting time relative to distance to the city centre
- the alternative use of urban land such as agricultural activity.

[5] Grimes and Liang (2007) show that Auckland's Metropolitan Urban Limit binds, impacting on prices.

Why this model over other approaches?

The Alonso-Muth-Mills model has a long history and stands as the workhorse model for urban planning.[6] The model is simple and abstracts from particular features of some cities. While simple, many researchers show that the insights from this model can explain the main features of most cities.

McDonald and McMillen (2007) review some of the evidence from US cities. Focussing on the 25 largest US cities in 2000, they show that one of the key implications of the model – that density decreases from the city centre – holds for all 25 cities.

However, while distance from the city centre is a significant driver of density, distance alone cannot explain all the variation in population density – additional factors are required.

Brueckner and Fansler (1983) show that extending the model to allow for commuting costs and adjusting for the agricultural value of land (that helps define the urban boundary) massively improves the model's ability to explain the size of cities.

Other economists test the model against a range of cities. For example, Brueckner (1987) and Kulish, Richards and Gillitzer (2012) look at Australia, Spivey (2008) shows how the model captures the structure of US cities while Verhetsel et al. (2010) shows the model explains much of Belgian city structures.

The model is also used by three Australian economists from the Reserve Bank of Australia to identify the key factors that drive the structure of Australian cities. Their work (Kulish, Richards and Gillitzer, 2012) provides a direct comparison with Australian cities as context for any study of Auckland using the model.

Kulish, Richards and Gillitzer (2012) argue that policies that were optimal at one point in time might prove far from optimal as population grows. They show extending an urban limit helps mitigate the impact of rising house prices considerably and that the increase in the urban limit that offsets population growth is quite small – at least for the case of increasing the size of an Australian city from two million to four million.

Can we apply the model to Auckland?

The model is simple and will not capture many real world features. For example, density and house prices for some suburbs are determined by localised amenity values such as schools and parks and beaches or views. We can't capture everything that drives urban structure.

The model's simplicity is incredibly useful. The simplicity helps tease out how families respond to different scenarios and trade-offs and how these responses in turn influence the structure of the city under a range of different policies and scenarios. Conclusions from the model are accessible so that the rationale for policies is well understood.

Before turning to the scenarios we see whether Auckland displays some of the features the Alonso-Muth-Mills model suggests. We take a closer look at the predictions of the model for density, housing costs and the location of employment.

A closer look at density

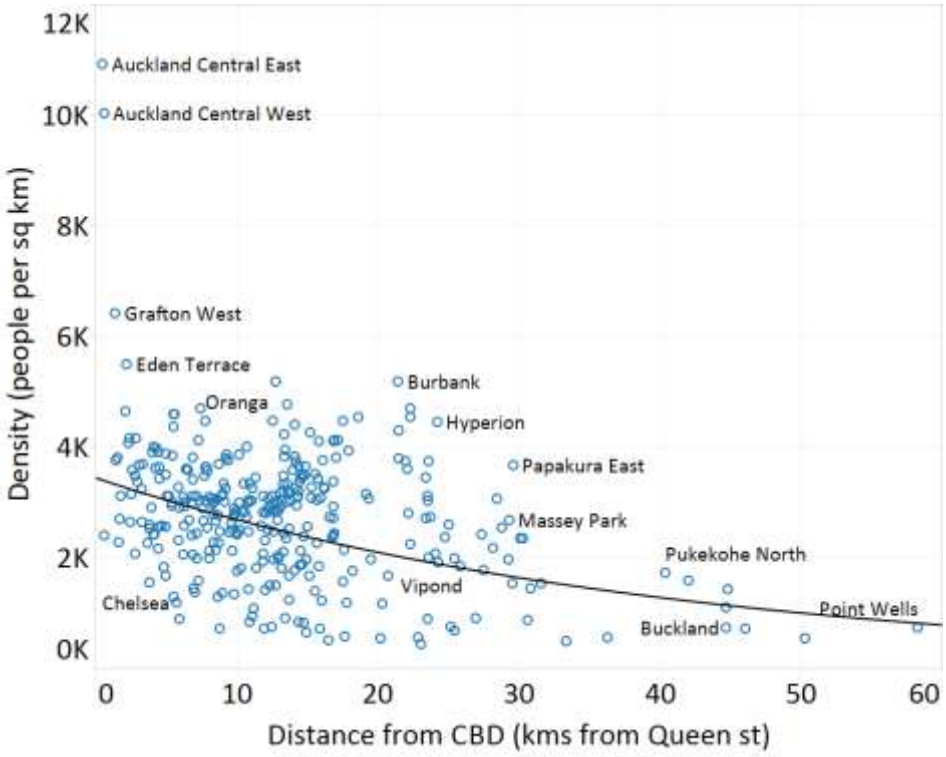
[6] See the original papers Alonso (1964), Mills (1967) and Muth (1969) and Brueckner and Fansler (1983), Brueckner (1987), Bertaud and Brueckner (2004), McDonald and McMillen (2007) and Kulish et al. (2012) for applications using the framework.

One of the key predictions of the model is that density declines with distance to the city centre. To test that prediction, we calculate density for each suburb within Auckland and map density against the distance from the city centre.[7]

Figure 3 shows that density declines as distance from the city increases. We also run simple econometric tests that show distance and the square of density are both significant predictors of density – matching one key prediction from the model.

Figure 3 Density declines as distance to the city centre increases

Population density using *Statistics New Zealand* Census 2013



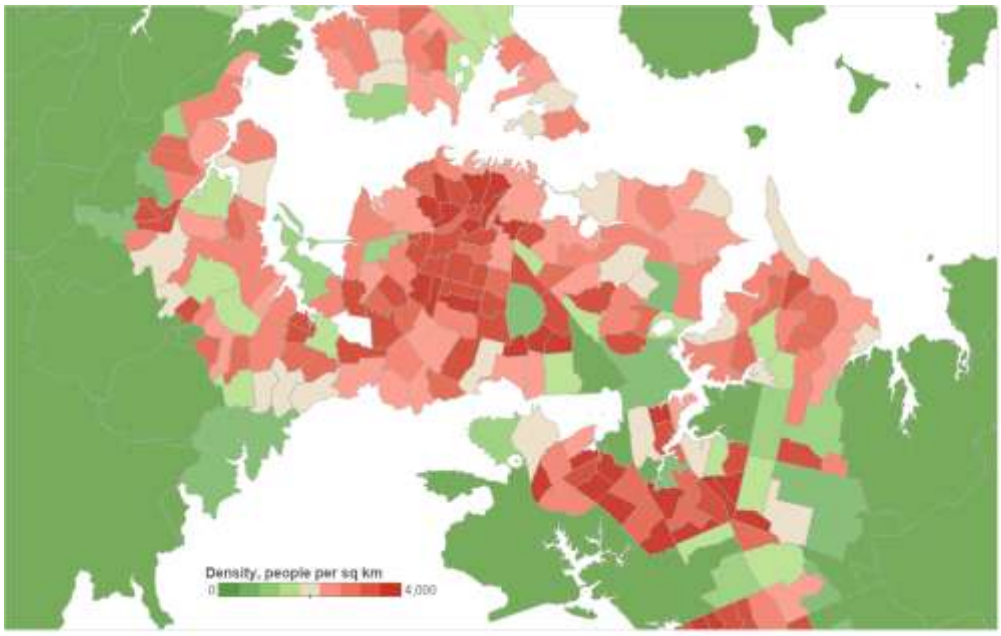
Source: NZIER, Statistics New Zealand

But while distance is significant, the scatterplot in Figure 3 shows many suburbs that don't fit with the predictions of distance alone. Distance only explains about one-third of the variation in density.

Auckland's geography must be at least partly responsible. Figure 4 shows a heat map of density. Urban corridors help support higher populations while some coastal areas also have more people per square kilometre.

