Cost - benefit analysis for a National Policy Statement on Urban Development

Final report for the Ministry for the Environment

July, 2020

pwc

Contents

Nicholas Smith
Senior Policy Analyst, Urban and Infrastructure Policy
Ministry for the Environment
23 Kate Sheppard Place
Wellington
6011

15th July 2020

Cost Benefit Analysis for the National Policy Statement on Urban Development

Dear Mr. Smith,

You have requested that PricewaterhouseCoopers Consulting (New Zealand) LP (PwC) assist you in conducting a cost benefit analysis of the National Policy Statement on Urban Development.

We are pleased to share the final report of our cost benefit analysis which has been developed by PwC in collaboration with counterparts at the Ministry for the Environment and Housing and Urban Development. In this document we provide estimates of direct and indirect costs and benefits of the proposed policies on urban intensification, minimum car parking requirements, and local government analysis and strategic planning requirements. We also provide analysis on locational targeting of the same policies. Included in the analysis is a description of the methodologies we used to derive our estimates, as well as key messages for each section.

This report is a final deliverable and is provided in accordance with the terms of our All of Government Consultancy Services Order Contract dated 29 October 2019, and is subject to the restrictions set out in Appendix A. This final report supersedes all previous advice.

Please do not hesitate to contact us if you have any questions, or for technical inquires about the analysis, contact Chris Crow (chris.p.crow@pwc.com).

Yours sincerely,

G Cooper.

Geoff Cooper
Director
geoff.c.cooper@pwc.com
022 0117881

Craig Rice
Partner
craig.rice@pwc.com
021 624 462

Executive Summary

This report has been prepared by PwC on behalf of the Ministry for the Environment. It sets out a cost benefit analysis for the National Policy Statement on Urban Development (NPS-UD). We provide estimates of private and social costs and benefits associated with the intent of the proposed policies. The report is in six parts, corresponding to policy areas in the NPS-UD. These include urban intensification, responsive planning, minimum car parking requirements, strategic planning requirements (including both the Housing and Business Assessment and Future Development Strategy), and targeting.

The purpose of the NPS-UD, as we understand it, is to improve the competitiveness of New Zealand's urban land markets through greater flexibility in urban policy. This means encouraging greater competition across urban land markets, both between locations and potential uses of land. In practice, it means increasing the responsiveness of development to *local* land price changes, wherever they occur.

The Strategic Context

Cities are more important now than ever before; not just as engines of productivity, but as centres of consumption and amenity. Today, some 86% of New Zealanders live in urbanised areas.[1] While many are drawn to city living for employment opportunities, social networks or education opportunities, others come for the diversity of thinking and the melting pot of culture. Despite advances in remote technologies, people continue to move to cities in large numbers. As knowledge and technology-based sectors continue to grow; and as cities invest in placemaking, the premium on accessibility will likely increase.

Cities offer the chance for prosperity and fulfilment, but the cost of admission has risen dramatically. New Zealand's cities face a severe housing crisis, with far-reaching effects that frequently impact most on the poor, vulnerable, new entrants, and younger generations. Urban policy that contributes to the scarcity of housing has made it difficult to access the benefits of city life. Improving urban accessibility and driving down the urban cost curve, both through lower housing costs and shorter commute times, is a sensible policy focus.

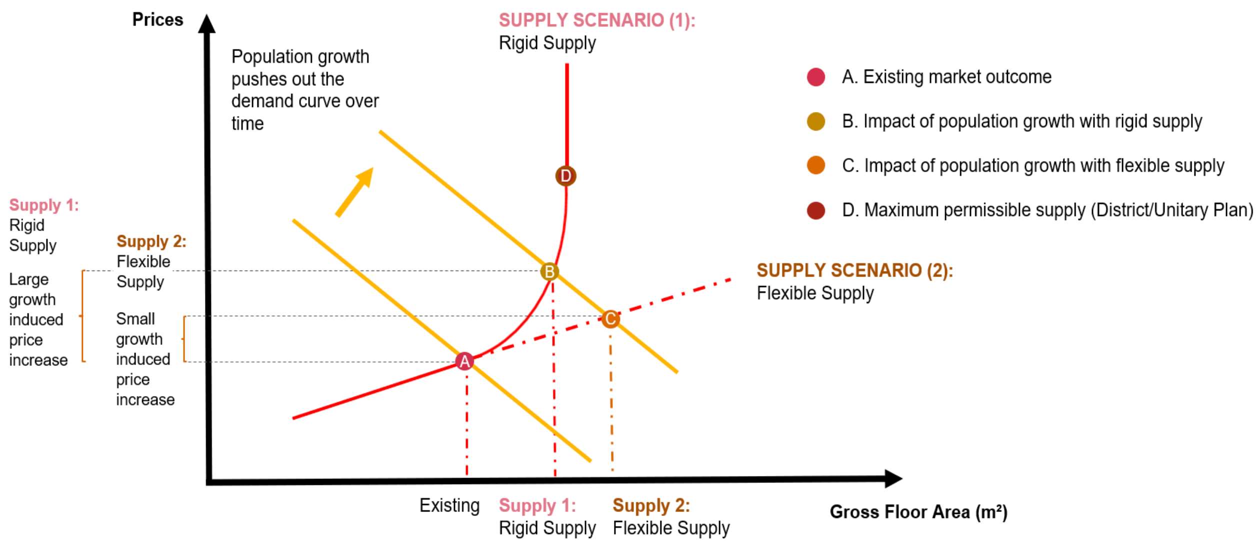
The National Policy Statement on Urban Development targets land competitiveness

The impacts of the NPS-UD are broad and generally support cities that are sustainable, accessible, and competitive. The policy directive seeks to achieve this by improving the competitive nature of urban land markets, the affordability of housing, and the quality of urban outcomes while minimising social costs and maximising social benefits. The policy has a more prescriptive focus on six major urban centres (MUCs) chosen for their large populations, rapid growth, or both. These are (from North to South) Auckland, Hamilton, Tauranga, Wellington, Christchurch, and Queenstown.

In many cities, local housing markets demonstrate severe supply rigidities such that development is unable to respond to changes in local prices. This is illustrated in Figure 1, where rigid planning rules in local markets result in subdued supply of housing and higher prices. These effects are magnified during times of higher demand and faster population growth. Supply rigidities can occur anywhere within a city where demand outpaces constraints, from attractive inner-city suburbs to the outskirts of a city. Improving the competitiveness of land markets - that is, the ability of both suppliers and consumers of land to compete across space and between land uses - can help ease these effects over time. Through more competitive land markets, New Zealand can create more flexible, vibrant urban spaces that are responsive to the modern demands of urban residents.

[1] Stats NZ.

Figure 1: Supply rigidities can result in higher prices and less housing in high amenity locations



Source: PwC analysis

Supply rigidities have a number of drivers…

Social impacts are one reason. In the face of social costs and benefits (known as externalities), supply rigidities can theoretically act as a second-best policy. They might be used to limit congestion or protect fertile soils that would otherwise be lost to urban development. Supply constraints are commonly used to preserve things like heritage, character, sightlines or other urban traits that planners, residents, or elected members value. Other times they are used to protect certain land uses so that the city might benefit from them being ringfenced or centralised, such as with industrial land. But while each of these policies aims to generate benefits, none are without cost.

Other times, urban policy may better reflect psychological heuristics. This can include status quo bias (where there is a preference for the current state, despite net benefits) or loss aversion (where residents place greater weight on losses over gains – again, despite net benefits) (Kahneman, 2011). The logic of collective action may also play a central role (Mancur, 1965), where political decision making gives greater weight to concentrated gains over diffuse losses (Blinder, 2018).

…and they are becoming more important

Whatever the reason for these supply rigidities, as cities have grown (driven by higher wages and improving amenity), the costs attributable to them have increased. This means that such rigidities play a greater and more central role in pushing development to second best locations. While intensification may stack up around Mount Manganui in Tauranga, Mount Eden in Auckland, or Te Aro in Wellington for instance, rigid housing zones limit or eliminate such possibilities. While urban expansion along high frequency rail corridors in Auckland might bring cheap land within the urban labour market, a greenbelt policy may make such transactions impossible. The result is that residents are pushed to alternative locations, either within the same city, to other cities in New Zealand or abroad.

When residents are forced to other locations within a city, living costs can be higher and the city may incur greater social costs. Since business is shaped by the powerful forces of agglomeration, where a large productivity gain arises through the co-location of firms, residential policies that limit density in accessible and high amenity locations may result in an urban form reliant on longer commutes. Such urban forms may face greater congestion and more expensive infrastructure requirements than might otherwise be the case.

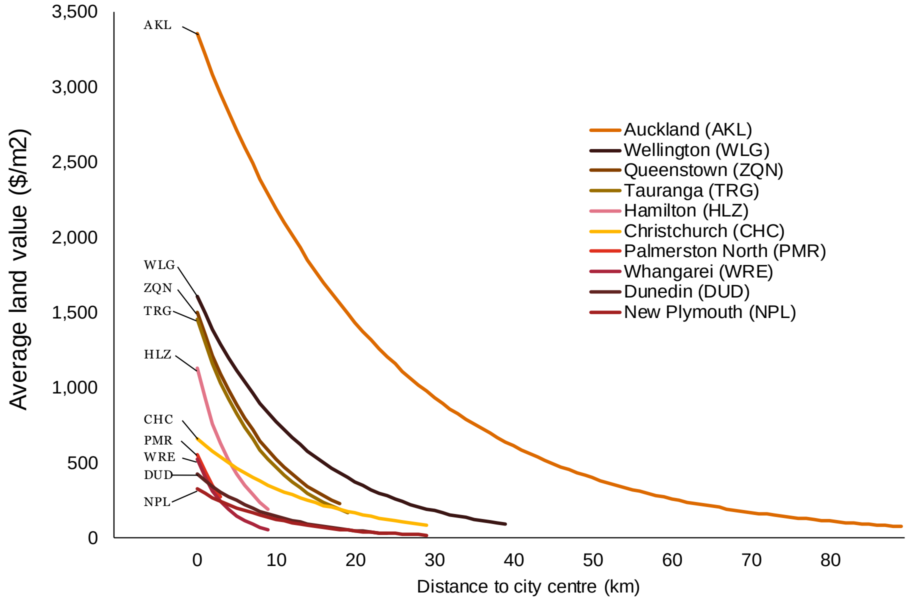
The NPS-UD brings together six key policy areas

The first three of these are at the heart of competitive land markets. *Intensification* policies seek to improve land flexibility in existing urban boundaries. *Responsive Planning* policies seek to improve land flexibility generally, but particularly on the urban limit. The policy on *Minimum Car Parking* seeks to improve land use flexibility across both existing and future urban land (within existing land use designations).

Evaluating each of these policies across multiple cities at the property level is complex. Urban land markets cannot be understood using averages or broad strokes. For instance, the average price of land in Auckland is $1,020 per square metre, but the range of possible value is $20 - $30,000 per square metre. This variation is typical of New Zealand's cities but is pronounced for the largest (Figure 2). These differences matter for regulatory policy evaluation. When land is cheap, regulations are less likely to be binding, meaning they are set at a level that does not influence development decisions. Developers might be unaffected by minimum car parking requirements or single dwelling zones on the periphery of the city where land is cheap and demand low; but these same policies could have very different consequences closer to the city centre. In other words, one policy can have significantly different impacts across a city.

Figure 2: Land values by distance to city centre (fitted exponential trend)

There is a clear relationship between the value of land and distance to the city centre for cities in New Zealand, which illustrates the value associated with proximity. Land use policy regulates how cities use land. But since land close to the city centre is scarce and expensive, the impact of city-wide urban policy will vary across is boundary. Therefore, understanding the consequences of urban policy requires an intra-city evaluation.



Source: Auckland Council, Ministry of Housing and Urban Development, PwC Analysis
Note: This chart uses an exponential fitted trend to aid an intra-city comparison. The approach is not a perfect representation of the data and tends to underestimate land values closest to the city centre for some cities, especially the largest cities – but it is helpful to illustrate a common feature of land in New Zealand cities.

High land values reflect a fierce competition for access to amenity and productivity and explain some of the differences in housing prices both between and within cities. Since there is far more variation in demand for intensification within cities than between them, the analysis attempts to disaggregate effects at a localised level to the extent possible, remembering that each city is made up of hundreds of micro markets, all competing against one another, all with different amenities and constraints.

The final three policy areas concern the 'who' and the 'how' of the policy package. *Targeting* addresses which cities are most likely to benefit from inclusion under the requirements of the NPS-UD. Housing and Business Assessments (HBA) and Future Development Strategies (FDS) relate to local government strategic processes for monitoring and reporting standards, that are designed to help implement the policies. The *HBA* policy establishes standards for how local governments identify housing supply requirements. The *FDS* policy is designed to encourage robust and transparent strategic processes for how councils plan for where growth will occur.

Our approach to modelling policy impacts is not a prediction, but an examination of a purposefully conservative interaction between historical trends and potential changes. In our choices of input assumptions, we err on the side of a conservative policy impact at every point of discretion. The cost and benefit figures reported below are not to be taken as the likely outcome, but an assessment of effects if (1) the status quo is better than we fear it will be and (2) the policy impact is weaker than we believe it will be. We take this approach to guard against optimism bias and to explore interactions of the policy mechanisms under less-than-ideal conditions. As such, our estimates should be interpreted as a near-worst-case scenario, with the understanding that net benefits are potentially much higher.

Intent and key findings of the cost benefit analysis

1. Urban intensification

The intent of the intensification policy is to improve land use flexibility and the competitiveness of land markets within existing brownfields. We interpret this as a flattening of the supply curve (as depicted in Figure 1), such that supply is more responsive to price changes. The policy is targeted toward urban areas where transport needs are well served. The benefits of this policy accrue to new residents who enjoy lower house prices and greater accessibility to employment, together with agglomeration benefits. Together, these are estimated at around $9 billion over the period to 2043.[2] These benefits tend to accrue to renters, new entrants, and future generations. Costs associated with the policy are estimated at $1.8 billion and relate to congestion, crowding, environmental, and infrastructure costs. The cost benefit ratio for each city is estimated at between four and seven.

Because urban land markets are complex and there are large variations between and within cities, this cost benefit analysis is necessarily indicative. There is greater certainty around some costs and benefits than others. To compliment the analysis and add greater clarity around the effects, we provide case studies for a deep dive into how intensification can support lower housing prices and living costs generally, by allowing for greater housing capacity in areas that demonstrate high levels of demand.

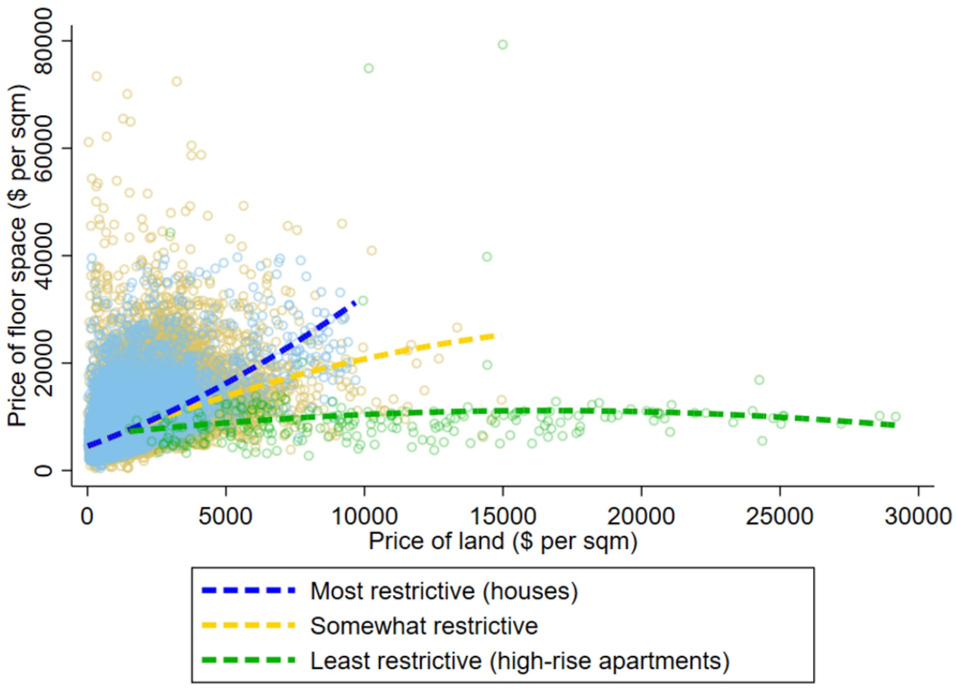
Land in high amenity areas of a city is expensive. We observe that homeowners and businesses compete fiercely to be in areas with good accessibility, short commutes, and, for example, sea views. This drives up the price of land, so that land prices usually increase with proximity to the city centre. Critically however, the relationship between land prices and the price of floor space is a function of zoning policy. At low land prices (say, at the periphery of a city), intensification policy has little effect on the price of floor space, presumably because zoning policies are not as binding. Allowing for high rises on the periphery of a city means little to a developer when demand is low. Put another way, if a resident is considering living on the periphery of the city with a long commute, they are unlikely to consider a small apartment. When space is cheap, why not consume more of it?