[7] We use population data from Statistics New Zealand's 2013 Census and calculate density for each area unit. We measure distance using the centre point of each area unit to the bottom of Queen St, as the crow flies, as our measure of distance to the city centre.

Figure 4 Coastal areas supported by urban corridors are more intensely populated



Source: NZIER

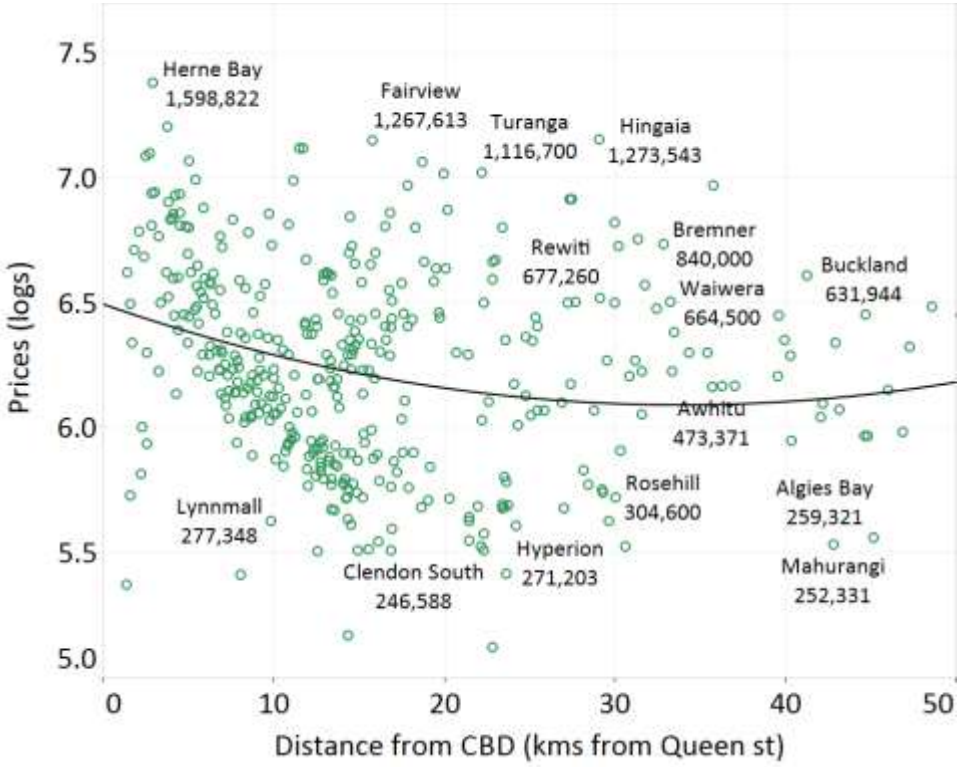
What about housing costs?

Our Alonso-Muth-Mills model predicts that the cost of housing will fall as distance to the city centre increases. But we need to tread carefully. The model predicts that the cost of renting housing per unit of housing (a square metre for example) declines with distance from the city centre since land is cheaper.

The model also predicts that the *size* of houses rises as distance from the city centre rises. Since house prices are a function of both the size and price per unit of housing, the price of a house can increase or decrease by distance from the city centre.

Figure 5 shows that Auckland house prices generally decline by distance from the city centre. Since we know that house sizes in the suburbs are larger than in the city centre we know the unit price of housing is probably falling.

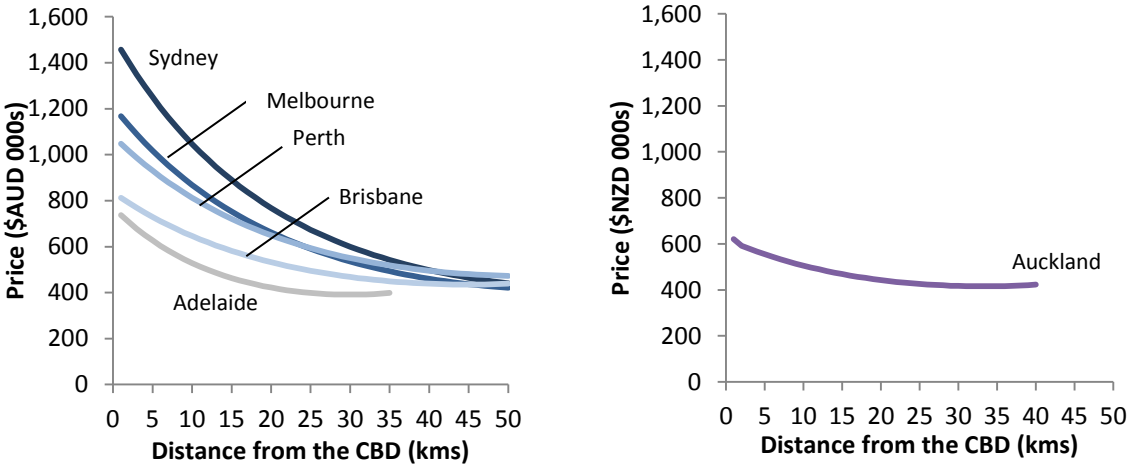
Figure 5 House prices decline as distance to the city centre increases



Source: NZIER, Statistics New Zealand

That pattern of activity roughly matches housing costs in the big six Australian cities. House prices consistently decline as distance to the CBD increases (see Figure 6).

Figure 6 Auckland prices decline more slowly than Australia



Source: Kulish et al. (2012), NZIER, Statistics New Zealand

Our results are comparable to the Kulish et. al (2012) Australian story although the decline in house prices is flatter for Auckland than the Australian cities, at least partly reflecting Auckland's smaller population.

Employment location

One of the assumptions of the modelling framework is that all employment occurs in the city centre. All workers are assumed to move into the city and commute home in the evening. Figure 7 shows that although employment spikes in the city centre – more than 60,000 people work in the core three CBD suburbs (Auckland Central East, Auckland Central West and Auckland Harbourside) but that leaves many places of work outside the CBD.

Figure 7 Auckland has employment concentrations outside the CBD

Number of workers by area unit, 2006 census

Source: Statistics New Zealand

Much of the employment is evenly spread across the city suburbs. But some centres of activity are located in the suburbs including Takapuna, North Harbour, Mt. Wellington and Manurewa, at least partly due to Auckland's four historic districts and partly due to amenity values like schools and beaches (see Coleman et al. 2011). .

How much should we worry about this? Our model assumes that *all* workers commute into the city so at a high level the model is at odds with the distribution of jobs across Auckland. The slow decay in the price of land as distance from the city centre increases, averages between a world with high benefits of locating close to the city centre, and a world with high benefits from locating to polycentric hubs of activity.

But the polycentric nodes in Figure 7 might matter. Hamilton (1982) shows that the Alonso-Muth-Mills model fails to explain the majority of commuting time in US and Japanese metropolitan areas. But other researchers find much more moderate implications from using a monocentric model to explain commuting times.[8]

Polycentric nodes mean our model might overstate commuting costs and limit the intensity of demand for well-located land close to the city.

[8] See Cropper and Gordon (1991) and Small and Song (1992).

Fujita and Ogawa (1982) build a polycentric model that allows *both* firms and households to choose where they located in the city. That model is very complex, difficult to solve and contains multi-equilibria – where more than one set of location points for households and firms balances the city. Then we need to decide *which* set of location points to evaluate policy over. Richer models come at a cost – complexity.

Other model extensions include making population flows to and out of Auckland respond to the quality of transport infrastructure (for example, see Duranton and Turner 2012 or the monocentric model of Desmet and Rossi-Hansberg 2013). But such an exercise requires modelling cities that compete with Auckland in addition to Auckland itself.

So we are approximating a rich reality – that includes polycentric centres of activity – with a simple model. Future work could useful test our results in a model that incorporate polycentric nodes of activity. Careful analysis could be used to inform planning that encourages polycentric centres.

First steps – calibrating our model to Auckland

Before modelling how the city responds to changing population and income, we need to calibrate our model to Auckland conditions.

We match the size of the city to the area within Auckland's Metropolitan Urban Limit – 577 km^2. Then we impose that Auckland's twin harbours mean only 2 radians or a little over a third of the sector of a circle are available for housing construction. For comparison three radians or almost one-half of the city is available for construction for Australian cities (see Kulish et al. 2012, for example).

That makes the city limits 22 kilometres from the CBD. So our model city is roughly constrained at Silverdale in the north and Manurewa in the south. While 1,415,550 people live in the greater Auckland region, we work with a population of 1,300,000 within the Metropolitan Urban Limit.

One of the key parameters is the annual income of each family that constrains purchases of consumer goods and funds the amount spent on rent. We use the median Auckland family income from the 2013 Census – $76,500 for all families.

To match expenditure on housing, we use the regional data from Statistics New Zealand's June 2013 Household Economic Survey to reveal how much Auckland families are prepared to pay for housing services. Housing makes up 18.4 percent of our consumption basket – a little higher than the case of Australia.

To calibrate the costs of transport per kilometre we first calculate the opportunity cost of time and then calibrate the per kilometre cost of operating a vehicle using the Inland Revenue Department's allowance for tax purposes – $0.77 per kilometre.

Table 1 lays out the assumptions we make to get yearly per kilometre commuting costs. We start with the time opportunity cost that we relate back to the hourly wage of each worker ($30.80) consistent with income per household ($76,500).

Many papers work with the assumption that the opportunity cost of time spent commuting is 60 percent of the hourly wage and we use that assumption here. Based on recent work (Wallis and Lupton, 2013) we use their estimate of average traffic flow of 44.1 kilometres an hour – slightly lower than the 50 kilometres an hour used by Kulish et al (2012). That makes the time cost of travel $0.42 a kilometre.

Adding in the operational cost ($0.77) and doubling the costs to include the return journey makes the commuting cost per worker per day per kilometre $2.39. Under our assumption of 1.35 workers per household and 230 work days per year, each families per annum costs are $738 for each kilometre of the commute.[9] Next we turn to our first question – what happens when geography constrains outcomes?

Table 1 Calibrating transport costs

Description	Parameter	Source	Australian calibration (2011)	Other points of comparison
Income per household	$76,500	2013 Census	AUD $70,000	
Workers per household	1.35	Kulish et al (2012)	1.35	
Income per worker	$56,666		$51,851	LEED Auckland Median earnings: $57,350
Work hours per day	8	Assumption	8	
Work days per year	230	Yearly work days (250) – 4 week holiday	240	
Hours per worker per year	1,840		1,920	
Hour per household per year	2,484		2,592	
Effective hourly wage rate	$30.80		$A 25.30	
Opportunity cost of travel	60% of wage	Assumption	60% of wage	
Time cost of travel per hour	$18.48		$A 15.18	NZTA Economic Evaluation manual $21.063
Kilometres per hour	44.1	Wallis and Lupton (2013)	50	
Time cost of travel per kilometre	$0.42		$A 0.30	
Operating cost of travel per kilometre	$0.77	Inland Revenue Department	$A 0.67	
Costs per km per day	$2.39		$A 1.94	
Costs per km per household per year	$738		$A 628	

Source: NZIER, Kulish et al. (2012)

[9] Changes in our key results are not particularly sensitive to our commuting cost calculations such as the rate of average traffic flow or the per kilometre operating cost of a vehicle.

3. Geography defines outcomes

Geography constrains the availability of well-located land for housing

Our first lesson is a geographic one. Perhaps unsurprisingly geography plays a critical role in determining economic outcomes such as the location of housing, the cost of housing relative to incomes, the cost of commuting and the overall size of our cities.

Critical for providing a place to live and a place to build is the land that is available to build on. Cities positioned close to the sea enjoy the amenities of living near the beach provides. But coastal cities dramatically restrict the land available for housing close to the city centre.

Almost 44 percent of the world's population lives in coastal areas. And all the big six Australian cities are located on the coast. Auckland is not alone in facing a small area of land for well-located housing.

But what Figure 8 shows is that relative to even Australian cities Auckland's twin harbours severely restrict the availability of well-located land close to the city centre.

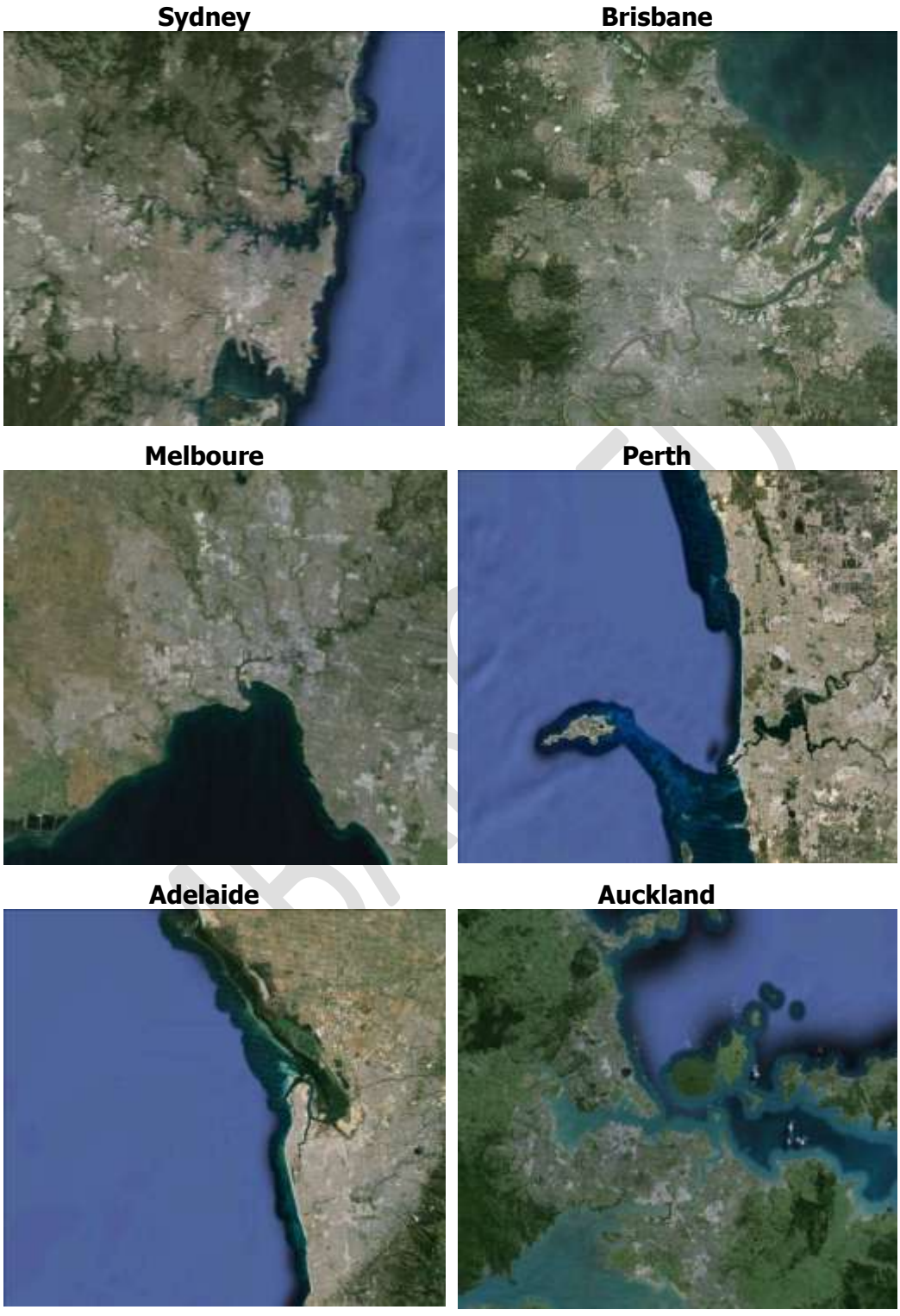
Land availability is crucial to making Auckland one of the world's most liveable cities

What would a wider city feel like? Increasing the land available for housing reduces the cost of land. That makes it less costly to construct a similar sized house of the same size in the same location so rents fall.