As the price of land increases, differences in the price of floor space emerge between zones. Figure 3 presents evidence of this effect in Auckland. For the most rigid residential zone (the single dwelling zone), there is a strong positive relationship between land values and the price of floor space. As the price of land increases with population growth, improved infrastructure, and other amenity, the price of floor space in well-positioned areas with rigid zoning rises in proportion. This implies that developers are not responding to price increases with supply (as the zoning restricts/prohibits their ability to do so). In marked contrast, the relationship between the price of floor space and land in areas of flexible zoning is weak at best and perhaps even non-existent (that is, a flat line). In the city centre, the price of floor space moves in a narrow band. In fact, land that is priced between $5,000/sqm – $30,000/sqm do not appear to drive housing prices up at all in high-density zoning areas.

High density development means residents and businesses can access high amenity locations without consuming much land. Auckland's city centre has the highest land values in the country, yet the price of floor space is low because the high price of land can be shared across many people. High land prices are overcome through building multi-storey buildings that provide a much larger total floor area. Areas such as these contribute to greater accessibility for the rich and poor alike.

[2] The time horizon for Stats NZ population projections as of 2019.

Figure 3: Empirical relationship between price of floor space and land value by land-use zone

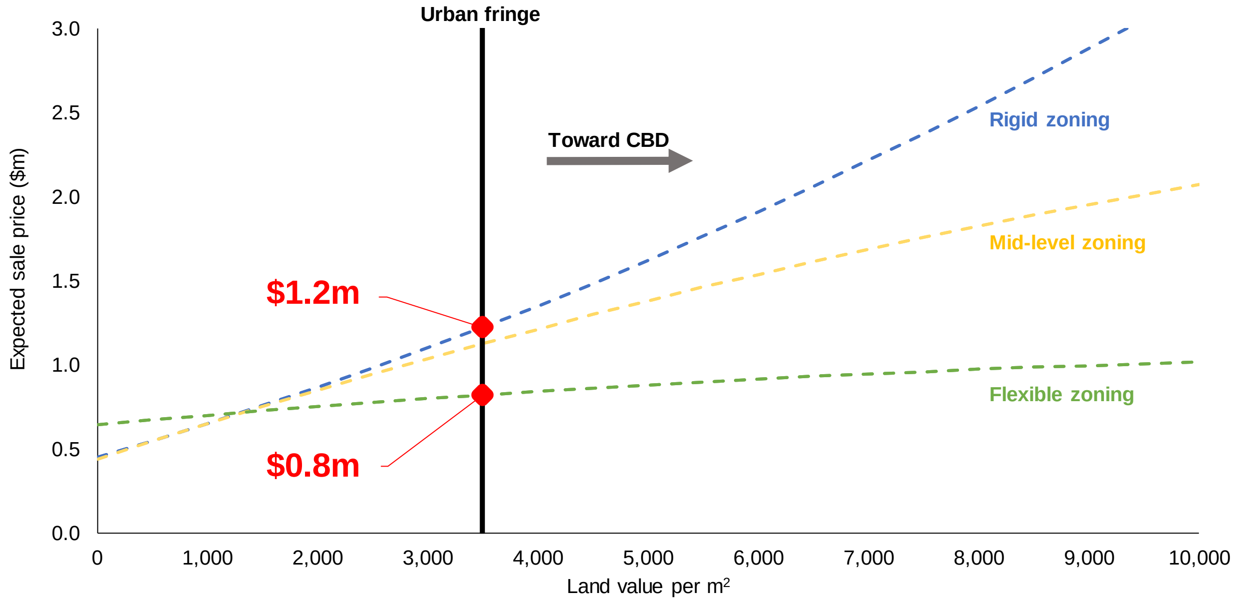


Source: Auckland Council data, PwC analysis, adapted from MRCagney, BECA & Covec (2016).
Note: A representative unit (right chart) is assumed to comprise 100m^2 of gross floor area.

Intensification policies are fundamental in decoupling land prices from dwelling prices in high amenity areas, allowing residents to sacrifice space rather than location. Such options let residents avoid congestion and long commute times. Critically however, these policies are most useful in areas of high demand. In Auckland, this means land that is valued above $1,500 per square metre (this is where the zoning curves in Figure 3 and Figure 4 begin to diverge).

These relationships can be used to evaluate the hypothetical effect of zoning on house prices at certain locations across a city (see Figure 4). For instance, using a 100m^2 house located on a piece of land that is priced at $3,500 per square metre (typical of Auckland's urban fringe); if the dwelling is in an area with supply flexibility, the existing pricing relationships imply an estimated dwelling price of $820,000. If the same dwelling is in the single dwelling zone, the observed relationship implies a dwelling price of $1,220,000 – or 49% higher. The price wedge arises from city planning requirements that effectively oblige residents to consume large quantities of expensive land in high amenity areas.

Figure 4: Expected price for a representative unit under three zoning assumptions.

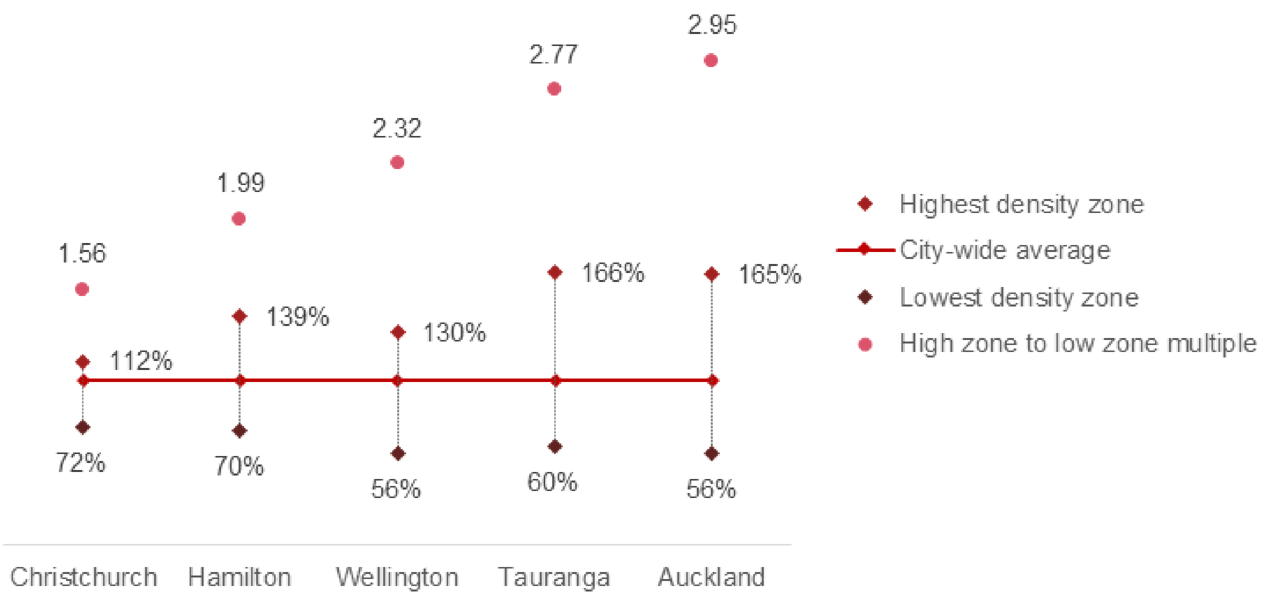


Source: Auckland Council data, PwC analysis.
Note: Expected sale price is derived using the equations of the exponential lines fitted to the data displayed in Figure 3. As that figure shows, actual prices vary around these price points.

Zoning policies have an impact on where people live by changing relative land prices across the city. If zoning policies were not binding, development would more evenly respond to price changes wherever they occurred. Figure 5 shows the cross-sectional relationship between the floor area ratio (FAR) and the land price for rigid and flexible zones in five New Zealand cities (standardised to 1 for the city-wide average). It shows that supply constraints relative to demand vary considerably across New Zealand cities. For rigid zoning areas in high amenity areas, supply responsiveness is 56-72 percent of city-wide averages for a standardised increment in land values. For flexible zoning areas in high amenity areas, supply responsiveness is 1.56 to 2.95 times higher on average for the same change in land values. Zoning policy is having a significant impact for areas with high amenity.

Figure 5: Cross-sectional relationship between floor area ratio and land price (city average standardised to one)

Observable floor area is highly responsive to changes in land price in high density zones, but less responsive in low density zones, implying that zoning is having a significant impact on urban form. In Auckland, the expected additional floor space for a unit change in land value in low density zones is half the rate (56%) of the city average and the difference in expected floor space response to land value between flexible and rigid zones is 2.95 times. In low density zones (many of which are in high amenity areas), prices tend to rise without stimulating much development.



Source: HUD data, PwC analysis.

Intensification policies are particularly important around areas of rapid transit (and improvements in rapid transit) because accessibility effectively concentrates amenity. For instance, properties within 400m of a high frequency rail station in Auckland have land values that are 25% higher than others, holding all else constant. In Wellington, properties within 250 metres of a train station are associated with an increase in land value of 15%. Residents are prepared to pay more to live around rapid transit nodes. If adequate supply is available, these effects are a signal to developers to build more housing, driving the familiar notion of transit-oriented development. However, if regulations are rigid, rising land values from transport improvements may not result in new housing but higher dwelling prices instead. In other words, when supply constraints are binding, the gains to transport investment are captured by existing landowners. When they are not binding, transport investment can induce land-use change by incentivising greater housing supply and lifting the number of people living in high amenity areas (as in so doing, improving the economic case for the transport investment). From a policy perspective, this reiterates the importance of focusing on supply flexibility around nodes of rapid transit.

2. Responsive planning for development

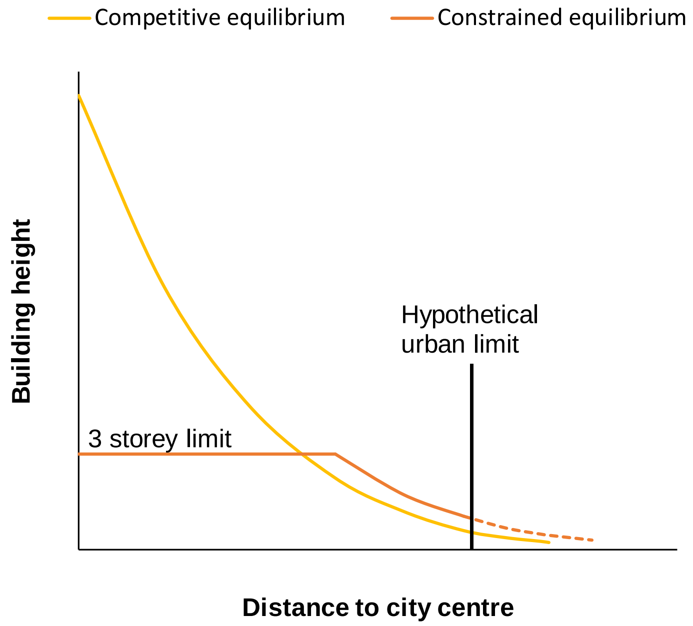
The intent of the responsive development policy is to improve land use flexibility and the competitiveness of land markets in areas that fall within a potential labour market catchment area but are currently not zoned for urban development. As with intensification, we interpret this as a flattening of the supply curve, such that supply is more responsive to price changes. However, unlike intensification where the balance of benefits and costs generally point in the same direction for each city, the effects of increased development in greenfield areas are more complex. For instance, in the absence of congestion charging or demand management policies, congestion externalities could erode gains to consumer surplus. Poorly planned greenfield development could lead to the loss of valuable greenspace or fertile soils with option value while supporting an urban form that enables lower levels of employment density with correspondingly lower agglomeration benefits. In addition, there is some evidence to suggest that infrastructure costs are higher for greenfield development on average, although this is highly location specific, with considerable variation.

To evaluate the impact of greenfield development on New Zealand cities, we model the relationship between greenfield development and consumer surplus, incorporating a wide range of external costs identified in the literature. Under certain circumstances, we find that high quality greenfield expansion can create significant levels of economic benefit by reducing housing costs in areas where infrastructure costs and congestion externalities are low. This is unsurprising: cities have been expanding for decades, and residents have benefited. However, there are circumstances under which potential greenfield development does not generate enough consumer surplus to offset wider social costs. Therefore, while high-quality greenfield development has the potential to enhance urban outcomes while improving affordability and encouraging modal shift, low-quality greenfield development can be costly. The policy implication is that greenfield development should undergo a robust evaluation process that evaluates gains to consumer surplus against all other social costs. Ideally this should be done through cost benefit analysis.

Greenfield policies are interrelated with intensification policies. A standard outcome from the closed-city Alonso Muth Mills (AMM) model of urban form is that a city with binding height restrictions will expand further than an identical city that has a demand-led regulatory framework (ie, with no height restrictions – see Figure 6). There are numerous examples of binding brownfield policies in New Zealand cities, so if NPS-UD intensification policies release pressure within the existing urban boundary, flexibility in greenfield development may be less important. In other words, for some cities, pressure on greenfield expansion may be a consequence of rigid brownfield regulation.

Figure 6: Modelled effects of building constraints (and urban limit) on urban spatial form

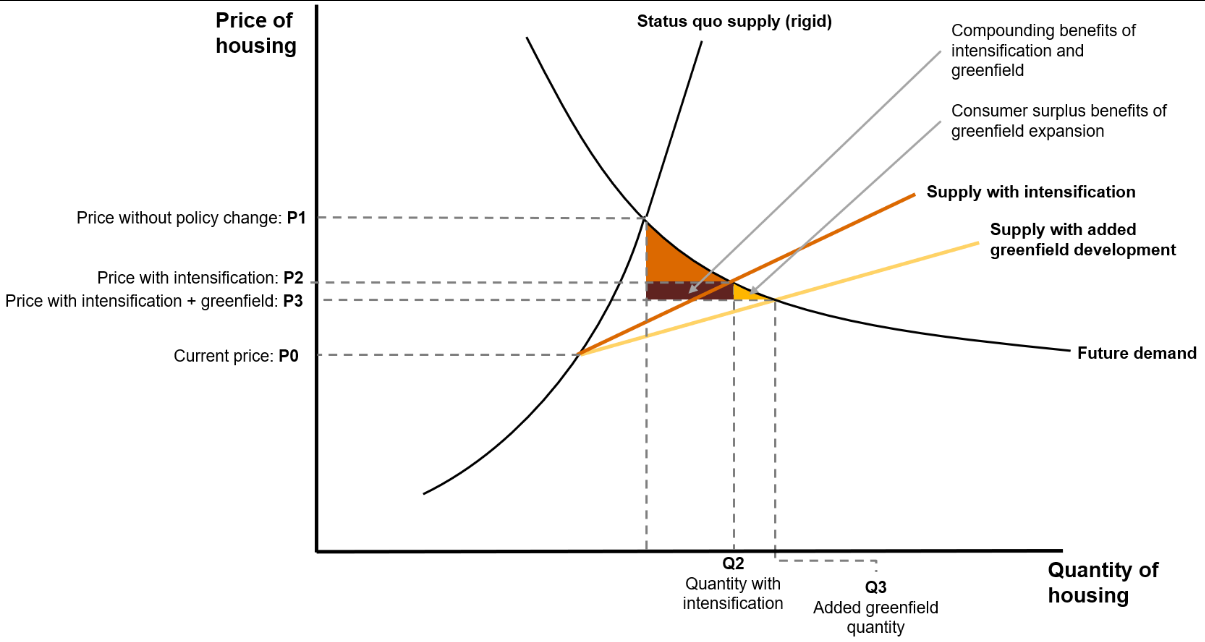
This modelled AMM result shows two identical closed, concentric cities. The first has a uniform three story building height limit. The second is demand-led. The constrained city has a larger spatial form holding other things constant. A hypothetical urban limit is also shown.



Source: Source: Kulish et al. 2013.

While density controls on brownfield land act as a ‘lid’ on urban form, urban limit policy act as a belt. This means that if growth pressures are strong enough, greenfield expansion can complement intensification policies. If supply rigidities are relaxed in the city centre holding all else constant, some demand for outward expansion will be relieved (as illustrated by a smaller city size in Figure 6). However, if urban limits are also constraining (as depicted in Figure 6), relaxation of the urban limits can also create benefits (by allowing residents to trade off a longer commute for more space for instance). These two actions can have a compound effect on consumer surplus in housing markets (Figure 7).

Figure 7: Consumer surplus effects of combined intensification and responsive planning policies



Source: PwC analysis.

However, greenfield expansion might carry higher external costs than brownfield expansion in three key categories:

a. **Driving-related externalities** tend to be higher for greenfield residents relative to brownfield residents due to higher vehicle ownership rates and vehicle kilometres travelled.

b. **Infrastructure-related externalities** are generally higher on a per-household basis for greenfield developments. This can include such costs as water supply, wastewater and stormwater management or the loss of open space. However, the internal and external costs of specific infrastructure projects vary widely according to the unique circumstances of each project and each city.

c. **Opportunity costs of foregone agglomeration benefits** arise when greenfield residents are diverted from brownfield locations, diluting density in high-productivity areas. This could include both agglomeration in production and agglomeration in consumption.

Since the impact of greenfield expansion is case specific, we cannot say whether the overall effect is positive or negative at the national level. Impacts vary considerably both between and within cities, meaning careful, evidence-based planning is important**.** The responsive planning policy encourages consideration of proposals for expansion holistically based on their merits. Our findings confirm the efficacy of this approach.