Households would be faced with a nice choice – stay put and bank the windfall from reduced rents or keep the rent payments the same but live in a much bigger house.

Some families would choose to stay put while some would choose to move. Either way, opening up the land available makes the families better off – rent payments fall and dwelling sizes increase offsetting any increase in commuting times. These benefits mean a city not so constrained by geography can sustain a larger population without making the resident population worse-off.

Figure 8 Auckland has less well-located land than Australian peers



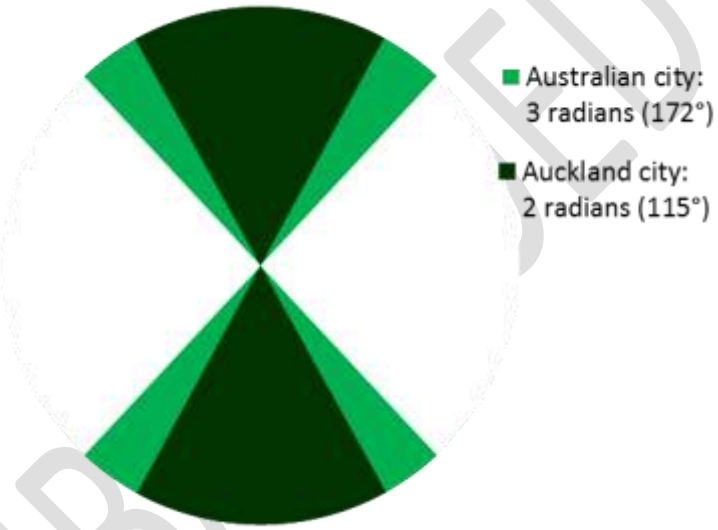
Source: NZIER

How much does geography really matter?

How much better off would a wider Auckland be? Conveniently, the Alonso-Muth-Mills model measures the happiness of each household in terms of housing services, commuting time, income and consumption goods. So we ask how many more people a broader Auckland city with similar geography to Australian cities could sustain.

We first start by generating outcomes for a population with the narrower geography from our baseline Auckland calibration (2 radians, see Figure 9). Then we relax the geography to 3 radians making people better off. Then we slowly increase the population in the city until residents are indifferent between living in the narrower city with fewer people and the less constrained city with more residents.

Figure 9 We impose a broader geography on the model



Source: NZIER

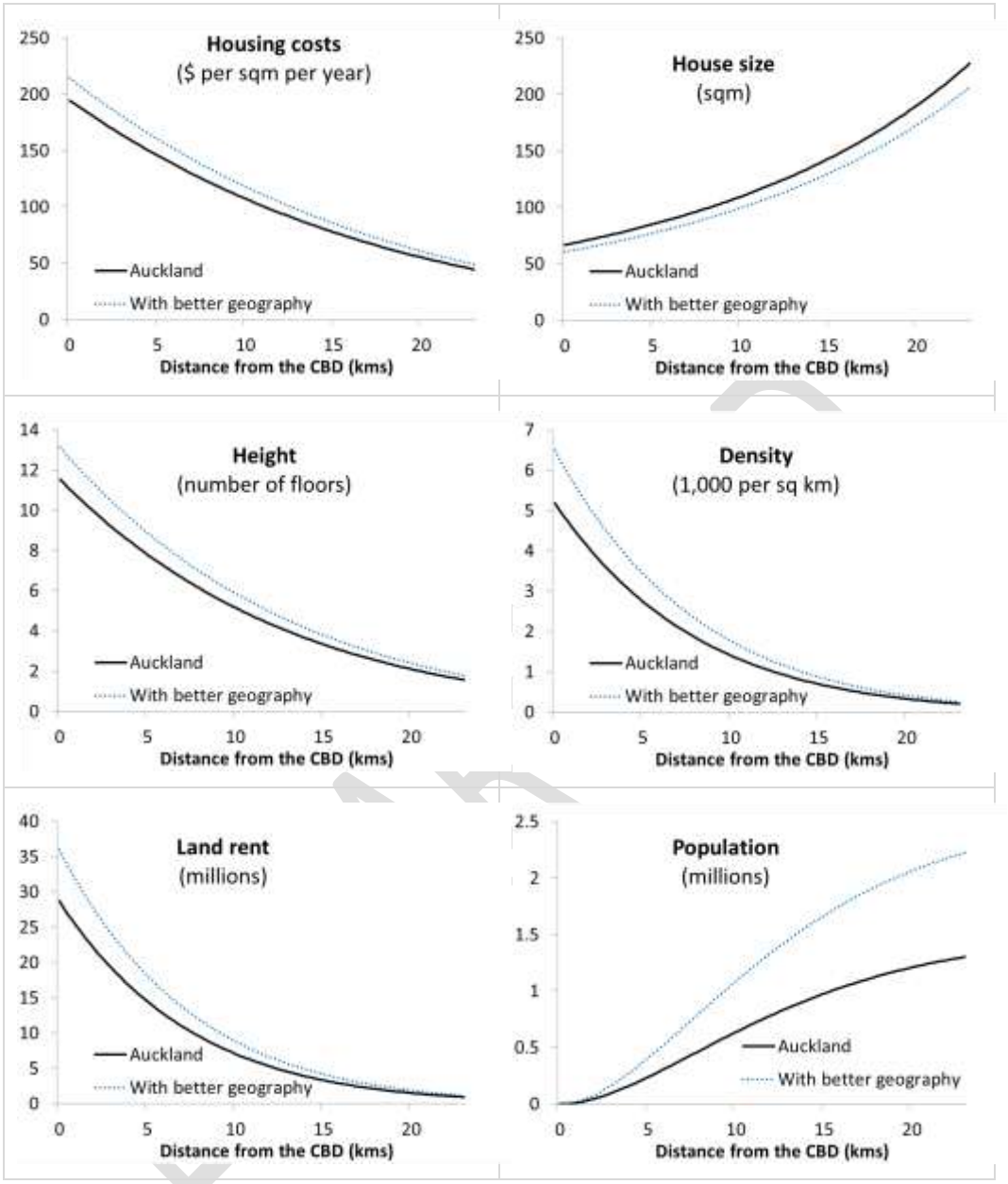
We find that the impact of Auckland's narrow geography is equivalent to adding about 900,000 residents or moving the city up to 2,200,000 residents – about the size of Brisbane. So we should expect big city outcomes in terms of housing and commuting times even though Auckland's population is much smaller than our trans-Tasman peers.

Figure 10 shows how the shape of the city changes. The top-left panel shows that the cost of housing are similar across the two scenarios – even though the better geography scenario sustains a larger population about the size of Brisbane (see the bottom-right panel). The top-right panel shows that the dwelling size is remarkably similar.

Finding a place for people to live and work in Auckland will be harder than other cities. So we should not be surprised at the intensity of some of the debate – Auckland's growth pressures changes some of the amenities we expect a city to deliver. Managing Auckland's growth is a difficult challenge.

Figure 10 Expect big city outcomes from narrow geography

Simulation based on Auckland calibration with narrow geography and without narrow geography



Source: NZIER

4. Growth in population and incomes shape the city

Accommodating population growth

Auckland's population continues to house migrants that have tended to settle in Auckland rather than elsewhere in the country. Statistics New Zealand projects that Auckland's population will grow to be around two million by 2031. How might the city shape accommodate that growth?