3. Minimum car parking requirements

The intent of the minimum car parking policy in the NPS-UD is to improve land use flexibility and the competitiveness of urban land markets within existing land uses. As with *Intensification* and *Responsive Planning*, greater flexibility lets businesses and residents move toward highest and best use of land. We estimate that removing minimum parking requirements (MPRs) in the five major urban centres for which data was available would result in indicative benefits of $670m, compared to indicative costs of approximately $78m for a cost benefit ratio of 8.6. The benefits of removing MPRs would generally accrue to consumers, while the costs would generally accrue to local residents or local government who may incur greater parking management costs.

MPRs commonly exist in district plans and are governed at the local council level. MPRs regulate the minimum number of off-street car parks a new development must provide. There is considerable variation and complexity in how and where they are applied across New Zealand's cities. The regulatory mechanism is usually based on estimated average near-peak demand for unpriced parking as a proportion of floor area, depending on the size and type of the new development. Demand is evaluated for 'free' parking, which generally induces an oversupply.

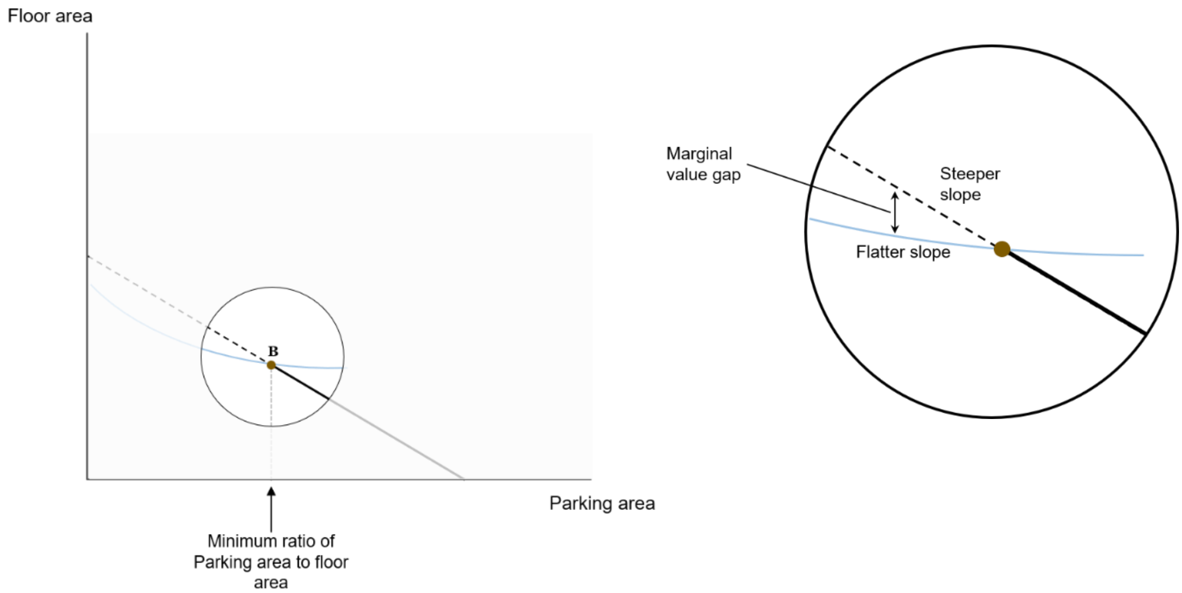
MPRs aim to prevent parking in undesignated areas, traffic congestion, and search costs, but carry significant long-term external costs where land is scarce. As the value of land has increased in New Zealand cities, MPRs have become more binding. This means that they impact development decisions and prevent highest and best use of land, even after accounting for benefits. In economic terms, they are distortionary. This is amplified when MPRs are applied without much spatial granularity or without regard to opportunity cost of land or changes in land use and land value across time (MPR rules change infrequently). As New Zealand's cities have grown and the value of proximity has increased, the economic distortion associated with MPRs appears to have followed.

As with other land-use regulations, there is considerable variation in the extent to which MPRs are binding on built form. Where the opportunity cost of land use is low, MPRs are less likely to influence development since developers will often exceed the minimum in response to market forces alone, meaning the minimum requirement has no effect (and therefore is not needed). This is more likely in smaller cities or on the periphery of large cities. As the price of land rises, and in the presence of constrained building dimensions (due to zoning rules, geography or construction costs for instance), the evidence suggests that MPRs can have a demonstrable impact on development and therefore prices.

To evaluate the economic cost of MPRs, we start with the premise that the profit maximising developer chooses to optimise floor and parking space by equalising the marginal value from each. Since binding MPRs require developers to provide more parking than they would otherwise choose, we expect MPRs to lift the marginal benefit of GFA above the marginal benefit of parking.

Figure 8: Inefficient allocation between floor area and parking area

Ordinarily developers choose an allocation between parking area and floor area such that the marginal benefit between the two is equal. This is the point where the profit curve and the budget constraint are tangential. MPRs distort this choice. More parking is required at the expense of floor space and so a marginal value gap emerges, as demonstrated below.

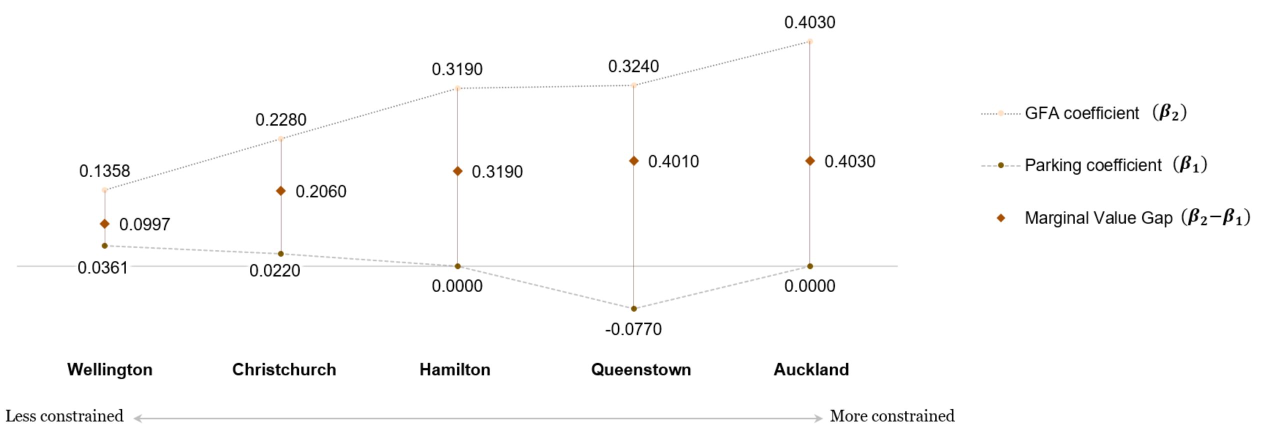


Source: PwC analysis.

Using parking data for five of the six cities, we find that the marginal value of floor space is higher than the marginal value of parking in every city. This is consistent with MPRs creating land use inefficiencies. Figure 9 illustrates this for each city. The distortions are highest in Auckland where a one per cent change in allocated parking area has no expected effect on property value but a one percent increase in gross floor area is associated with a 0.403% increase in property value.

Figure 9: Regression results – Marginal value of gross floor area (GFA) vs. marginal value of parking

The chart demonstrates the extent of the marginal value gap between floor space and parking space across New Zealand cities. For each city, the marginal value of floor space is higher than parking.



Source: HUD data, PwC analysis.
Note: Tauranga is excluded due to lack of available data.

The removal of MPRs does not necessarily result in significant declines in parking. Using a case study in Christchurch where the removal of MPRs in the city centre coincided with a large rebuild of the city (meaning the effects were evident more quickly), recent development patterns show concentrated patterns of parking, where businesses were left to specialise in floor space and parking buildings to specialise in parking. The amount of parking provided in Christchurch's CBD appears less dependent on floor area. We infer from this that developers are making more efficient decisions regarding the choice between parking and floor space. This means more employment, more productive firms and labour, greater agglomeration benefits and a boost to public transport competitiveness.

No city is too small to consider removing these distortionary rules. The costs of the Minimum Car Parking policy decline in proportion with the benefits, meaning the policy change will most likely either be neutral or net positive. Moreover, as a conservative assumption, we calculate the costs of removing MPRs assuming that additional parking management activities will be needed and provided by councils. The approach does not consider potential net revenue increases from parking management, which would further strengthen the (financial) case for removal. To the extent that councils take action to shift the full social cost of parking onto users of parking then, the costs of removing minimums will approach zero.

The effects of MPR removal would not be felt immediately. Urban development and redevelopment occur over generations, so the distortionary impacts of MPRs will likely persist for many years. Therefore, both the costs and the benefits associated with removing MPRs would likely occur over many years.

4. Housing and business assessments

The HBA policy generates benefits through enhancing the effectiveness of the intensification and responsive supply policies. Potential sources of benefit are lower average infrastructure costs per household, lower average housing prices, and smoothing house price cycles. HBA costs in the first year of reporting were estimated at $150,000 to a maximum of $300,000. We use the maximum number for cost-benefit analysis in all MUCs.

Small improvements in NPS-UD effectiveness have potential to create large gains in policy benefits. In the six MUCs, it would require very small marginal changes in housing supply elasticity to generate $300,000 worth benefits.

The potential benefits of HBA compliance are greatest in larger cities with constraints to flexible housing supply and strong demand growth. An unexpected increase in growth rates would make the HBA monitoring and reporting requirements more valuable to a city, including reports from years before the acceleration in growth.

5. Future development strategies

If HBA asks councils to consider "how much supply?", FDS asks councils to consider "where?" and "what outcome?" The potential sources of benefits for the FDS policy include lower average infrastructure costs per household and prevention of severe rises in housing prices, similar to those envisaged in the HBA. The FDS also creates benefits from better timing of land use review to avoid premature redevelopment of high-potential areas. Consultation with local councils indicate a range of costs for FDS compliance from levels similar to HBA expenses up to $2 million for councils engaging consulting firms for large parts of the process.

Small enhancements to the impact of the NPS-UD on supply responsiveness result in benefits that far outweigh the costs of compliance. The case of Wellington is closest to neutral: a marginal enhancement equivalent to a change from our pessimistic intensification scenario to our preferred scenario (an elasticity shift of approximately one standard error relative to historical variance) would generate enough benefits to justify a payment of $2.1 million every three years between now and 2043. For Auckland this number is over $160 million. Compliance with the FDS need not cost the upper bound however and it is reasonable to expect that compliance costs will decline over time as processes and methodologies are standardised. Such opportunities are reason for confidence that the policy will be net beneficial for the six MUCs. For smaller and slower growing cities, there may be benefits created by the FDS process even in the absence of gains in housing affordability—such as more efficient infrastructure spending and long-term planning.

6. Targeting

The NPS-UD targets six cities in New Zealand and their surroundings labour market areas. These six cities are generally on New Zealand's growth frontier, meaning they are either small with fast annual average growth rates (Queenstown, Tauranga and Hamilton) or large with more modest annual average growth rates (Wellington, Christchurch, Auckland). These areas also tend to be among the least affordable places to live in New Zealand.

There are three categories of cities to consider in the targeting of the NPS-UD, based on the existing targeting of the NPS-UDC.[3] These are:

Category 1 – Cities included under NPS-UDC requirements but excluded under the most prescriptive NPS-UD requirements, such as Gisborne, Marlborough, Whangarei, and New Plymouth. Cities in category 1 will regain any costs they would have incurred under the NPS-UDC if it were to remain in force. They will also forego any expected benefits to the extent that they choose not to continue with changes established under the NPS-UDC. If the intent of the NPS-UD is achieved, cities in this category will be able to continue compliance with the NPS-UDC at the discretion of local councils, implying no costs of removing the national mandate.

Category 2 – Cities included under the most prescriptive requirements of both NPS-UDC and NPS-UD. This includes Auckland, Hamilton, Tauranga, Christchurch, and Queenstown. Cities in category 2 experience the full benefits of the policy, and a reduced cost of compliance as much of the necessary transition has already been made under the NPS-UDC. Moreover, changes in the new policy ease some of the reporting costs of the NPS-UDC by allowing greater flexibility in how the new processes are integrated with existing ones. Our analysis indicates that even under pessimistic assumptions, the policy effects as intended carry net benefits in these cities.

Category 3 – Cities not included under the NPS-UDC requirements but included as metropolitan urban centres (MUCs) under NPS-UD. This category comprises Wellington alone. In our data and modelling, Wellington presents the weakest case for NPS-UD policies among the MUCs. Wellington has an unusually high status quo elasticity of supply that may not account for recent changes in constraint patterns. The city also has weaker historical population growth than the others—the reason given for its exclusion from the most prescriptive requirements of the 2016 policy. These two factors contribute to low projected price impacts and housing supply response for the city compared to its MUC peers. Despite this, Wellington's considerable supply constraints in high-demand areas contribute to an expected magnitude of intended policy benefits net of costs ranging from $50 million to $140 million overall for the period to 2043. These estimates support the decision to include Wellington.

[3] This analysis was completed based on the consultation document for the proposed NPS-UD policies circulated in August 2019. Later revisions to the targeting approach have not been reflected here.

We estimate the intent of the NPS-UD, which assumes improvement over the status quo. The intended types and mechanisms of benefits of the NPS-UD are similar to those of the NPS-UDC as assessed in the 2016 cost benefit analysis. For the cities targeted under each NPS, the policy intent is to improve the affordability of housing and the quality of urban outcomes while minimising external costs and maximising external benefits. However, the NPS-UD also includes an improvement over the new status quo as an implied intended outcome; that is, over the already assumed benefits of the NPS-UDC in cities where it applied. Accordingly, we estimate benefits in the present study as assumed deviations from the status quo, whether that involves NPS-UDC effects or not.

Land use flexibility is valuable when demand is stronger than expected. The six targeted cities, which all face significant growth pressures, benefit from the policies. Smaller and slower growing cities carry less potential to benefit from these policies in the medium-term because land use efficiency is not as consequential. For these cities, benefits are certainly less, and less certain. The external costs of urban growth are likely to be lower as well, but costs of transition and ongoing compliance will remain at a minimum level, even if the policy has no impact. This implies a threshold at which the policy might carry a net cost for smaller cities (notwithstanding the fact that this can change with an influx in demand). Accordingly, we suggest that second tier cities should be encouraged to opt in but not be compelled to join.

Targeting recommendations by policy area

Based on the insights provided by the modelling of land and housing market dynamics and urban spatial structure, the sections that follow provide recommendations by policy area regarding the risks and benefits of extending NPS-UD targeting to smaller or slower growing cities.

Intensification and responsive growth – Each of these policies increases the responsiveness of housing supply. With this comes the possibility that population growth will increase, leading to higher congestion and crowding impacts. Crowding and congestion costs are dispersed across the population, while benefits are concentrated among newcomers, new buyers, and renters. For smaller cities, responsiveness of demand to price changes is central to the cost benefit analysis. The responsiveness of migrants to move from city to city as a result of relative living cost differences determines the impact of a policy on population change (and therefore the costs). At one extreme, if population does not change, the effects are distributional, from homeowners to renters for instance. If population is highly responsive, crowding and congestion costs would be higher as new residents move into the city (and benefit through doing so). Because these dynamics are complex and always changing, smaller cities may find it useful to undertake periodic projections of demand and assessments of supply rigidities. For the NPS-UD, we recommend that policy makers consider a mechanism to refresh the targeting of cities over time.

Minimum parking – The MPR policy proposes removal of existing distortions in how land and building space is allocated between storing cars and other uses. In smaller cities where other uses of space are less constrained by MPRs, this policy may have no impact. However, since costs will decline in proportion to benefits, there is little risk of a net loss by implementing this policy, regardless of city size or growth rate. We note that there may be benefits in all urban areas in using more active parking management approaches, rather than minimum parking requirements.

HBA and FDS requirements – if the costs of HBA and FDS requirements are relatively fixed across cities, but the benefits of land use flexibility accrue to large cities, then a threshold effect is possible, where benefits don't outweigh costs. It is complex to evaluate this threshold with any certainty. For instance, the monitoring and strategic forecasting capacity that councils would develop under these requirements may carry significant option value under uncertain growth trajectories. For cities such as Dunedin, New Plymouth, and Palmerston North, whose land value profiles are similar to Hamilton's, we recommend consultation with local urban planners to determine whether a national mandate to meet some or all of the HBA and FDS requirements would be preferable to optional participation.

Competitive land markets in New Zealand cities

Faced with a housing affordability crisis, policy makers increasingly recognise the importance of improving urban land competitiveness.[4] This means encouraging greater competition across urban land markets, both between locations and potential uses of land. Under such a focus, historic land use patterns, unnecessarily rigid planning rules, or psychological heuristics (such as status quo bias) would become relatively less central to the shape and feel of New Zealand cities; the monopoly power currently enjoyed by many existing landowners reduced.

Competitive land markets are supported through greater land use flexibility. This means increasing the sensitivity of development to *local* land price changes, wherever they occur. When commuting times lengthen and residents are prepared to pay more to live in central suburbs, development moves inward. If transport investment brings two pieces of land closer together, development expands to wherever accessibility has improved. Since urban demands, city amenities and transport technologies are all dynamic and constantly changing across space, relative local land prices are constantly in flux. In the face of such immense complexity, it is difficult to expect any planning department to keep up. Land use flexibility is a powerful policy tool to help stay ahead of the curve and plan for uncertainty.

The potential benefits of flexible urban policy include higher productivity and wages, shorter commute times, lower housing costs, and more competitive urban spaces. Policy benefits especially accrue to lower socioeconomic groups and future generations. New Zealand's cities would also be better equipped to respond to a range of urban problems, from changing patterns of wealth inequality and housing affordability, to climate change and urban sustainability. The six policies examined in the NPS-UD represent one important step in this direction.

[4] For instance, see New Zealand Treasury (2016), Chew Session on Competitive Land Markets.

Part 1: Urban Intensification

Problem statement

New Zealand has some of the most liveable cities in the world, but within those cities, housing that has good accessibility to jobs and amenity is expensive. One contributing factor to these high housing prices is that planning rules that make development in these areas unresponsive to increases in price. Where planning rules are having an impact on development decisions, urban residents are pushed to second best locations; either to other parts of the city (that may have higher social costs), to other cities, or abroad.

Intended outcome

The intent of the intensification policies is to ensure that council plans enable increases in home ownership, job participation and activities in areas with high levels of accessibility to jobs, amenities and services – for both existing urban areas and greenfield development.

Intensification key messages

To keep housing affordable and accessible in high amenity areas, the **NPS-UD policies intend to decouple house prices from land values** by allowing for a greater intensity of development in high-demand areas, alleviating scarcity of building space in response to scarcity of land.

The **benefits of urban intensification are driven by an increase in the responsiveness of housing supply** arising from removal of regulatory barriers to brownfield redevelopment, particularly in areas where benefits of intensification can be achieved efficiently (for instance, those close to public transit nodes). More responsive supply creates benefits through two key mechanisms: lower costs of housing for renters and new homebuyers, and agglomeration economies of productivity from the resulting increase in employment density.

Based on empirical estimates using ratings data at property level for each city (and building on the approach used in the 2016 assessment of the NPS-UDC), we find that **zoning policies are having a constraining effect on supply in all six major urban centres (MUCs)**, with the strongest constraints in Tauranga and Auckland. Cities that are highly constrained are likely to see significant impacts from the policies. We use these city-specific estimates of regulatory constraint to evaluate the impact of intensification policy on supply elasticity.

The **added congestion and external costs to network infrastructure users drive policy costs**, which vary according to population growth. Using conservative assumptions in the base case, **all six MUCs would achieve benefits that outweigh costs by a multiple of between two and seven**.

There are large distributional consequences to the policy. Typically, these are transfers from existing land and property owners to renters and new homebuyers. The estimated value of these transfers to renters is around **two to six times the net benefits** in each city.

Cities are about access: the theoretical foundations for intensification

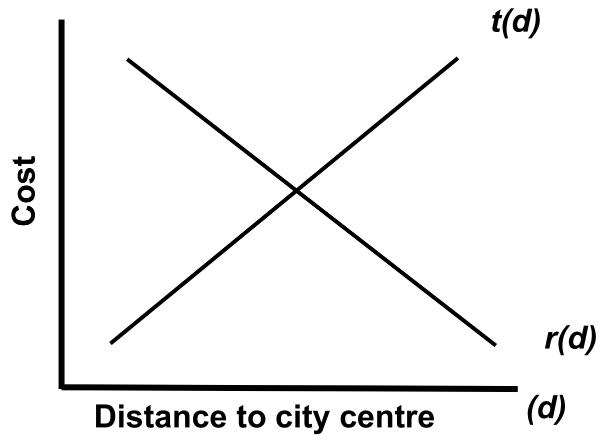
To estimate the benefits and costs of responsive housing supply in brownfield areas, we rely on the theoretical underpinnings of the Alonzo Muth Mills (AMM) model of spatial equilibrium.[5] In the sub-sections that follow, we provide an overview of the model and the most relevant economic relationships it implies. An understanding of this theory is important to the analysis that follows. The assumptions and limitations of the model are discussed in more detail in Appendix B.

Overview of the Alonzo Muth Mills model

The AMM model is a simple yet powerful depiction of urban spatial structure that explains the economic substitutions associated with spatial choices that individuals make about where to live, work, and consume within the urban landscape. The model assumes a monocentric city built around the two key observations that (1) cities exist to maximise access to opportunity and amenity and that (2) access can be attained by direct proximity or, as a substitute, by transport. By extension, commuting cost differences within an urban area must be balanced by differences in the price of living space, which has strong implications for the spatial structure of the city.[6]

Because commuting is costly in terms of time and money, households prefer to live closer to the Central Business District (CBD) if they can afford to, all else equal. In areas further away from the CBD, land is less scarce, but transport costs to the centre are higher. As households substitute between consuming more space and having greater access to the amenities of the CBD, prices and density of housing adjust to clear the market. In the spatial equilibrium, market prices adjust to compensate for differences in non-market amenities between locations. This means there are no rents to be gained from shifting location. Consequently, housing is expensive close to the CBD because individuals bid up the price to avoid transport costs. Bidding will theoretically stop when the cost of living in the CBD is equal to transport costs plus the costs of living in a house on the fringe of the CBD. The relationship between travel costs and house prices (rental cost) is illustrated by Figure 10.

Figure 10: Spatial equilibrium in the AMM model



Transport and rental costs are a function of distance, denoted *(d)*, where *d* is the distance from the city centre.
t(d)= transportation costs
r(d)= rental cost (one proxy for r(d) is median house values)

Source: Kulish et al. 2013, PwC analysis

Figure 10 demonstrates the central feature of spatial equilibrium. If the sum of all housing and commuting costs—including, for example, cost of time spent commuting or maintaining a house—could be held constant as distance changes, residents would be indifferent between residing at any distance from the city versus any other. This indifference implies that housing costs must decline with distance to exactly offset the increase in transportation and other costs. Accordingly, land values will decrease as distance to the city centre increases, and the magnitude of this decrease is a function of transportation costs.

The AMM model predicts, for example, that cities with higher transportation costs will have a steeper housing

[5] We refer indirectly here to the seminal papers by Alonso (1964), Muth (1969), and Mills (1967), but our primary source of reference for the model is that developed for policy analysis by the Reserve Bank of Australia as described in Kulish, Richards, and Gillitzer (2011).
[6] Brueckner, J. (1987)

cost gradient (*r(d)*), because the slopes of r(d) and t(d) are opposite.[7] If these are added together, the result is a fixed total cost of living for any location in the city that is equal to the cost of housing at the centre of the city *r(0)*.

Because land is more expensive closer to the CBD, developers economise the use of land by building more dwellings per unit of land—meaning fewer single-dwelling houses (for which average floor area is often less than the land area of a given plot) and more terraced housing and apartments (for which floor area may be many times greater than land area for a given plot). The city structure is therefore characterised by higher density and taller buildings close to the CBD and lower density and building heights on the city fringe. The overall size of the modelled city will be determined by the size of the population, the cost of transport, and the value of land in alternative uses, such as commercial or agricultural use.[8]

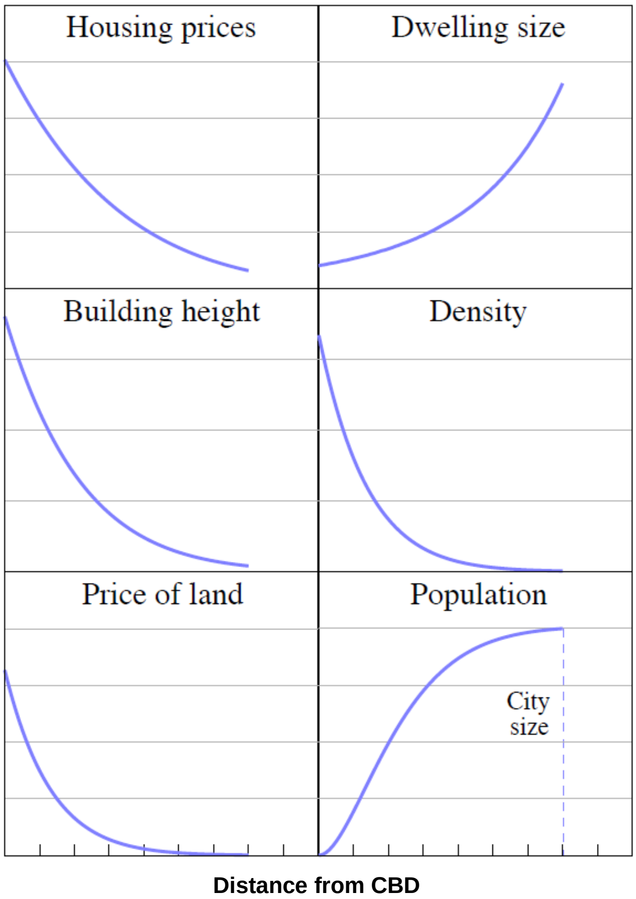
Implications of the AMM model for land markets and spatial economic relationships

The assumptions described above have important implications for the relationships we expect to observe between key urban parameters and distance from the centre of the city. Depicted below are a series of graphs that demonstrate the key economic relationships implied by the AMM model between important variables in urbanisation and the costs and regulations that affect their behaviour. In the unconstrained competitive equilibrium, we observe the following, as illustrated in Figure 11:

- **Land values decrease as distance from the CBD increases.** Demand for land is highest in the CBD as it has the greatest access, and lowest cost of access, to opportunity and amenity. This strong demand for access to amenity causes willingness to pay for floor area to rise, allowing developers to maximise returns to land purchases by building more floor area per unit of land.
- **Housing prices decrease as distance from the CBD increases**. The decrease in rent reflects weakening demand and compensates for higher transport costs and less proximity to amenities.
- **Dwelling sizes increase as distance from the CBD increases**. This reflects that people consume more space as it becomes cheaper and applies both to land plot sizes and floor area of dwellings.
- **Building heights decrease as distance from the CBD increases**. As land values decrease relative to construction costs toward the fringes of the city, developers provide less floor area per unit of land.
- **Population density decreases as distance from the CBD increases**. This is a combination of two factors: less floor area per unit of land, and more consumption of floor area per person.
- **Cumulative population increases at a decreasing rate as distance from the CBD increases**. This is a direct summation of the density curve described above.

[7] Glaeser, E. (2008)
[8] Kulish, M. Richards, A. Gillitzer, C. (2013)

Figure 11: Unconstrained urban equilibrium



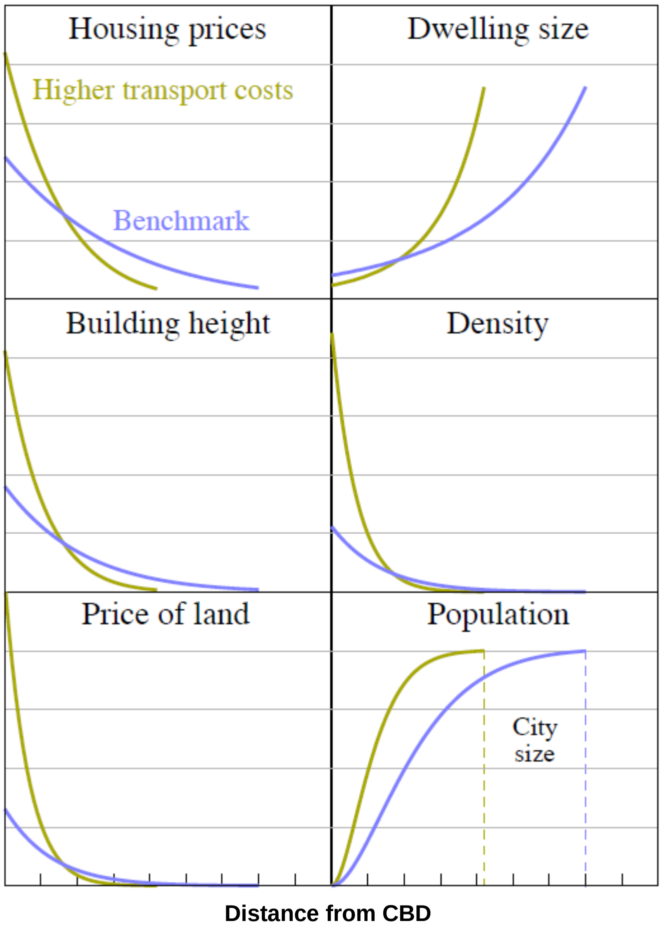
Source: Kulish, M. Richards, A. Gillitzer, C. (2013);
Note: Population shown above is cumulative. As noted by the authors, "the parameterised model should not be expected to fit all dimensions of any particular city. The units of this figure and subsequent ones are as follows: housing (rental) prices in dollars per square metre of living space per year; dwelling size in square metres of living space; building height in housing floor space per unit of land, which corresponds roughly to stories; density in persons per square kilometre; (rental) price of land in thousands of dollars per hectare per year; and population in thousands. The model refers to the rental price of housing and land, but under an assumption of a given capitalisation rate, these translate directly to purchase prices."

The following subsections introduce some of the important implications of these relationships and briefly describe their relevance to the intent of the NPS-UD to encourage efficient use of scarce urban land by improving the competitiveness of land markets.

Impacts of higher transport costs on land markets

Figure 12 illustrates a key link between competitive land markets and the cost of transport as implied by the AMM model: the expected impact of an increase in transport costs on the relationships between distance from the city centre and house prices, land values, density, building heights, and space consumption per household (dwelling size). As direct transport costs borne by residents (as opposed to the external costs described in later sections) rise, locations further away become a more costly substitute for proximity to the centre. This shrinks the effective size of the city, or more accurately, the urban labour market, increasing the scarcity of land available for all urban uses.

Figure 12: Effect of higher transport costs



Source: Kulish, M. Richards, A. Gillitzer, C. (2013).

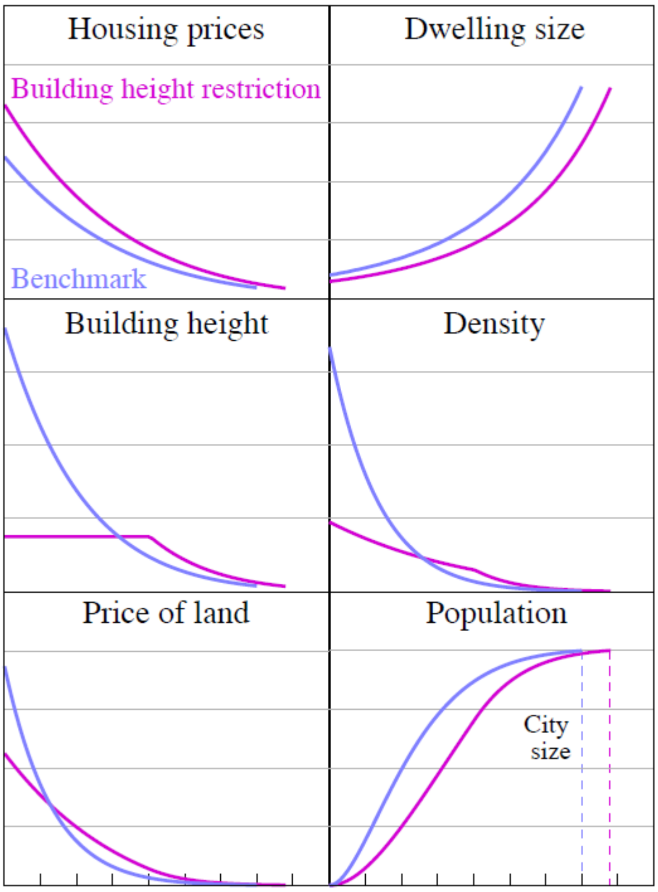
The policy implications of this basic relationship are not straightforward. A rise in transport costs may be either an intended consequence of a policy decision, as in a congestion charge or increase in parking rates, or an unintended consequence, as in higher congestion caused by an increase in automobile use resulting from low-density expansion at the urban fringe. Moreover, a policy intending to reduce transport costs may increase it overall when other factors such as time, health, and risk are considered. Finally, policy implications depend on local priorities. If a city aims to achieve a dense urban form, policies that tax car use might be effectively combined with high-density zoning to create the intended incentives. If the primary concern is affordability of housing for the greatest number of people, policy makers may wish to effect targeted reductions in transport costs that minimise unintended consequences, such as congestion. For our assessment of the policy initiatives of the NPS-UD, we refer to the effects of changes in transport costs on spatial equilibrium in the chapters on minimum car parking requirements and responsive planning for development.

Impacts of density controls on land markets

Figure 13 illustrates the expected impact of density controls (such as building height restrictions), all else equal, on the same set of spatial equilibrium relationships. We observe that housing prices increase across all distances from the city, with the greatest increase corresponding to the largest gap between constrained and unconstrained heights. This reflects the greater scarcity of floor area imposed by the height restrictions in areas of high land values.

Dwelling sizes decrease across all distances from the city as higher floor area prices induce consumption of less space per household. Building heights are capped at the permitted level until more distant locations, where land values are low enough to induce heights below the permitted limit. The same restriction can be binding in high-amenity locations (meaning it impacts development decisions), but non-binding in distant locations. This has important consequences for policy evaluation, which we discuss in later sections. Density controls also have an impact on the size of the city. Land values at the periphery of the city are higher than under the competitive equilibrium, to meet overflow demand from the now restricted centre. We observe more intensive development on the periphery than under the competitive equilibrium. That is, height restrictions push density further away (in the absence of an urban limit).

Figure 13: Spatial equilibrium effects of building height restrictions



Distance from CBD

Source: Kulish, M. Richards, A. Gillitzer, C. (2013).