Working from our baseline Auckland calibration, Figure 11 shows the city structure with the higher population of two million people, near 2031 levels relative to the baseline.

More people means a greater demand for housing. That bids up the price of land within the urban limit. Families then face a trade-off: pay more to rent the same house or keep the rental payment the same by moving to cheaper land further out from the city centre. Housing and land prices (see top-left panel) are higher at all locations in the city with a larger population (see bottom-left panel).

The increase in demand for housing incentivises developers to purchase agricultural land beyond the urban limit and construct houses, expanding the city. Developers use more capital to construct larger houses with less land, reflecting the relative price shift away from using land to construct houses and towards using more capital. Since housing is more expensive, households switch away from renting larger houses and spend more on consumption goods. Density increases and the average heights of dwellings increase, particularly close to the city centre (see middle-left panel).

An additional pressure comes from rising incomes. Incomes for the average Auckland household grew to $76,500 in 2013 from $64,400 in 2006 making families much better off. At that growth rate, we expect the average household income to be $119,000 in 2031. That lifts welfare significantly. But how does that income growth shape the city?

Accommodating growth in income

When income increases, and assuming that the costs of commuting and housing remain fixed, pressures on the city shape are quite different relative to population growth.

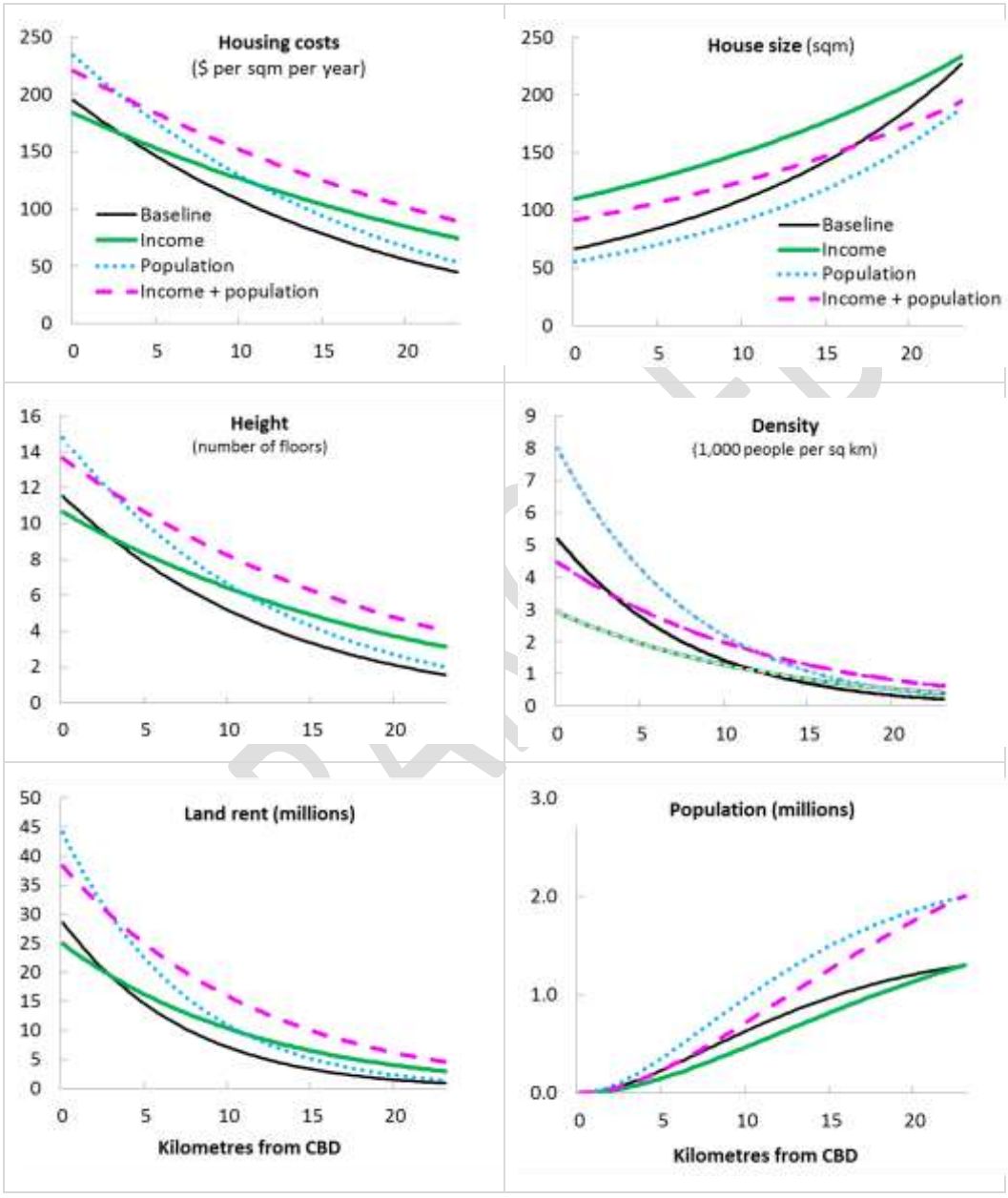
When income increases, families can afford the costs of commuting.[10] A typical family in Mt Eden faces a trade-off: stay put and spend more on consumption goods or move out from the city centre a little into a larger newly developed home that is now affordable.

Developers find it easier to build larger dwellings by combining more land and capital further out from the city. So growth in incomes encourages families to think hard about moving out to the suburbs to live in bigger houses. The city becomes more decentralised. After a 50 percent increase in income housing costs actually fall at the

[10] Increases in income are likely to increase the time opportunity cost of travel and hence transport costs, indirectly.

heart of the city, are unchanged on average within the first six kilometres of the city centre but 28 percent higher in the outer suburbs.