Unlike an increase in transport costs, the imposition of building height restrictions has a clear effect on housing affordability. By a direct restriction of supply in areas where demand is strongest, housing becomes scarcer, and prices higher, for the whole city. The effects on land values are notably different: at the core of the city, where restrictions impose the largest gap between the unconstrained building heights and the imposed limit, land values decrease. Further from the centre, where displaced demand has resulted in higher density than would otherwise have been feasible, land values increase. This is an important point: land values decrease where demand is high and increase where demand is lower, but housing prices increase in both areas. This has the following implications for the NPS-UD:

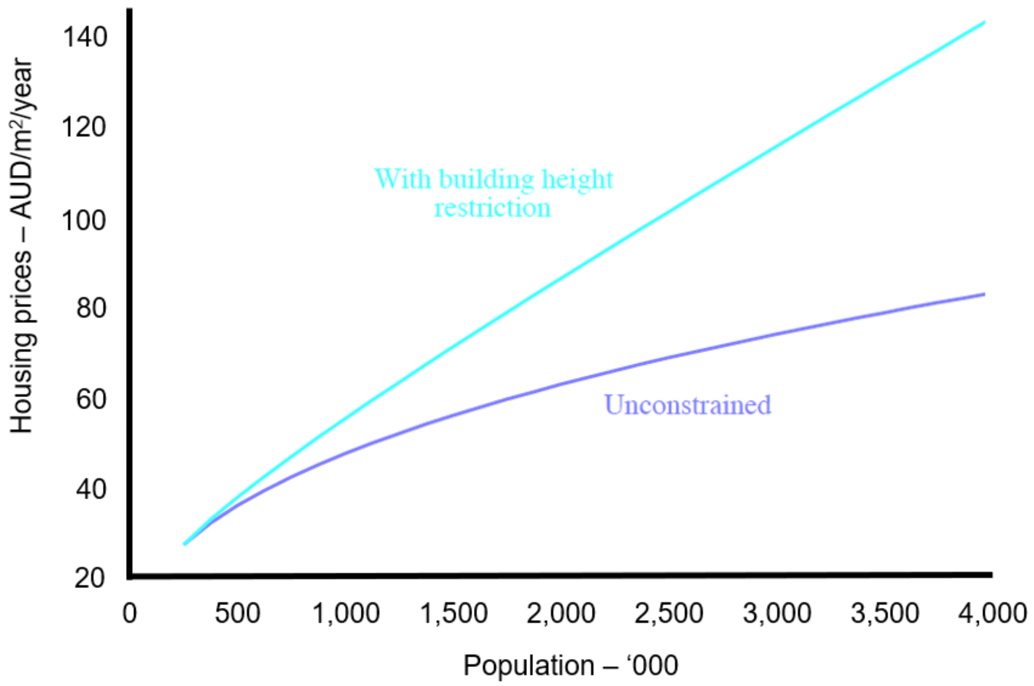
- A decrease in land values does not necessarily indicate an improvement in the competitiveness of land markets. In the case of building height restrictions, the land-value decrease is a result of a relative decrease in demand due to a regulatory change in revenue potential of the land.
- In the reverse case, when a building restriction is removed, we expect an increase in land values where demand is highest to coincide with an improvement in housing affordability city-wide. This idea is critical to our assessment of the intensification policy and explored in depth in our case study on Mount Eden.
- The relationship of housing affordability to competitive land markets must be considered within the context of competitiveness among buyers as well as among sellers; that is, competitiveness of potential uses as well as of potential locations. The former deteriorates when building dimensions or uses are constrained in areas of high demand. This effect is observed empirically in our chapters on minimum parking requirements and intensification.

- When height restrictions or other limitations on building dimensions make floor area in the city centre scarcer, residents and businesses substitute by locating further away. This substitution inflates demand for development at the edges of the city, as illustrated in the building height portion of Figure 13. This becomes important as we consider interactions between policy objectives aimed at intensification and urban expansion.

As population grows over time, building height restrictions will have an intensifying effect on housing prices. As growing demand puts upward pressure on prices, the restrictions enforce provision of less new housing for the same increase in price, i.e. the price elasticity of supply decreases.

Figure 14 illustrates the modelled effect of this decrease in supply responsiveness on prices as city population grows. This growth of demand over time is a key driver of our assessment of the benefits of urban intensification. The next subsection further explores the role of demand.

Figure 14: Housing prices at 10km from CBD



Source: Kulish, M. Richards, A. Gillitzer, C. (2013)
Note: Y axis represents prices in AUD/m^2 per year.

Demand is not exogenous

Thus far we have focused on the dynamics of land market competition between locations and uses within cities. However, city populations do not grow independently of local housing market conditions. Growth rates are directly affected by the trade-offs between accessibility, amenities, housing prices, and travel costs in a city. In practical terms, this means that when the cost of living rises, some households choose to leave the city in search of more affordable living situations, and others who may have moved to the city for new opportunities decide against it.

A high-level observation of Auckland's net internal migration and discretionary income over the last decade shows some evidence of this concept. Between 2008-2012, newcomers to Auckland experienced relatively strong discretionary income growth and the city saw a net gain in internal migration from the other growth cities. Conversely, between 2012-2016 newcomers to Auckland experienced a decrease in discretionary income driven by house price appreciation and rising transport costs (Figure 15).

Figure 15: Auckland net migration with growth cities and estimated discretionary income

Source: Stats NZ, New Zealand Treasury, PwC analysis.
Note: The term "growth cities" indicates Whangarei, Hamilton, Tauranga, Wellington, Lower Hutt, Christchurch, Dunedin, and Queenstown. Estimated discretionary income is calculated for the marginal household by deducting median housing, transport, and other expenditures from median income.

This demonstrates another core component of the spatial equilibrium: if house prices rise faster than wages and other urban benefits, some residents will respond by moving away. If housing remains affordable as benefits rise, cities will see stronger population growth. For example, a recent study by Nunns (2019) finds an association between housing price distortions in New Zealand and labour migration to Australia.[9]

The AMM model and empirical examples discussed above illuminate a key challenge facing policymakers focused on housing affordability: the high price of land in areas where people want to live and work, and the low demand to live and work in places where land is affordable. In the following subsection, we present an important implication of this theoretical foundation: that high land values need not sentence urban residents to high housing prices.

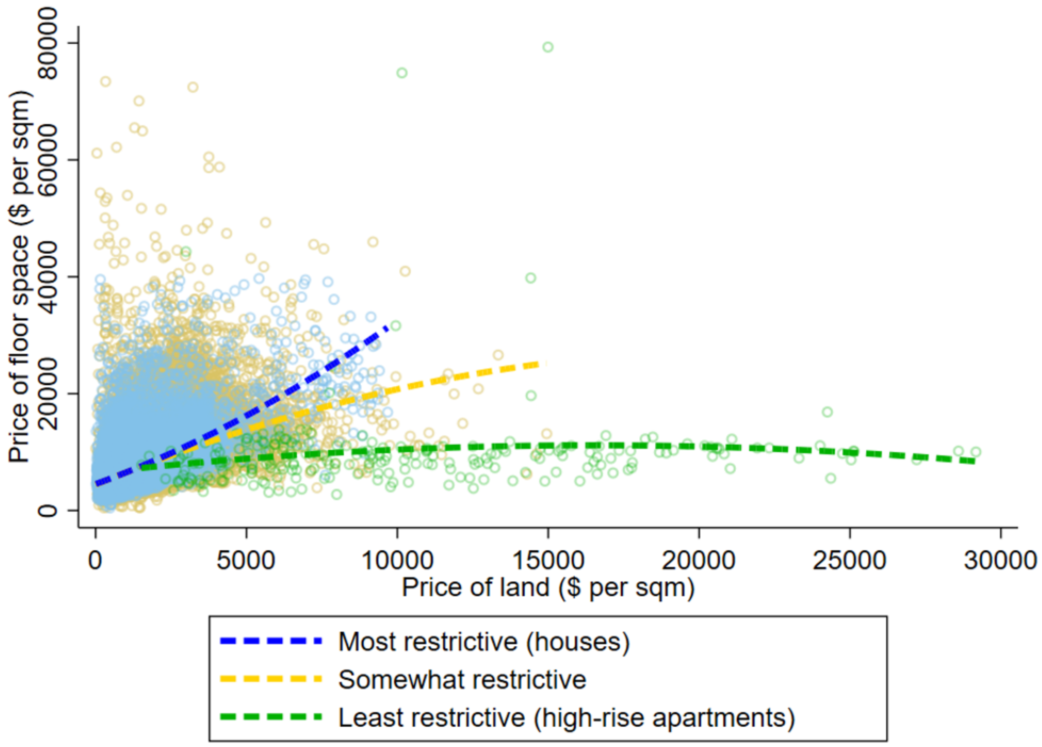
More housing, same land: the benefits of intensification

To keep housing affordable and accessible, the NPS-UD policies intend to decouple house prices from land values by allowing for a greater intensity of development in high-demand areas. By doing so, scarcity of floor space is alleviated, and prices can fall.

Figure 16 demonstrates this concept in Auckland and shows that floor space in apartments is not correlated to land values in the high-density centre area. This is shown by the dotted green line and suggests that as the price of land increases, the price of floor space remains relatively constant. In contrast, floor space in less-dense housing zones is positively correlated with land values, as shown by the blue dotted line, meaning that as demand increases, supply does not keep up and prices increase with land values.

[9] Nunns, *The Causes and Consequences of Rising Regional Housing Prices in New Zealand*, 2019.

Figure 16: The relationship between price of floor area and land values for residential properties in Auckland



Source: HUD data, PwC analysis. Adapted from MRCagney, BECA & Covec (2016).

The cost of land becomes less important for house prices as the number of dwellings per unit of land increases. For example, land costs from $5000/m² – $30,000/m² appear to have almost no effect on the price of floor space in Auckland's high-density zoning areas. This means that residents have the option of accepting less floor space consumption to retain access to the most desirable locations.

In the sections that follow, we develop a model based on these concepts to estimate the potential costs and benefits of the intended outcomes of the NPS-UD policies relating to urban intensification.

Estimating the costs and benefits of intensification

In this section, we describe the technical steps and methods used to arrive at an estimation of the benefits and costs that might arise if the NPS-UD policies on urban intensification were to succeed in their intent. The assessment divides costs and benefits into four categories:

- Direct benefits to new homebuyers and renters as a result of more affordable housing in the with- versus without-policy scenario. These benefits are assessed through a comparative statics approach focused on added consumer surplus attributable to the policy.[10]
- External costs of greater urban density on existing infrastructure networks, incumbent residents, and the environment.
- External benefits of agglomerations in production arising from higher density labour markets.
- Desirable transfers of benefit from existing home and landowners to new homebuyers and renters, also assessed through a comparative statics approach.

To develop our model and the assumptions that inform it, we rely on data provided by the Ministry of Housing and Urban Development, Statistics New Zealand, the Real Estate Institute of New Zealand (REINZ), the Ministry for the Environment, the Ministry of Business Innovation and Employment, Land Information New Zealand (LINZ), city and district councils, and other sources. See Appendix B for a full description of data and sources used.

The discussion presented below is structured as follows:

- The first section presents our theoretical approach to estimating the direct benefits and transfers of intensification using a comparative statics model, describing calculation steps for key model inputs and quantitative relationships before presenting our comparative statics model results.
- The second section examines costs using a modified version of the approach used in MRCagney, BECA & Covec (2016), the cost benefit analysis of the NPS-UDC.
- The third section describes calculation steps for a second model that estimates the agglomeration benefits resulting from the population impacts projected by the comparative statics model.
- The fourth section summarises costs, benefits, and transfers of the intensification policy intent.

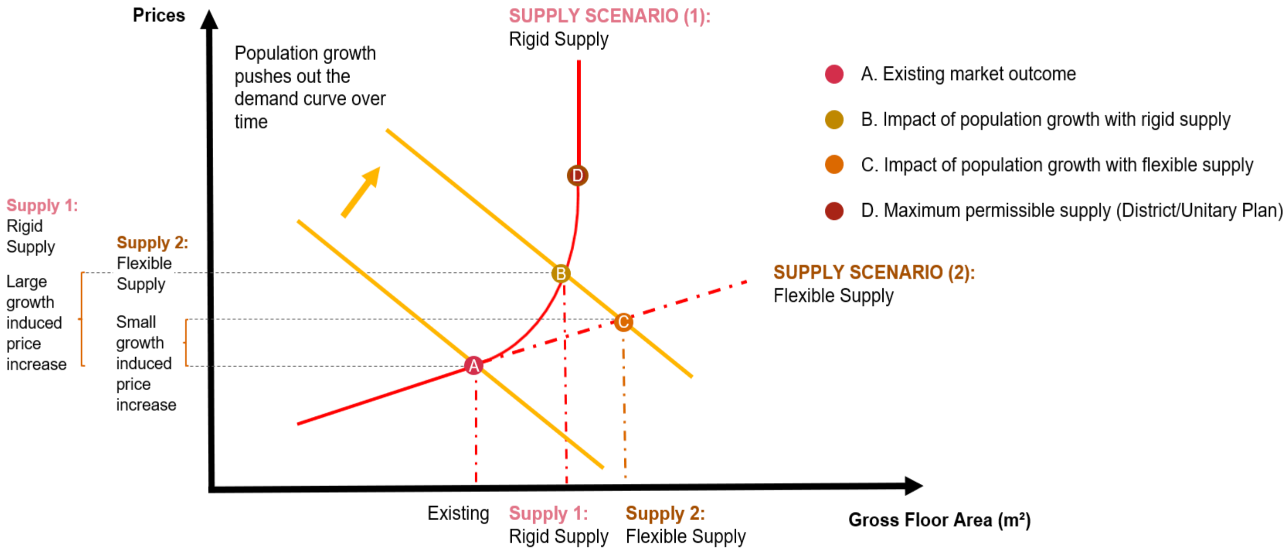
Consumer surplus benefits and transfers: a comparative statics approach

The nature of supply for housing as demand increases is a key consideration for the policy intent we aim to model. Rigid supply can cause large price increases with disproportionately small supply increases as the population grows, meaning housing becomes increasingly unaffordable and significant wealth is transferred from renters and first-time homebuyers to existing owners of real estate.

Figure 17 illustrates the effect of supply constraints on the equilibrium price in the market for floor space. In the figure, a city is growing under two scenarios, the first of which features a rigid supply response to price while the second features more flexible supply. Point A is the existing market outcome today, where demand and supply intersect.

[10] Comparative statics is the comparison of economic outcomes for relevant stakeholders (usually producers and consumers of a given good) with and without a change in a certain input parameter. In our case, the good is housing and the input parameter is the price elasticity of housing supply. This approach focuses on comparing two alternative states of equilibrium, simplifying transition period or time-based effects.

Figure 17: Effects of supply rigidity on price and quantity of floor area



Source: PwC analysis.

The increase in population over time is shown by the yellow demand line shifting upward and to the right. The magnitude of this demand shift is determined by the size of the existing population, the net of birth and mortality rates, and the net demand for migration to the city. A larger shift will cause greater policy impacts, all else equal.

In scenario one, point B is the market outcome, whereas point C is the market outcome for scenario two. Point B has a higher price point and lower Gross Floor Area (GFA) quantity compared to point C, where suppliers provide more floor area at a lower price. The relationship between price and the quantity supplied by developers is characterised by the slope of the supply curve, as depicted by supply scenarios 1 and 2 in Figure 17, and referred to as the price elasticity of supply.

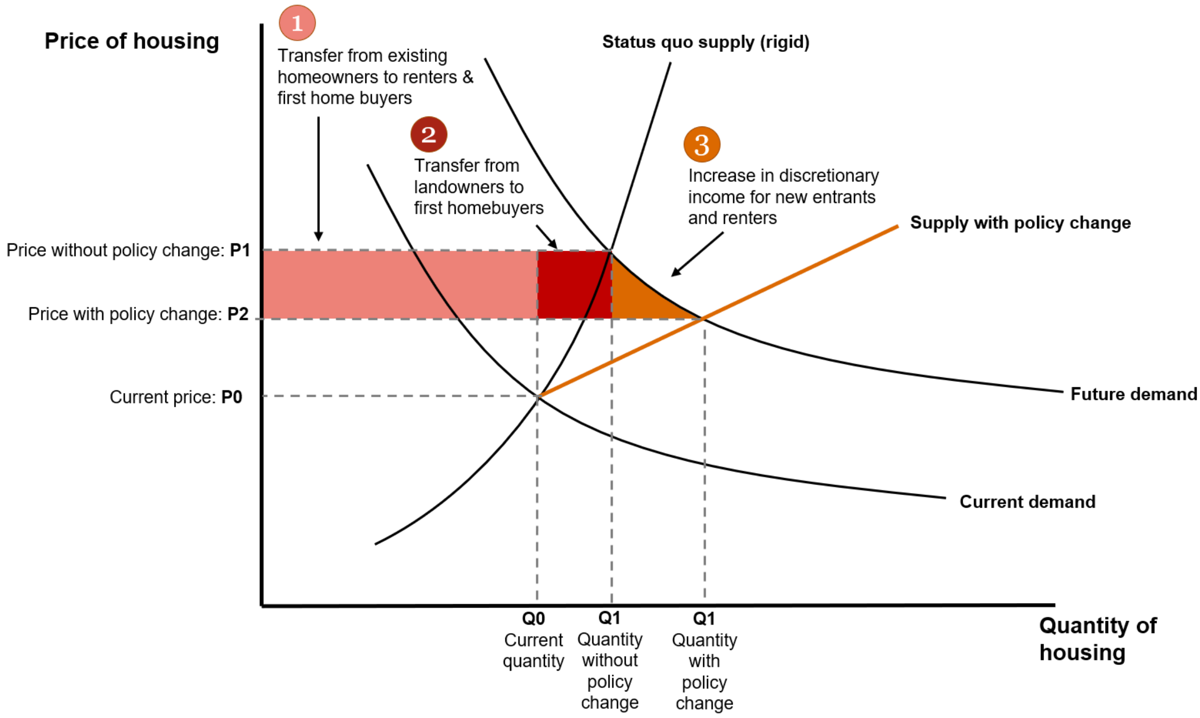
When demand for proximity is high, rigid density controls are more likely to be binding, reducing local supply and increasing prices. This in turn pushes growth into second-best areas, which can often involve expansion at the edges of the city as the AMM model implies.