Figure 11 Income growth and population growth shape the city differently



Source: NZIER

5. Many levers makes light work

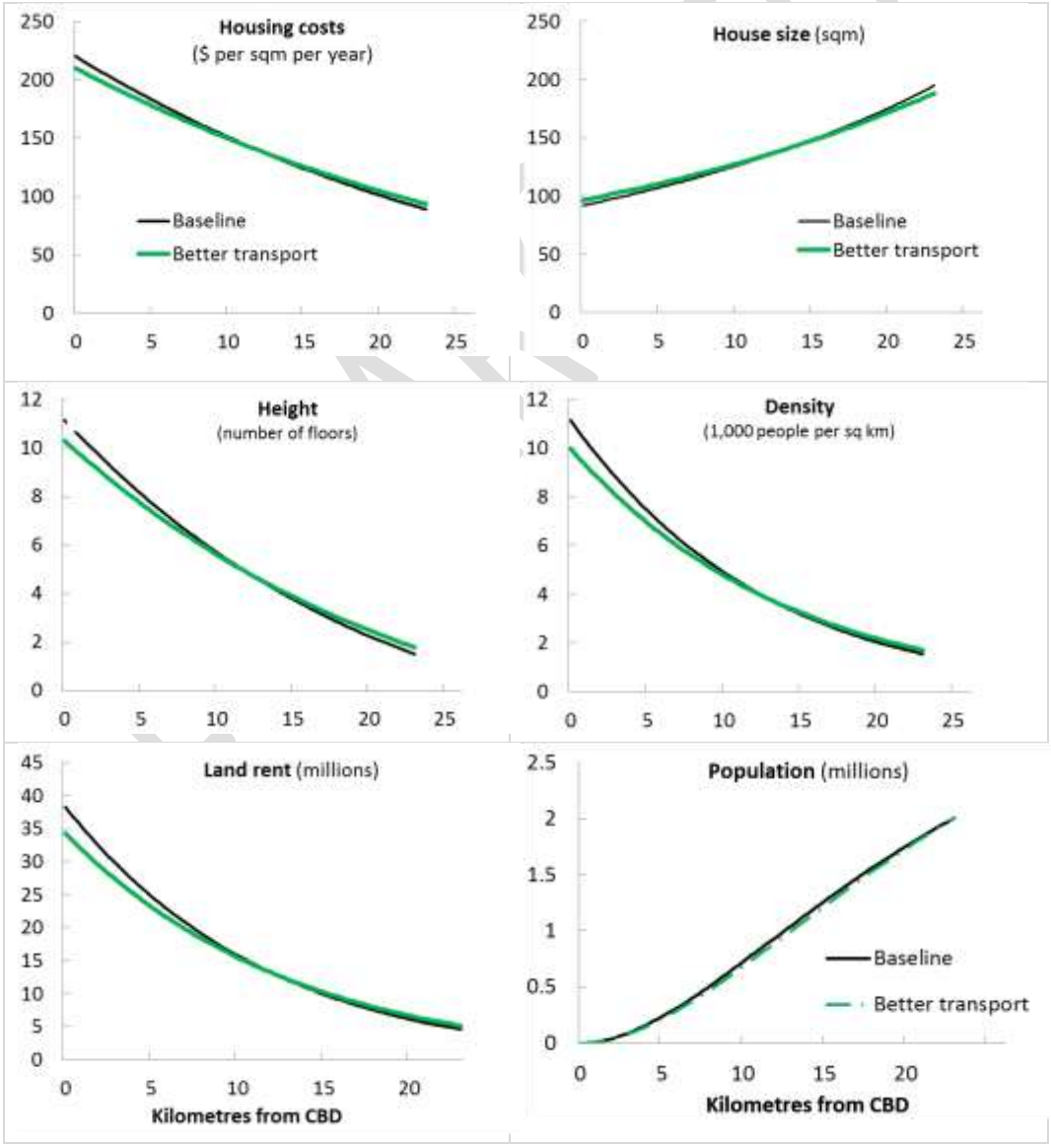
Auckland has many policy options to improve outcomes across the city. To gradually build up a picture of what is possible we start by looking at improving transport infrastructure by adding on productivity improvements and extending the MUL.

Improving transport infrastructure

Our first scenario looks at improving transport infrastructure. Our scenario shows the effect of reducing transport costs by 2 percent financed by a 1 percent increase in income tax on Auckland families. increases.

Figure 12 shows improving transport infrastructure – we make no distinction between private or public transport – leads to better outcomes. Commuting times decrease and the cost of housing falls, as the supply of well-located land increases.

Figure 12 Better transport infrastructure reduces density



Source: NZIER

Lower commuting costs reduce the appeal of land close to the CBD relative to building larger homes in the suburbs.[11] That drives down the price of land located in the centre of town by more than the increase in the price of housing in the suburbs.

By contrast, the model suggests that well-directed investment in transport infrastructure makes it more feasible to live further from the CBD and can thereby reduce the cost of housing. Overall, the effect of poor transport infrastructure and higher transport costs is that households spend more of their resources commuting, live in smaller homes and face higher than average housing and land prices.

Transport infrastructure projects can change land use, shaping local population and housing outcomes. These changes should be incorporated in evaluations of the costs and benefits of infrastructure investments.[12]

Increasing productivity

Building houses in New Zealand is a complex industry characterised by the New Zealand Building Code and many local government regulations. There are many reasons to regulate housing construction. But the costs from complying with administration of these regulations can be material.[13]

Within the building industry inefficiencies can exist. Compared to Australian operators, housing construction in New Zealand tends to be bespoke and lacks the scale that would allow developers to build several units at the same time, allowing for the construction of cheaper homes.

These inefficiencies might come from either costs of complying with regulations in the building sector, development fees charged by councils for new housing developments or productivity inefficiencies within the building industry. The New Zealand Productivity Commission (the Commission) (2012) lists several ways to improve productivity including:

- achieving scale and greater use of technology to achieve faster processing of building consents
- identifying pathways for alternative building solutions to become acceptable building solutions
- scaling up house production from one house at a time to larger production models
- reducing vertical fragmentation in the construction supply chain that creates additional management costs
- reducing demand cycles that make it difficult to retain skilled staff
- better aligning industry training with industry needs through housing cycles.

Sitting behind the scenes in our model are developers who put together land and capital to make houses that are then rented back to the families living in Auckland.

One of our key assumptions is how efficiently these developers can operate to deliver a house from a fixed set of inputs costs. Developers that are more efficient will produce a house with a smaller wedge or premium between inputs costs to the

11 Molloy and Shin (2013) and Tanguay and Gingras (2013) show how reducing transport costs changes the cost of housing.

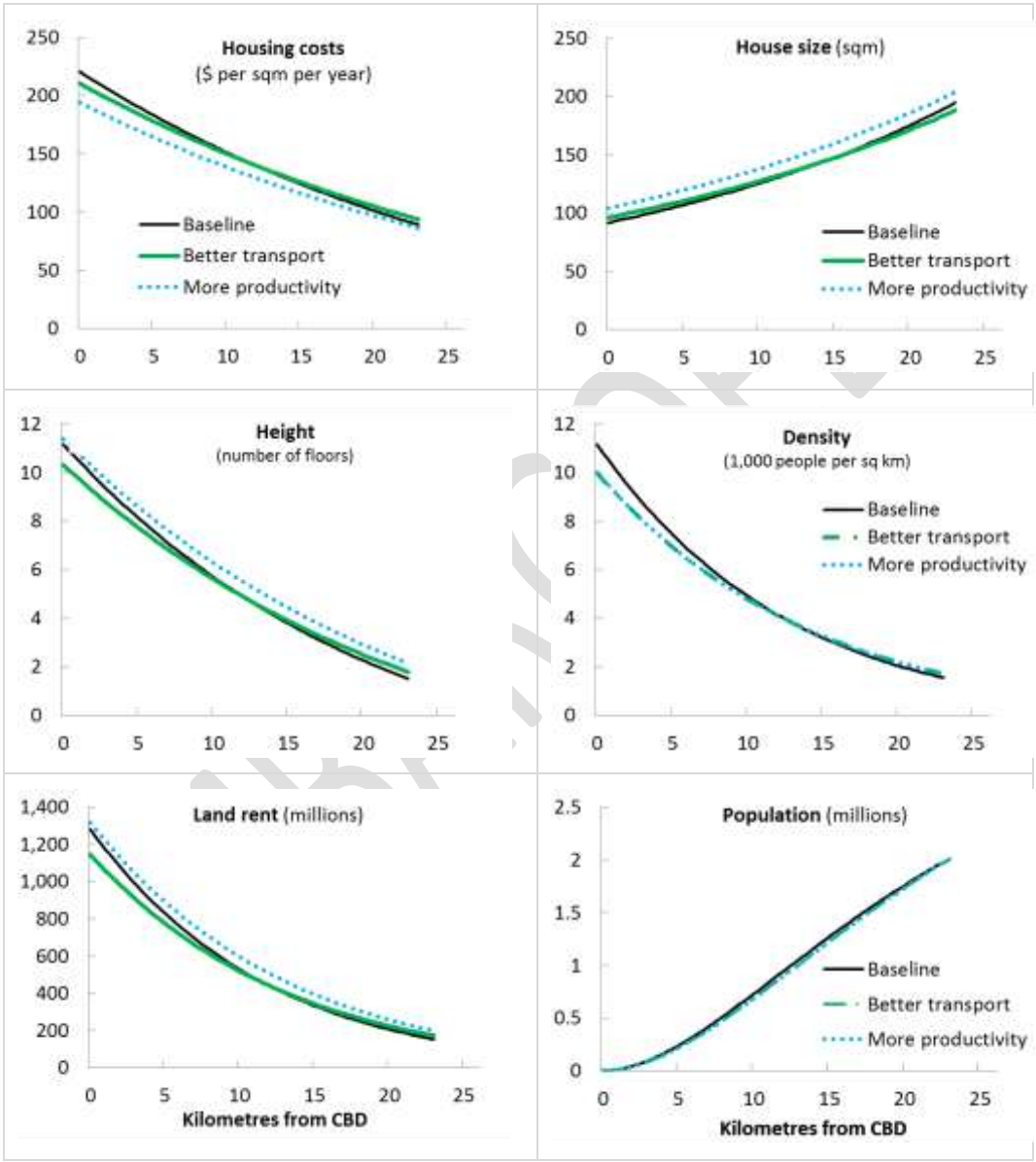
12 See Parker (2013) for example and the discussion in Coleman (2010) and Harris (2005) on the development of the Auckland motorway system is insightful. Coleman makes the point that a metropolitan urban limit may be optimal in a dynamic setting by encouraging intensification of land use as the population grows.

13 See the Productivity Commission (2012) report on housing affordability.

final output cost of the house. Conversely, very inefficient development means a city with large differences between inputs costs and the final cost of a house.

There are several reasons why houses might be 15-25 percent cheaper to build in Australia than New Zealand.[14] We use the lower end of that figure, 15 percent as a benchmark for possible productivity improvement in Figure 13.

Figure 13 Better residential construction reduces housing costs



Source: NZIER

Per unit housing costs fall. That incentivises families to either move to bigger (and higher) houses provided by developers. Since capital and land can now be combined more efficiently the demand for land increases, pushing up the price of land across all locations. Families are better off since they now live in bigger houses or similar sized houses closer to the city.

[14] See the Productivity Commission (2012) report on housing affordability.

Extending the MUL

Urban planning restrictions play a key role in forming urban structure. Urban limits are contentious, restricting urban sprawl by pushing up the costs of housing and reducing housing affordability since the supply of land is restricted.

Auckland's Metropolitan Urban Limit (MUL), that restricts the availability of land for development, is the centre of much debate. There is clear evidence that the MUL binds with land prices within the MUL much higher than land immediately outside the urban boundary.[15] Containment policies such as 'Smart Growth' and Auckland's Metropolitan Urban Limit (MUL) were also found by the Commission to have an adverse effect on housing affordability by limiting the availability of land for housing.

From the Australian case, one of the key recommendations of the Kulish et al (2012) paper is the strong connection between density and house prices – retaining density restrictions in the inner city pushes up the cost of housing throughout the city.

It is relatively easy to model a generic expansion in the urban boundary within our model by simply allowing the city to take up additional land area.[16] That decreases the opportunity cost of building on the boundary opening up additional land for housing.

We tie our generic extension of the urban boundary to a previous shift in the MUL. Between 2011 and 2013, Auckland Council made an additional 12.9 km^2 of land available by increasing the MUL from 564.8 km^2 to 577.7 km^2 an increase of a little over 2 percent. We calibrate an increase in the model at the same pace of the increase in the MUL. That means land within the MUL covers 707.9 km^2 by 2031. The average distance from the city fringe to the CBD increases only 10 percent or 2.5 km – roughly the distance between Orewa and Red Beach in the north, Papatoetoe to Manukau in the south and Raniu to Swanson in the west.

Figure 14 shows our results for the case of extending the MUL. Extending the MUL makes more land available for housing construction. Families face a choice either move further out from the city centre and enjoy larger houses or remain well located and enjoy cheaper rent since some families opt to move out to the suburbs reducing demand close to city centre

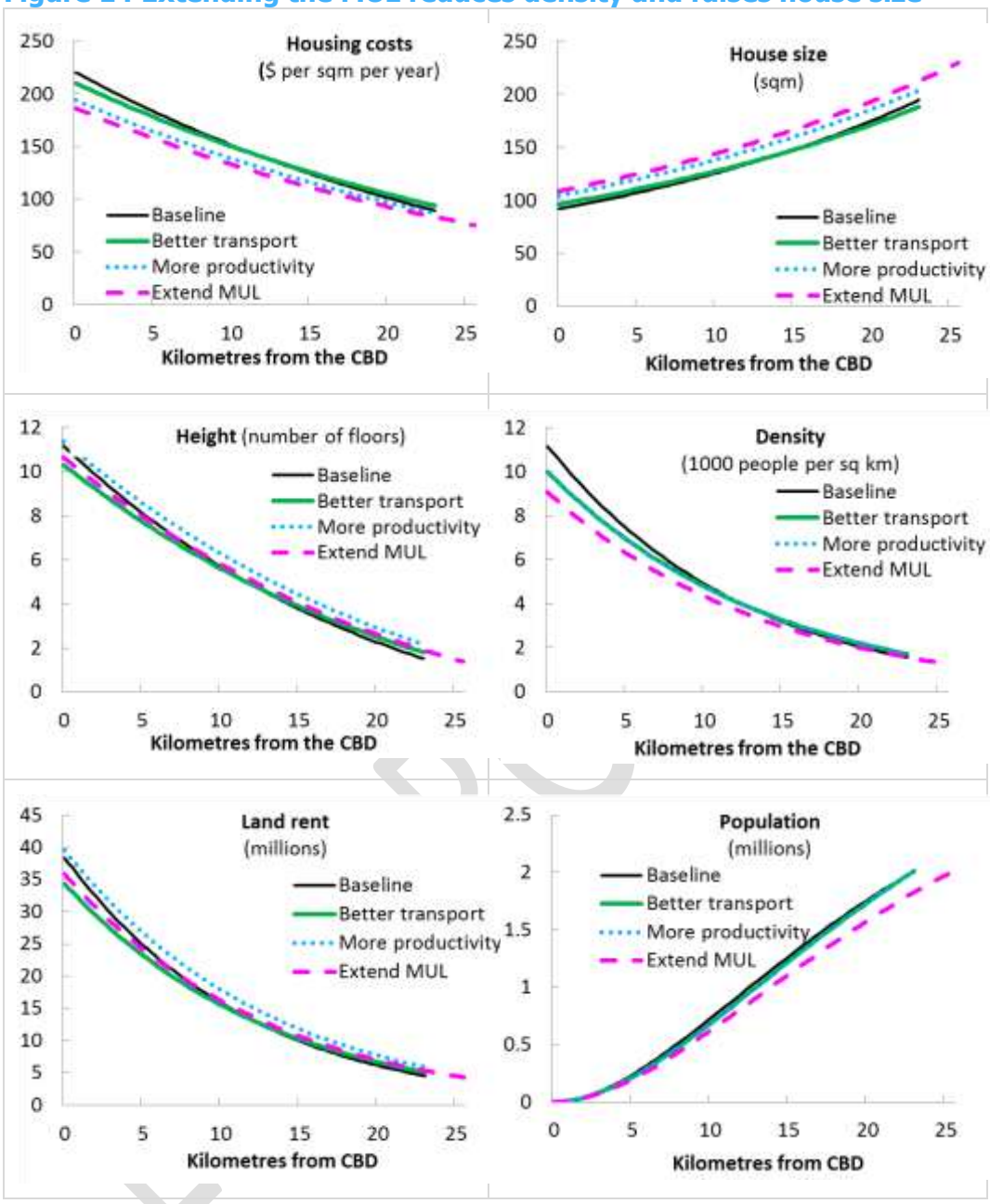
Figure 15 shows extending the MUL can be material – using our baseline welfare measure that includes consumption goods, housing and commuting costs, families are 0.7 percent better off or about $860 a year.[17]

15 See Grimes and Liang (2007).

16 More technically, the Alonso-Muth-Mills models allows city size to be determined by the demand for land within the city and the opportunity cost of developing land at the city fringe – using that land for agricultural purposes. In our work we restrict the size of the city to the Metropolitan Urban Limit by solving for the price of agricultural land that restricts the city to the same land area as the MUL.