An increase in the price elasticity of housing supply (that is, the responsiveness of developers with respect to price) in desirable, high-access areas has the following effects as population grows over time:

- Developers will provide more units of housing for the same increase in price in high amenity locations.
- Prices will rise less steeply, reflecting lower scarcity of housing and resulting in a lower future price.
- Housing transactions that would have occurred without the change in elasticity still take place, but at lower prices. This creates a transfer of surplus between consumers and suppliers.
- Some transactions take place that would not have occurred without the change in elasticity, as consumers who would have refused to participate at higher prices are now able to afford a place to live in the city. This creates a purely additional consumer surplus benefit as a function of the magnitudes of price and quantity changes.

Intensification increases the elasticity of supply under growing demand conditions by reducing costs and barriers to maximal redevelopment of brownfield properties. As discussed above, the resulting price and quantity impacts have distributional consequences as well as purely additive economic benefits.

Figure 18: Comparative statics with and without a change in supply elasticity



Source: PwC analysis.

In Figure 18 above, the width of rectangle (1) represents the volume of secondary-market and rental transactions that will take place over the projected period involving existing homes. The height of the rectangle represents the impact of the policy on price during the period. The area of rectangle (1) therefore represents a transfer of value from existing homeowners to new buyers and renters, or more accurately, a decrease in the expected transfer in the opposite direction. This implies a potentially large distributional effect of the policy in favour of reducing inequality between asset owners and wage-earners.

- Rectangle (2) represents transfers from existing landowners and developers to new homebuyers and renters of new homes.
- Triangle (3) represents the purely additional benefit gained in the form of discretionary income of new arrivals.

To model the potential value of these three effects, we follow a similar linear demand and supply approach to that used by MRCagney, BECA & Covec in the 2016 CBA, described in detail in Appendix B. Our calculations require the following as inputs:

- Current housing supply and households in each city.
- An estimate of baseline demand growth in each city over our study period.
- Assumptions about the slope of the demand curve.
- An estimate of baseline supply elasticity in each city without policy effects.
- Assumptions about the level of impact the policy might have in each city if successful in its intent.

To provide these inputs, we rely on data from Statistics New Zealand for current supply and households and for population growth projections, from which we derive baseline demand growth.

We establish the slope of demand based on the New Zealand-wide estimates of Hyslop et al (2019), who observe a demand elasticity of -0.516 with a standard error of 0.717 using data from 308 Territorial Authorities and Auckland Wards from 1991 to 2013.[11] We use this estimate to inform two scenarios for demand elasticity:

[11] That this estimate is not statistically different from zero is irrelevant as we are not testing a hypothesis about whether the relationship between price and quantity demanded of housing exists. The high standard error tells us instead that the strength of the relationship (the existence of which we assume) varies widely by time and location. The estimated elasticities are in log-log form.

- A low-response scenario equal to the New Zealand-wide estimate of -0.516. This reflects our assumption that the six major urban centres (MUCs) targeted by the NPS-UD are likely to have above-average demand responses to a given change in housing price, particularly a decrease.
- A high-response scenario equal to -1.233; that is, the same estimate plus one standard error. This higher demand scenario remains well within the bounds of historically observed variation.

Our estimates of baseline supply elasticity and the change resulting from the policy are described in the following two subsections.

Model inputs for baseline elasticity

We estimate the price elasticity of new housing supply for the six MUCs targeted by the policy using an adaptation of the econometric model used by Caldera-Sanchez and Johanssen (2011). Our estimates focus on the long-term responsiveness of new housing supply to changes in median house price observed in the six cities, based on building consent and sales price data for the period from 1998 to 2019. Detailed descriptions of our model specifications and methodology as well as a complete list of data sources are provided in Appendix B. Table 1 summarises the outputs of the model, which provide our baseline estimates for the elasticity of supply in each city under the status quo scenario.

Table 1: Housing Supply Elasticity Estimates

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Housing supply elasticities	0.876	0.840	0.517	1.353	0.778	0.875
P-value[12]	0.000	0.000	0.021	0.000	0.000	0.000
R^2 value[13]	0.869	0.667	0.5199	0.250	0.631	0.856
Standard error	0.221	0.118	0.221	0.218	0.214	0.115

Source: PwC analysis

As an example of interpretation, the value of building consents in Auckland is expected to increase by approximately 0.876% in response to a 1.0% increase in real house prices. Note that the estimate for Wellington is significantly higher than the other cities, with a lower R^2. We observe that the month-to-month volatility of building consent data for Wellington is an order of magnitude higher than the other cities, which all had similar consent volatility. This may be an idiosyncrasy associated with Wellington's role as the national capital, or Wellington may be an outlier in other ways. It is difficult to determine whether the anomaly is relevant to our expectations of housing supply response to prices in the long term, as long-term trends in the data show little deviation from patterns in other cities. For the purpose of interpreting cost and benefit estimates generated by the model described below, note that the unusually high baseline elasticity for Wellington will dampen the magnitude of both costs and benefits, in near-equal proportion, but will not affect their direction or the general conclusions. Nevertheless, care should be exercised in comparing the magnitude of effects between Wellington and the other cities.

Model inputs for policy effectiveness

To estimate policy impact on elasticity, we use a high and a low input assumption derived from the maximum and minimum observed standard errors in our empirical results summarised above. This ensures that our assumed policy impacts are well within the scope of historical variation in elasticity for New Zealand cities as a starting point. We emphasise that a difference of one standard error is an undramatic choice for our starting policy impact—it represents a change equal to the square root of the observed historical variance in supply response to price changes. An impact of this magnitude would be unremarkable if it happened by mere chance. Our high and low estimates thus might be better described as "conservative" and "very conservative" estimates of the potential benefits of a successful intensification policy—they do not represent the extremes of possibility, but two unremarkable outcomes within a much larger range. We intend this conservative choice for potential

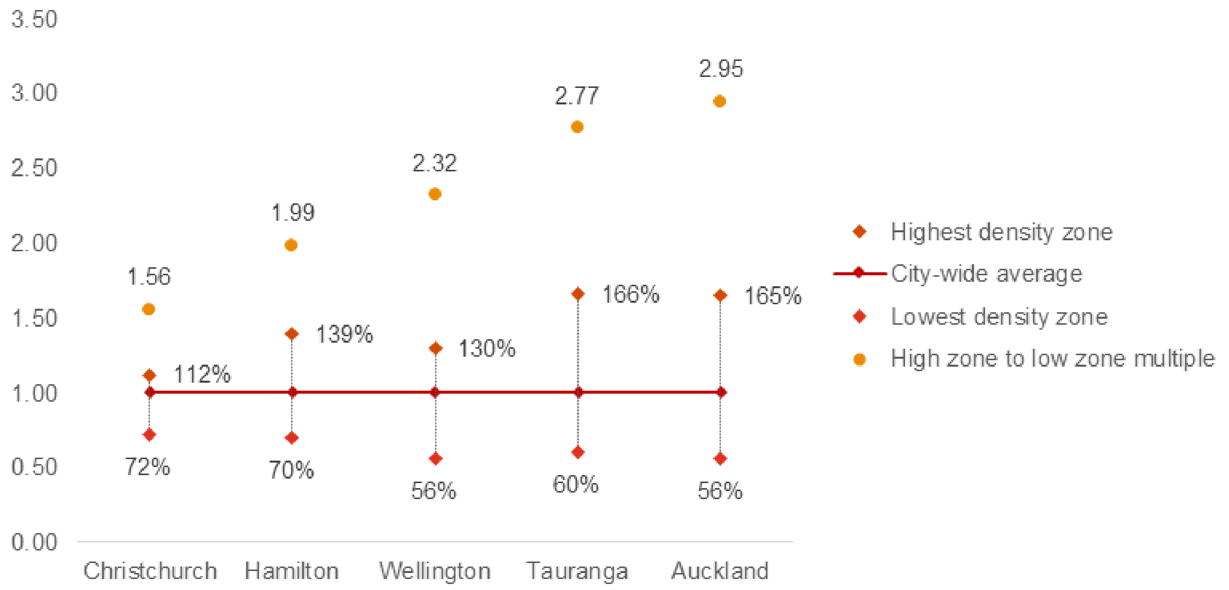
[12] P-values indicate the probability of obtaining a test result at least as extreme as the estimated value if the actual elasticity were zero (meaning no relationship between price and new supply). A P-value below 0.05 indicates statistical significance at the 5 percent level.
[13] The R^2 value is an indication of the proportion of observed variation in the dependent variable (new housing supply) that is explained by our independent variables (median house price and other control variables as described in Appendix B). A low R^2, as observed in Wellington, implies that there are significant factors influencing the dependent variable that are omitted in our model.

benefits to guard against undue optimism and ultimately to emphasise the mismatch in orders of magnitude between the potential benefits and costs of the policy.

From this starting point, we further adjust our estimates to reflect some of the relevant characteristics of specific cities. To do this we need an estimate of how constraining existing land use regulations are in each city.

As the AMM model demonstrates, if zoning policy is binding relative to demand, it limits supply and pushes up prices. If zoning policy is not binding, developers respond to price increases wherever they occur. However, we observe that developer response to price increases is much weaker in areas zoned for low density. Figure 19 illustrates this difference in response across different allowable densities within the five largest cities.

Figure 19: Expected change in floor area ratio (FAR) for a given increase in land value[14]



Source: HUD valuation data, LINZ spatial data, PwC analysis.

As an example of interpretation, for every $100 increment in land value per square metre, we expect a proportional increase in floor area ratio (FAR) – as implied by the AMM model and the concept of spatial equilibrium. In Tauranga, that amount is 66 percent above the city-wide average in zones where the rules allow the highest density and 40 percent below average in zones where the rules are most restrictive, when comparing the same change in land value. For Tauranga, the increment in the high-density zone is 2.77 times the increment in the low-density zone. This means that in low density zones in Tauranga, prices are rising but not much development is happening.

The higher floor area supplied on plots with less severe zoning restrictions at the same land value levels suggests that zoning policy is having a constraining effect on supply in all five cities. Low-density zoning is limiting the competitive equilibrium of density. The degree of constraint—over double the response for equivalent land values in four of the five cities—indicates a significant potential impact on price as the policies create an artificial scarcity of housing and commercial floor area in desirable locations. This effect will be even more pronounced for any low-density zones with land values above the city average, such as a single-dwelling zone near the CBD.

When regulations are relaxed, cities that are highly constrained by regulation are likely to see greater impacts compared to cities where regulatory constraints have only a mild effect. We use these city-specific estimates of regulatory constraint to calibrate our base case assumptions for intensification policy impacts on supply elasticity.[15] We expect policies that relax existing zoning regulation in high-demand areas to have an impact on supply and prices, in alignment with our discussion above on the AMM model. Our final low and high elasticity impact inputs for each city are summarised in Table 2. For comparison, Caldera-Sanchez and Johanssen

[14] The estimates in Figure 19 are derived from the following regression model: $FAR = \beta_1 + \beta_2 Land\ Value + \beta_3(Land\ Value * LowestDensity) + \beta_4(Land\ Value\ * HighestDensity)$

[15] While this is a novel approach, it serves the purpose of establishing a credible range of magnitude for the potential policy impact on supply elasticity that is informed both by historically observed changes in supply responsiveness across New Zealand cities and by an empirically derived proxy for the degree to which development is constrained in each city. This is not a prediction, but a starting point from which to test sensitivities in our model. For a full description of calculations, see Appendix B.

(2011), on whose paper our model is based, estimate national level supply elasticities at 2.014 for the United States, 1.381 for Sweden, 1.187 for Canada, and 0.705 for New Zealand.

Table 2: Modelled assumptions for policy impact on supply elasticity

	Status quo elasticity	With-policy elasticity - Low	With-policy elasticity - High
Auckland	0.876	1.0658	1.4304
Hamilton	0.84	0.9997	1.3065
Tauranga	0.517	0.7079	1.0747
Wellington	1.353	1.5026	1.7900
Christchurch	0.778	0.9067	1.1540
Queenstown	0.875	1.0298	1.3274

Source: PwC analysis.

Model results

With the bounding parameters defined, we quantify the benefits of the policy by calculating the area of rectangles (1) and (2) and triangle (3) in Figure 18. The elasticity estimates inform the slope of the status quo supply curve, and the estimates for policy impact on elasticity inform the shift in slope of the supply curve. We test two demand curve slopes informed by the demand elasticity estimates discussed above. Calculation steps are detailed in Appendix B.

Economic benefits of more responsive housing supply

Table 3 summarises our model results for a scenario using the higher supply impacts and demand response. Our supply constraint and demand growth factors are included for clarity.

Table 3: Model outputs – Preferred supply elasticity impact and demand response assumptions

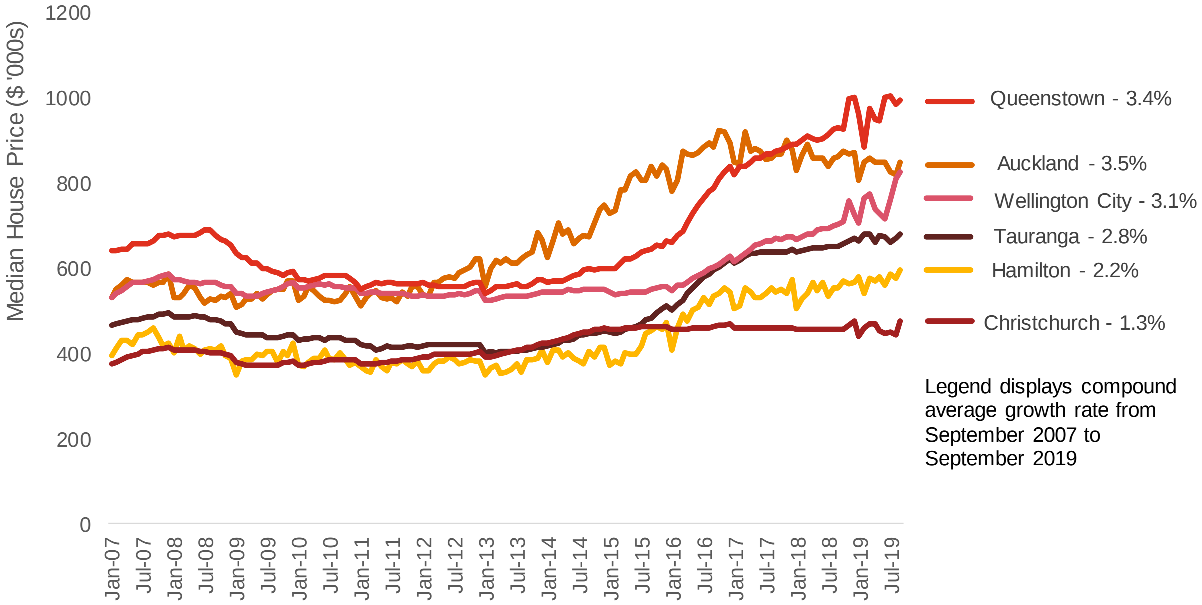
	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Supply constraint multiple	1.65	1.39	1.66	1.30	1.12	1.35
Baseline demand-growth factor	1.51	1.46	1.48	1.28	1.35	1.62
Households						
Current Households	539,902	57,841	50,411	78,386	143,913	11,688
Status quo Households in 2043	798,028	81,921	66,893	104,074	187,067	18,448
With policy Households in 2043	849,881	86,312	73,030	106,471	194,254	19,582
Change in added households	51,853	4,392	6,137	2,397	7,187	1,134
Price impacts ($)						
Change in median house price	-70,071	-37,858	-83,387	-17,886	-20,244	-81,882
Current median price	844,333	570,250	668,458	751,453	457,500	963,338
Status quo price in 2043	1,305,149	852,867	1,091,202	933,464	633,830	1,600,157
Implied 2019-2043 CAGR	*1.83%*	*1.69%*	*2.06%*	*0.91%*	*1.37%*	*2.14%*
With policy price in 2043	1,235,077	815,009	1,007,815	915,578	613,586	1,518,275
Implied 2019-2043 CAGR	*1.60%*	*1.50%*	*1.73%*	*0.83%*	*1.23%*	*1.91%*
Shift in CAGR (percentage points)	0.23	0.19	0.34	0.08	0.14	0.22
Economic Benefits (Cumulative $ at 2043)[16]						
Increase in discretionary income for new entrants (millions)	**1,817**	**83**	**256**	**21**	**73**	**46**
per status quo houshold	2,276	1,015	3,825	206	389	2,517
per added household	35,036	18,929	41,694	8,943	10,122	40,941

Source: PwC analysis.