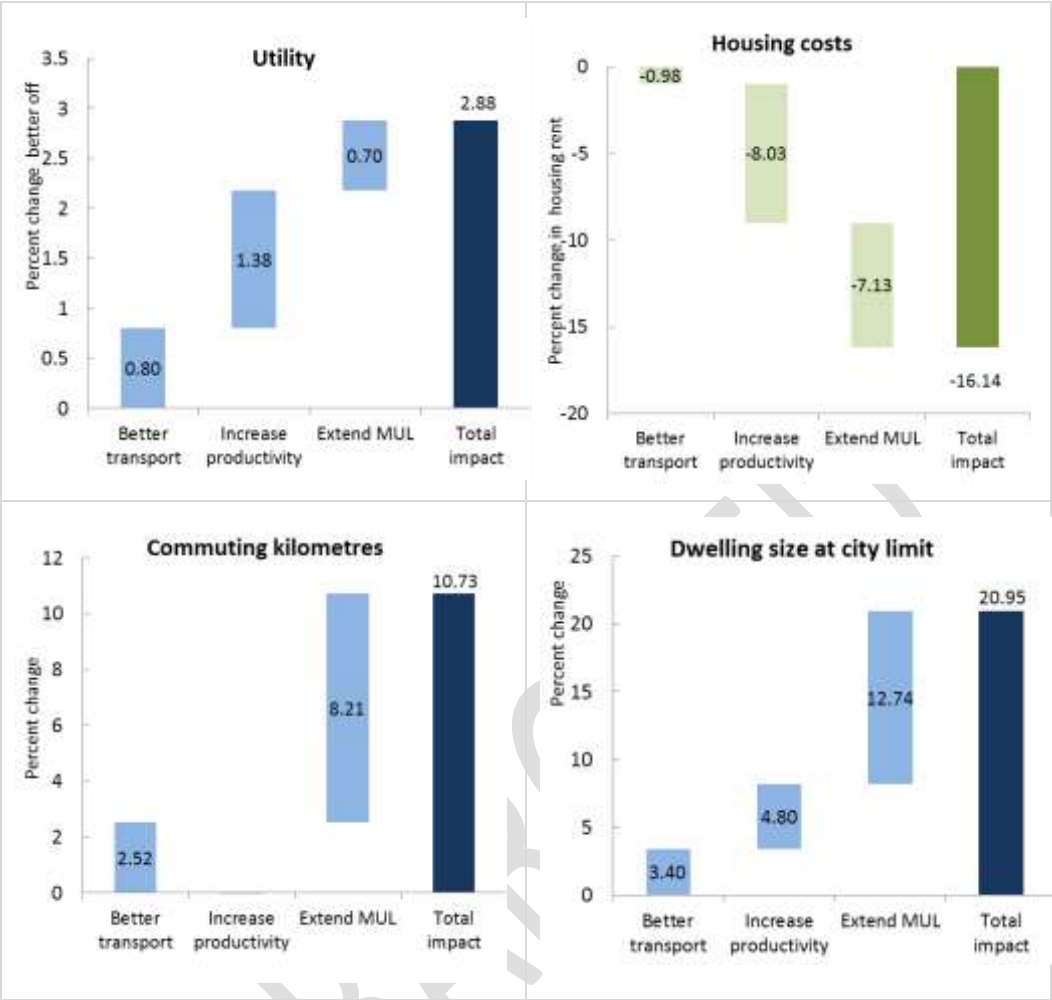
17 Using our framework, a city completely unconstrained by an urban limit would be $4,560 better off.

Figure 14 Extending the MUL reduces density and raises house size



Source: NZIER

Figure 15 Impact of policy on family welfare and urban structure



Source: NZIER

6. Conclusions and next steps

At the heart of what can make or break Auckland as a liveable city is its narrow geography. We show how the twin harbours restrict the availability of well-located land close to the city. That means Auckland experiences big city outcomes in terms of housing that is more expensive and commuting costs relative to its peers across the Tasman.

As geographic constraints bind tighter than elsewhere, that raises the premium on getting our transport infrastructure, urban planning and the efficiency of housing construction right.

Both population and income growth will start to change the shape of the city in the coming decades but in different ways. Income growth incentivises a push to the suburbs to build larger houses while population growth increases density, the price of land and housing costs.

Policymakers have options to help improve the quality of housing, reduce costs and improve outcomes for city residents. We looked at three: transport infrastructure, increasing productivity in housing construction and extending the Metropolitan Urban Limit. One of our key findings is leaving all the adjustment to a single policy lever means heroic assumptions about the magnitude of adjustments a single policy lever might be expected to deliver.

Our work is intentionally broad brush. We work with a simple model so that we can understand at the expense of integrating detailed real world features that nuance where policymakers should lend their attention.

For example, less than 20 percent of Auckland families work in the CBD. Understanding the robustness of our policy conclusions in a model that allows for multi-centric work locations and population flows that respond to the quality of transport infrastructure and cost of housing is desirable, although these models can be very complex. Exploring the impact of relaxing height restrictions through Auckland would also be a useful model extension provided the policy in the model can closely mimic policies that might be implemented (rather than a generic height restriction in the inner city area only).

But putting aside these concerns our work highlights the role transport infrastructure can play in improving outcomes not just for commuting but for housing outcomes within a city. We show that by increasing the supply of well-located land, housing costs fall, making families better off while encouraging development in the fringes of the city.

Our work also shows the outcomes we expect from improvements in housing construction. More effective construction – whether from local government regulation or private sector efficiencies – lowers the price of a unit of housing, incentivising families to build larger houses in the suburbs.

Perhaps our most contentious finding relates to relaxing the Metropolitan Urban Limit. Within our stark model, we show that by 2031, shifting out the Metropolitan Urban Limit and making 22 percent more land available effectively makes each family better off by $860 a year by lowering housing costs. This illustrates that there can be material benefits to shifting out the Metropolitan Urban Limit.

Above all, our work shows simple economic models can help broaden the understanding of some of the trade-offs across policy choices. Understanding the sometimes-unintended consequences of policies that change how land is used can make for better policy advice.

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Appendix B Our Model: Introducing Alonso-Muth-Mills

B.1 The model

Overview

The Alonso-Muth-Mills model

$$p = \frac{v_q(y - tx - pq, q)}{v_c(y - tx - pq, q)}$$

Demand

$$v(y - tx - pq, q) = u$$

Supply

$$l(ph(S) - r - iS)$$

F.O.Cs

$$ph'(S) = i$$

$$r = ph(S) - iS$$

Equilibrium

$$r(\bar{x}, u) = r_a$$

$$r\int_0^{\bar{x}} \theta x \frac{h(S(x,u))}{q(x,u)} dx = L$$

B.2 Calibration

Table 2 Model calibrations, baseline and scenarios

Value	Description	Baseline	Better geography	More income	More people	Better transport	Improved productivity	Extend MUL
y	Income ($/year)	$76,500	$76,500	$119,000	$119,000	$117,810	$117,810	$117,810
α	Utility function – expenditure share	0.17	0.17	0.17	0.17	0.17	0.17	0.17
β	Housing production parameter	0.575	0.575	0.575	0.575	0.575	0.600	0.600
i	Price of capital	1	1	1	1	1	1	
t	Transport costs	$738	$738	$738	$738	$664	$664	$664
θ	Radians available for construction	2.2	2.2	2.2	2.2	2.2	2.2	2.2
MUL	Metropolitan Urban Limit	22.9km	22.9km	22.9km	22.9km	22.9km	22.9km	25.4km
L	Population	1.3 m	1.3m	1.3m	2.0m	2.0m	2.0m	2.0m

Source: NZIER, Kulish et al. (2012)