Our model is designed to be conservative; we want estimates to reflect a level of benefits for which there is a high degree of confidence. For this reason, the key inputs for status quo supply elasticity, demand characteristics, and policy impact have all been selected to err on the side of underestimating benefits. The choice of a linear supply-demand model reinforces this, as non-linear models would estimate steeper status-quo price increases and greater price and quantity response to a given elasticity impact. As a robustness check, we compare the modelled increases in and impacts on median house price to historical growth rates in each city. As Figure 20 shows, the modelled projections for price growth in Table 3 are well below the observed growth rates from 2007 to 2019 in all cases except Christchurch, where modelled projections exceed historical price growth by about one tenth of one percent.[17] If, for example, we adjust demand growth to allow Auckland's baseline price growth rate to reach 3.5 percent, the modelled consumer surplus benefits surge from $1.8 billion to $10 billion, all else equal.

[16] Consumer surplus figures are not discounted.
[17] Christchurch faced a negative population shock and years of weak population growth following the devastating earthquake of February 2011. This period coincided with the strongest housing price growth in recent decades for the other MUCs. Statistics New Zealand expects Christchurch and the Canterbury region to return to pre-earthquake population growth levels, while the construction boom that accompanied earthquake recovery has cooled in recent years. For these reasons, we see the modelled price growth for Christchurch as a moderate estimate, though less conservative than for the other cities.

Figure 20: Historical median house prices and growth rates



Source: REINZ data, PwC analysis.

As a further sensitivity check, we test a pessimistic scenario in which demand response and policy impact on supply elasticity are set to the lower bounds discussed above. Table 4 summarises the resulting outputs. Other tests have shown that results are significantly more sensitive to lower base elasticity impact than to lower demand responsiveness, both of which have been decremented by one standard error of historically observed variation in our pessimistic scenario.

Table 4: Consumer surplus benefits and transfers – Pessimistic supply elasticity impact and demand assumptions

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Supply constraint multiple	1.65	1.39	1.66	1.30	1.12	1.35
Baseline demand-growth factor	1.51	1.46	1.48	1.28	1.35	1.62
Households						
Current Households	539,902	57,841	50,411	78,386	143,913	11,688
Status quo Households in 2043	805,360	82,838	69,420	102,503	189,439	18,642
With policy Households in 2043	823,337	84,365	71,956	103,205	192,012	19,032
Change in added households	17,977	1,527	2,536	702	2,572	390
Price impacts ($)						
Change in median house price	-57,991	-31,803	-83,974	-12,533	-17,381	-67,261
Current median price	844,333	570,250	668,458	751,453	457,500	963,338
Status quo price in 2043	1,318,238	863,636	1,156,021	922,337	643,523	1,618,384
Implied 2019-2043 CAGR	1.87%	1.74%	2.31%	0.86%	1.43%	2.19%
With policy price in 2043	1,260,248	831,833	1,072,047	909,804	626,142	1,551,123
Implied 2019-2043 CAGR	1.68%	1.59%	1.99%	0.80%	1.32%	2.00%
Shift in CAGR (percentage points)	0.19	0.16	0.32	0.06	0.12	0.18
Economic Benefits (Cumulative $ at 2043)						
Increase in discretionary income for new entrants (millions)	**521**	**24**	**106**	**4**	**22**	**13**
per status quo household	647	293	1,534	43	118	704
per added household	28,995	15,901	41,987	6,266	8,691	33,630

Source: PwC analysis.

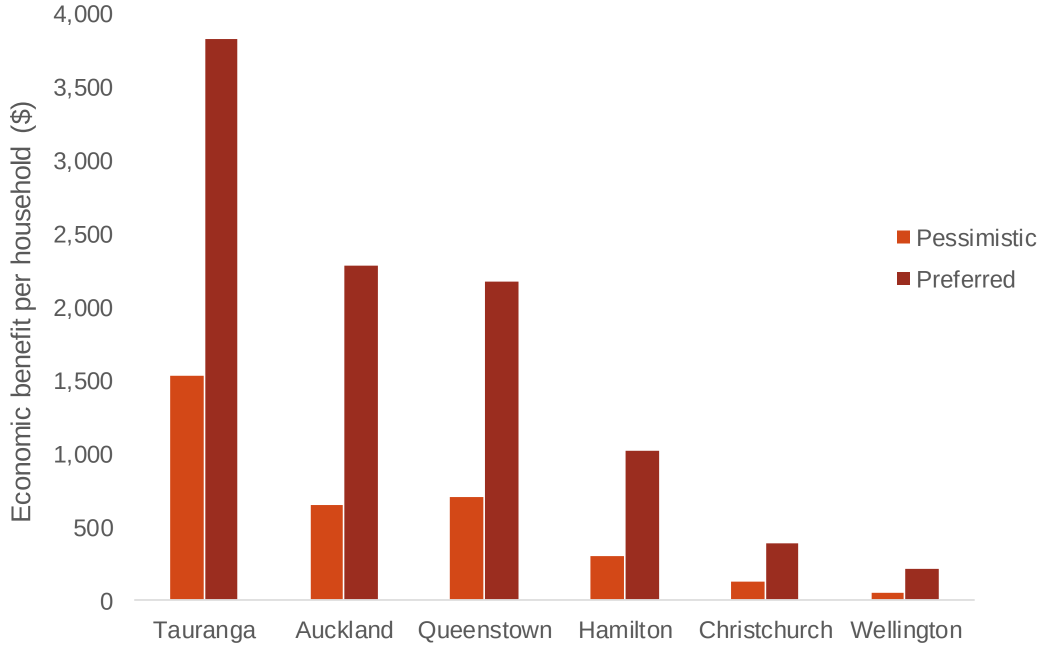
The results of our pessimistic scenario place potential economic benefits to the public of more affordable housing in the order of a few million to hundreds of millions nationwide. Both scenarios show large variation in benefits between cities, even on a per capita basis. Note the following about the modelled relationships between inputs and outputs:

- Higher supply constraint, such as in Auckland and Tauranga, and higher baseline demand growth, such as in Queenstown, will contribute to higher impacts of the policy.
- Higher baseline supply elasticity, such as in Wellington, will contribute to lower impacts of the policy. The reverse is true for Tauranga, where historical supply response is the least elastic.
- The status quo estimates for population (households) and median price are affected by the choice of demand elasticity. This reflects the assumption, discussed above, that population growth is not exogenous to price, but rather households are mobile between cities and consider the cost of housing when choosing where to live. Both demand scenarios reflect conservative estimates for price increases when compared to historical growth rates for median house prices.[18]

Figure 21 summarises the economic benefits on a per household basis across the six cities for the preferred and pessimistic scenarios, illustrating at local scale what the modelled relationships imply for the potential impact of the intensification policy.

[18] See Figure 20 above and accompanying discussion for details.

Figure 21: Economic benefits of intensification per status quo household for preferred and pessimistic scenarios



Source: PwC analysis.
Note: Figures represent cumulative change in affordability from enactment of the policy to 2043.

Combined with the tables above, Figure 21 provides several relevant insights on the degree to which the relaxation of building and zoning constraints in brownfield urban areas create benefits can benefit the public:

- Benefits are highly sensitive to the magnitude of modelled changes in price and quantity supplied: the marginal increase from the low estimate to the high estimate more than doubles the total benefit in all cases. This comes from the nature of the demand curve, as each marginal decrease in price both allows new beneficiaries to participate and increases benefits by exactly the price decrease for all existing beneficiaries.
- The sensitivity between the two scenarios diminishes as total benefits increase—benefits under the preferred scenario in Tauranga are about 2.5 times greater than under the pessimistic scenario, while the same multiple for Wellington is 4.8. This reflects the interaction between:
    - the baseline elasticity and constraint levels, which vary across cities and have significant impacts on overall benefits
    - the magnitude of our supply impact adjustment between scenarios, which is constant across cities.

  In other words, the effective level of pessimism in our pessimistic scenario is most severe for cities with the least to gain from the policy.
- Tauranga stands out as the ideal candidate for intensification policies. The city's stringent observed regulatory constraints and low supply elasticity provide the conditions for strong policy impact.
- Wellington's low benefit estimates are most influenced by its unusually high starting elasticity. As noted above, this may be unduly influenced by an anomalous pattern in the building consent data. If we set Wellington's starting elasticity equal to that of Auckland, benefits approximately double for the preferred scenario and triple for the pessimistic scenario. That Wellington's median house price has grown over 10 percent annually since 2016 while Auckland's has declined slightly provides good reason to consider that Wellington may stand to benefit more from the intensification policy than our preferred scenario indicates.
- Benefits for Christchurch are notably low, but this fits the evidence: low constraints, stable housing prices, a recent surge of building consents, and moderate supply elasticity and population growth. If the policy has little impact in Christchurch, it is likely to be because existing rules are not yet constraining under demand conditions. However, if population growth is stronger than expected and zoning

regulations become a constraint, the policy would accordingly have greater benefits. For example, if Christchurch were to experience the rate of population growth projected for Auckland and the levels of elasticity impact modelled above for Tauranga, economic benefits would more than quadruple in the preferred scenario and more than double in the pessimistic scenario. The city stands to benefit from flexibility in the face of uncertain growth trajectories.

The results above are all sensitive to the expected levels of constraint to brownfield development that the MUCs will experience in coming decades, which we have attempted to model for each city based on available evidence. In the following subsection we present the implications of the same modelled scenarios for distributional effects among homeowners, landowners, developers, renters, and first-time homebuyers.

Distributional effects of more responsive housing supply

As Figure 18 above illustrates, the distributional impacts of the policy are necessarily larger in gross than the purely additive benefits. This arises from the existing population of homeowners, renters and buyers for whom the price impact has an effect, which is larger in all scenarios than the marginal increase in population resulting from the policy. Rectangles (1) and (2) in Figure 18 represent two categories of transfer:

- Rectangle (1) represents the housing units existing at the enactment of the policy, which subsequently appreciate less in value than they would have under the status quo, creating a transfer of value from existing owners to first-time buyers and renters. For existing homeowners selling their home to buy another (already existing) home, the transfer has no effect, as those homeowners are both benefitting from lower prices as buyers and absorbing a lower home equity gain as sellers. A portion of the value represented by the rectangle should thus be discounted. The same is true for existing homes that do not change ownership during the study period.
- Rectangle (2) represents the new housing units added to the market between the enactment of the policy and 2043. These units are the same in quantity as those that would enter the market under the status quo scenario, but they are sold at lower prices as a result of the policy, creating a transfer of wealth from existing landowners and developers to first-time homebuyers and renters. This value must be discounted for existing homeowners selling their home to buy a newly built one.

Table 5: Estimated benefit transfers under two modelled scenarios

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Preferred scenario – High elasticity impact, high demand response ($m)						
Transfer between developers and households	18,087	912	1,374	459	874	821
Transfers to renters of new units	6,511	328	495	165	315	296
Transfer between households	37,832	2,190	4,204	1,402	2,913	1,380
Transfers to renters of existing units	13,619	788	1,513	504	1,048	496
Pessimisstic scenario – Low elasticity impact, Low demand response ($m)						
Transfer between developers and households	15,394	794	1,596	302	791	467
Transfers to renters of new units	5,542	286	575	109	285	168
Transfer between households	31,309	1,839	4,233	982	2,501	786
Transfers to renters of existing units	11,271	662	1,523	353	900	283

Source: Stats NZ, PwC analysis.

Table 5 summarises our estimates of the transfer effects. To provide a lower bound in accounting for the discounted cases discussed above, we calculate the transfer to renters alone that would take place if the proportion of renters in each city were equal to the 2018 national average of 36 percent.[19] This ignores the case of first-time homebuyers, who if accounted for would increase the estimate. Moreover, rental rates in the MUCs

[19] Statistics New Zealand.

are likely to be above the national average. Therefore, the actual transfer of wealth is thought of as being between the value represented by each rectangle and the renters-only estimate, but likely to be closer to the lower bound than the upper.

These estimates are sensitive to the same model inputs as the economic benefits discussed above, however the starting population of each city has a much larger impact than previously. For every household that benefits from a transfer, the benefit is equal to the price impact of the policy. From the individual household perspective, this effect can be significant: from around $12,000 in Wellington in the pessimistic scenario to around $118,000 in Queenstown in the preferred scenario. From the perspective of intended impact on housing affordability for all, these transfers are a core purpose of the NPS-UD.

Externalities of intensification

The primary intent of the NPS-UD intensification policy is to mitigate the scarcity of urban housing and improve affordability by enabling more flexible and less costly urban development at higher densities. While urban intensification can increase the efficiency of land use and enable more affordable housing for urban residents, there are impacts to increased density that carry costs and benefits beyond those experienced by the added households themselves and in areas beyond the housing market. Economists call these effects externalities.[20]

There is a range of negative and positive externalities associated with increased urban density. Our assessment follows the method used in the 2016 cost benefit analysis of the NPS-UDC. The exception is our modelling of agglomeration economies, for which we develop a new approach to examine interactive effects between urban areas. Table 6 below defines the externalities to be assessed.

Table 6: External costs and benefits of brownfield urban development

Externality	Explanation
External infrastructure costs	Costs shared by existing stakeholders in an infrastructure network when new entrants do not pay for the full marginal costs of connecting. We estimate these costs for transport, water supply, and stormwater and wastewater management.
Congestion costs	Costs of slower trips and trip avoidance shared by all road users because of added vehicle trips.
Costs of overshadowing from tall buildings	Shadows cast by taller or larger buildings that reduce amenity for surrounding inhabitants.
Costs of reduction in air quality	To the extent that intensification results in increased concentrations of petroleum-powered vehicle use, or of heavy industry where applicable, residents may suffer deterioration of health and amenity from increased exposure to poor air quality.
Water quality	Costs of degradation of waterways and marine environments by increased runoff of contaminants from roads and roofs resulting from urban development.
Agglomeration economies	Benefits arising from efficiencies of matching, sharing, and learning gained by the compounding proximity to employment opportunities, labour and consumption markets, and large indivisible amenities associated with increases in urban density.

Source: Adapted from MRCagney, BECA & Covec (2016), PwC analysis.

The following subsections examine first the external costs of urban intensification, then the potential benefits of agglomeration economies.

Infrastructure, congestion, and environmental externalities

To estimate the costs of intensification not borne directly by added households, developers, or suppliers of housing, we rely on the extensive estimates provided in the 2016 CBA of NPS-UDC. We apply both the low and high estimates for each type of externality to our modelled policy impacts in each city to derive costs comparable to our calculated benefits. The modelled projections for households added as a result of the policy are aligned with the population impacts implied by our consumer surplus calculations above.

MRCagney, BECA & Covec (2016) provides estimates of present value per household for impacts on water and air quality, loss of open spaces and community facilities, external costs to stormwater, water supply, wastewater infrastructure networks, transport infrastructure and congestion. Each category is assessed for both urban

[20] The economic term 'externality' refers to costs or benefits generated by a transaction but not reflected in the price of the transaction. For example, the increased cost of waste management incurred when a manufacturer chooses to increase the plastic volume of packaging for a popular consumer product is a negative externality; the health benefits of a more active commute enabled by taking the bus rather than driving are a positive externality.

intensification and greenfield costs, each of which is given a high and a low estimate. These are summarised in Table 7.

Table 7: External costs per added household per year

Externalities	Urban intensification		Greenfield	
	Low	High	Low	High
External infrastructure costs				
Transport	-	-	(475)	(721)
Water / wastewater	(227)	(892)	(227)	(1,500)
Stormwater	-	(114)	-	(114)
Open spaces and community facilities	-	-	(146)	(223)
Congestion	(1,590)	(2,078)	(2,466)	(3,428)
Overshadowing from tall buildings	-	(688)	-	-
Blocked views from tall buildings	-	(715)	-	-
Loss of peri-urban open space	-	-	(186)	(326)
Air quality	(267)	(295)	(224)	(267)
Freshwater quality	-	(156)	(125)	(250)
Coastal water quality	-	(55)	(134)	(268)

Source: MRCagney, BECA & Covec (2016).

The costs shown in Table 7 are estimated on a marginal, per household basis net of costs borne directly by users or developers through utility bills, road taxes, development charges, or other mechanisms. This approach does not attempt to address the challenge of financing faced by councils for large upfront capital outlays but considers costs as amortized over the life of the asset.

Part of the challenge of investment in large scale brownfield infrastructure is the accumulated costs of deferred maintenance over periods of decades in cases where needed maintenance is poorly funded. The timing of large payments to cover these costs during infrastructure upgrades may be affected by higher than expected brownfield development, but the costs themselves are not attributable to the policy as they would also exist under the status quo. Moreover, because the added households are a fraction of the total population growth expected, the marginal impact on financing costs for large outlays is likely to be minimal.

To err on the side of pessimism toward the policy, we use the higher cost estimates from the 2016 CBA. To derive estimates of the cost impacts of the policy, we:

- project population growth in the with-policy case so that the change in total households reaches the change in added households calculated for the intensification scenarios above by 2043
- calculate the costs in each year using a weighted average between the greenfield and brownfield estimates in Table 7 to reflect each city's planned ratio of urban infill to greenfield expansion shown in Table 8 below[21]
- discount the resulting costs at 4 percent to obtain a present value.

[21] If we instead assumed that if all additional households attributable to the policy were to locate in urban infill areas only, the resulting cost estimates would be ten to fifteen percent lower.

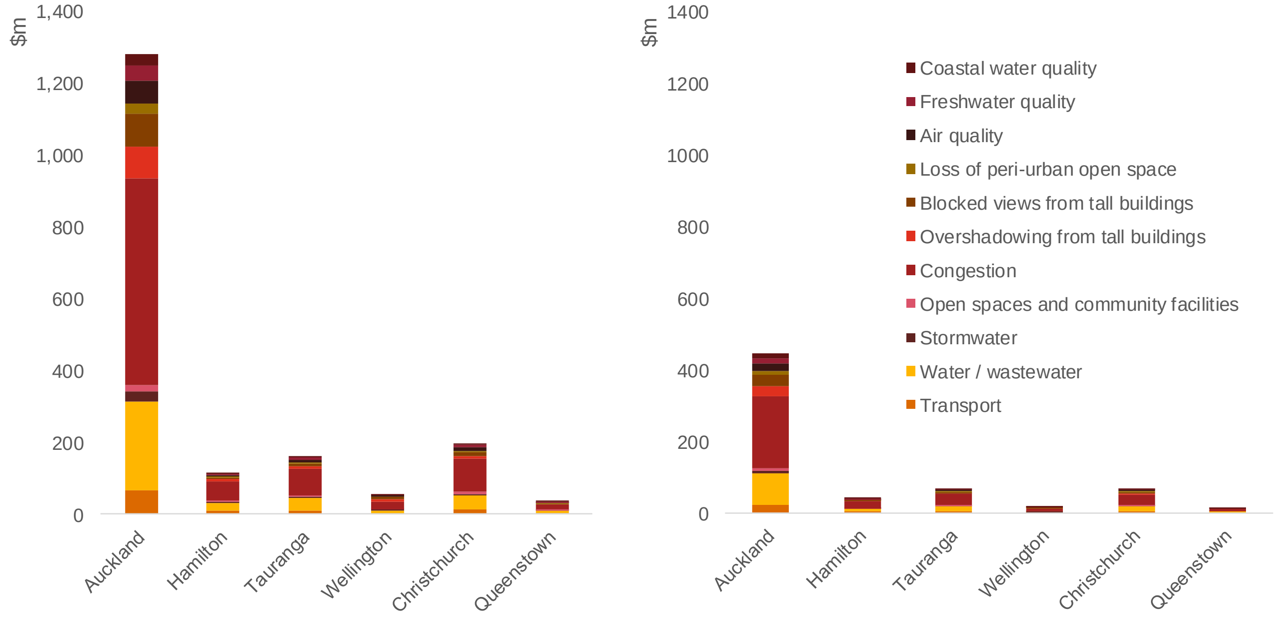
Table 8: Local plans for greenfield development

	Projected demand for housing units	Planned greenfield dwellings	Proportion planned for greenfield development
Auckland	354,000	147,672	42%
Hamilton	47,793	33,140	69%
Tauranga	35,449	22,559	64%
Wellington	21,920	2,300	10%
Christchurch	49,682	30,288	61%
Queenstown	18,590	18,590	100%

Source: Local authority Housing and Business Assessments and zoning plans where available. Stats NZ growth projections for Wellington and Christchurch.

The results of cost calculations for our two scenarios are shown in Figure 22. The primary driver of magnitude for these costs in each case is the number of added households attributable to the policy impact. A much less impactful secondary driver is the relative weighting of greenfield development in local council plans, which is more costly per household than brownfield development. If we were to assume that all added households located in brownfield areas, the total costs for each city would be ten to fifteen percent lower than shown in Figure 22.

Figure 22: External costs of urban intensification – Preferred scenario (left) and pessimistic scenario (right)



Source: MRCagney, BECA & Covec (2016), PwC analysis.
Note: The pessimistic scenario is so named due to the assumption of weaker policy impact. This results in lower external costs because those costs are driven by the number of additional households choosing to live in a city in response to lower housing prices.

The approach varies external costs at a constant rate for added households, while our modelled consumer surplus benefits vary at a rate equal to half the product of the price impact and added households. This simplification gives an approximate estimate of magnitude, but we note that the actual costs of higher density cities will depend on how well local authorities design and implement infrastructure as the city grows. Marginal congestion costs of an added vehicle rise more sharply as roads reach capacity, but good infrastructure planning can induce fewer added vehicle trips per household where density is high enough to support investment in alternative transport modes. Because vehicles are the primary contributor to degradation of air and water quality, the same modal shift will also mitigate those costs. The marginal costs per household decrease as density increases for wastewater management and other network infrastructure. In sum, costs per household may increase or decrease as policy impact increases, depending primarily on the walkability and efficiency of transport infrastructure in each city. These nuances are important to the quality of urban outcomes.

Agglomeration externalities in production

The final category of externalities are agglomeration economies in dense urban areas. Agglomeration benefits arise from the capacity of dense concentrations of population to enable economies of sharing, matching, and learning.[22] In New Zealand, doubling the number of jobs within commuting distance of a person's home is associated with a 6.5 percent increase in that person's productivity, defined as value-added divided by labour input.[23]

In examining agglomeration economies, we expand our analysis to consider interaction effects between cities resulting from internal migration. Our model takes assumptions about population growth over time as an input rather than producing estimates of population as an output (as with our comparative statics model above). This enables us to test the aggregate impact of suppression of growth in smaller cities as a result of strong growth in New Zealand's largest city. These inter-city dynamics are of interest to our discussion on targeting of the NPS-UD policies in our chapter on that topic. For this reason, we examine four cities near the growth frontier discussed in that chapter in addition to the six MUCs: Whangarei, New Plymouth, Palmerston North, and Dunedin.

Estimating productivity elasticities of agglomeration

Different types of industries benefit from density differently, and those that benefit most tend to collocate in large cities. The gain in production or consumption in response to a unit increase in density is known as 'agglomeration elasticity,' which applies to two broad types of benefits:

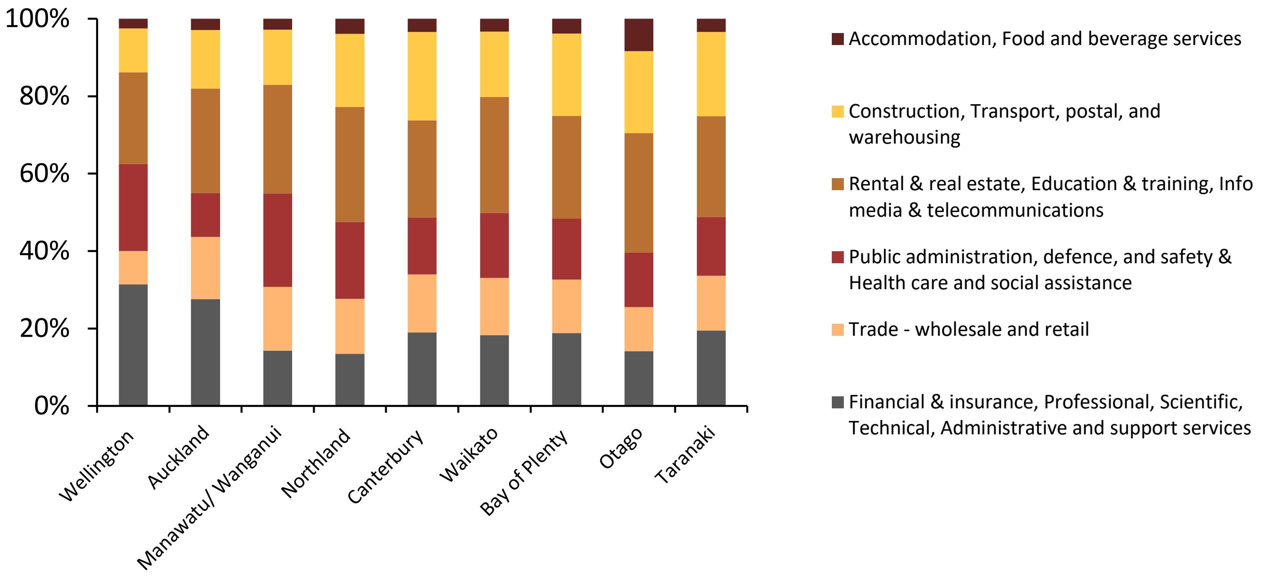
- Agglomeration benefits in production arise from the ability of firms to share inputs, match with better workers and customers at lower cost, and capture knowledge spill-overs.
- Agglomeration benefits in consumption arise from greater variety of goods and services available at competitive prices and access to indivisible goods, events, and facilities. These are more difficult to measure.

We focus our estimates on production-side agglomeration benefits and ignore the consumption side in our final cost-benefit estimates, as the limited literature implies that agglomerations in consumption may be partially offset by increases in consumer prices.[24]

Our estimates of agglomeration benefits employ the industry-specific agglomeration elasticities estimated by Maré and Graham (2009), weighted by the relative portion of gross regional domestic product (GRDP) for each industry within the host region of each city. In our weights, we omit industries that are predominantly rural. Figure 23 shows the breakdown of relevant industries per region by contribution to GRDP.

[22] Duranton and Puga 2004.
[23] Maré and Graham 2009. Value added is the difference between the price of finished goods or services and the cost of inputs used in production.
[24] Tabuchi and Yoshida (2000) use a general equilibrium model to observe that while accounting for nominal wage increases in larger cities, households accept a decrease in real wages as consumption prices rise. They argue that the acceptance of lower real wages is evidence of agglomeration economies in consumption at least equal to the decrease.

Figure 23: Composition of industry by region



Source: NZ Stats data on GRDP by industry and region. Industry agglomeration elasticity estimates from Maré and Graham (2009).

Regions in Figure 23 are ordered from most elastic on the left to least elastic on the right, while industries are grouped by similar elasticities, from lowest (top) to highest. Low-elasticity industries include accommodation, food and beverage services, construction and transport, postal services, and warehousing. High-elasticity industries include financial, professional, scientific, technical, and administrative services. Our agglomeration elasticity assumption by city is calculated as follows:

$$Elasticity_{city} = \sum_{i=0}^{Industries} IndustryElasticity \cdot IndustryProportion_{city}$$

The resulting estimates of agglomeration elasticity by region are shown in Table 9.

Table 9: Estimated agglomeration elasticities by region

Region	Agglomeration Elasticity
Wellington	0.0769
Auckland	0.0768
Manawatu-Wanganui	0.0759
Northland	0.0741
Canterbury	0.0736
Waikato	0.0730
Bay of Plenty	0.0726
Otago	0.0712
Taranaki	0.0701

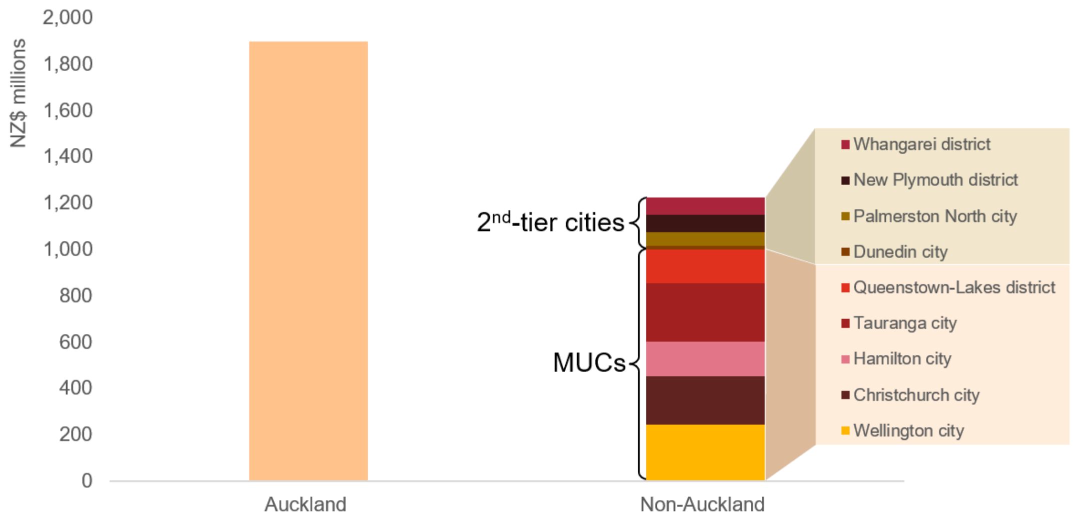
Source: Maré and Graham (2009)

As an example of interpretation, an elasticity of 0.0769 in Auckland implies that a doubling of the city's employment density is associated with an increase in productivity of 7.69%. As Table 9 shows, productivity in the Auckland and Wellington regions are the most responsive to an increase in employment density, while productivity in Taranaki and Otago are the least responsive to an increase in employment density. This is a direct reflection of the industry makeup in each region. This method likely underestimates the elasticity of the larger cities, as each industry's responsiveness is measured at a region-wide level, concealing within-region differences.

Agglomeration favours density

The location of employees is important to productivity, wages and employment, and returns to productive density are compounding. Figure 24 shows the difference in productivity gains from a shock of 150,000 workers concentrated in Auckland versus the same 150,000 workers distributed among nine smaller cities in proportion to each city's GRDP.

Figure 24: Productivity gain from a shock of 150 thousand workers – Concentrated in Auckland vs. dispersed proportionally among 9 cities



Source: PwC analysis.

The same workforce increase creates more social benefit when added to one dense and productive area than when spread across several less dense areas. This reflects the greater baseline value-added per worker in larger, more dense centres of employment. The existing workforce, before the shock is about 50 percent greater in Auckland than in the other cities combined, so the former's greater base productivity and returns to density are overcoming a proportionally smaller workforce shock. This concept applies both between cities and within cities.

Agglomeration estimation model

Our modelled estimates of agglomeration benefits are derived as follows, using the elasticity estimates described above. The approach is a modified version of that used in MRCagney, BECA & Covec (2016).

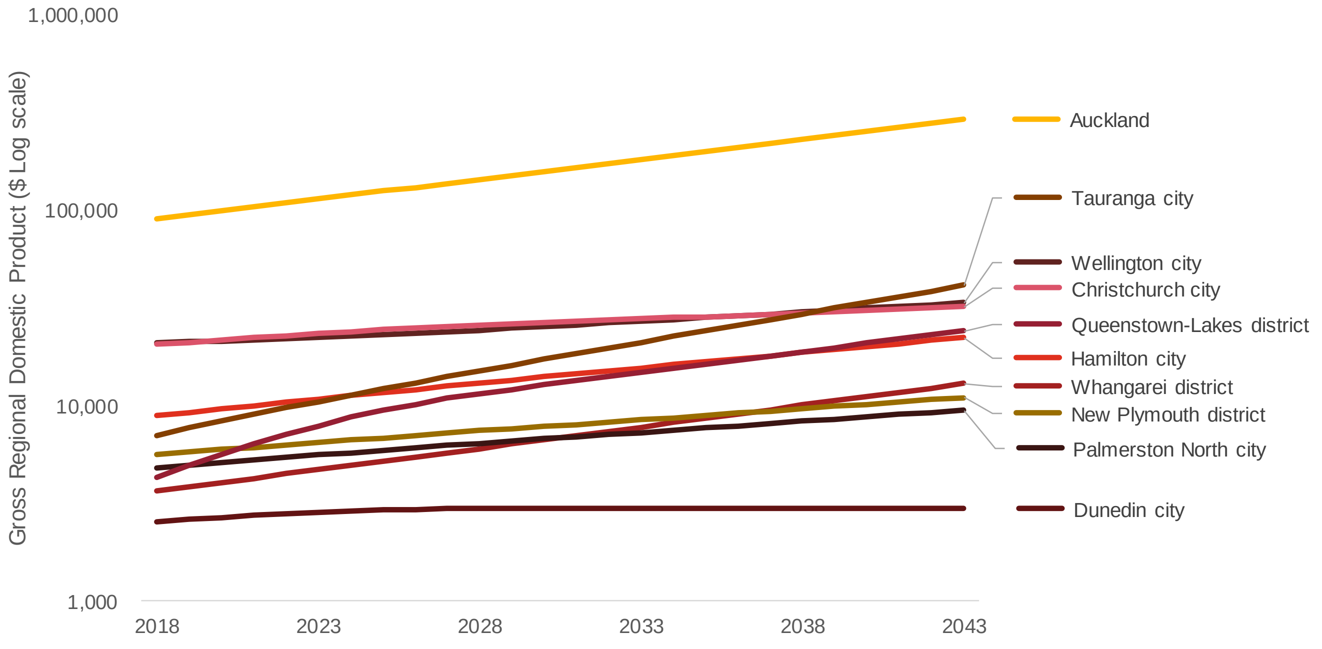
$$AgglomerationBenefit = \left(\left(\frac{New\ workforce}{Base\ workforce}\right)^{Elasticity} - 1\right) \cdot GRDP_{Baseline}$$

Baseline economic growth projections

We use historical GRDP data from 2015-2018 at the territorial authority (TA) level to calculate a compound average growth rate for each TA. To adjust for inflation, we use the GDP deflator multiple for New Zealand provided by World Bank. All figures are in 2019 New Zealand Dollars.

For projection to 2043, we assume each TA will grow at the 2015-2018 rate in year 1, then linearly converge to its regional average growth rate from years 2 to 9. As regional growth rates are generally more moderate than urban growth rates in our sample period, these assumptions help prevent optimistic growth projections. An exception is Taranaki and New Plymouth, where recent changes in industry regulation have contributed to a GRDP contraction. We assume New Plymouth will resume moderate growth in the medium term, so to model this we set the TA growth projection to converge with Manawatu-Wanganui growth rates for 2015-2018. The resulting growth projections are shown in Figure 25.

Figure 25: GRDP growth projections

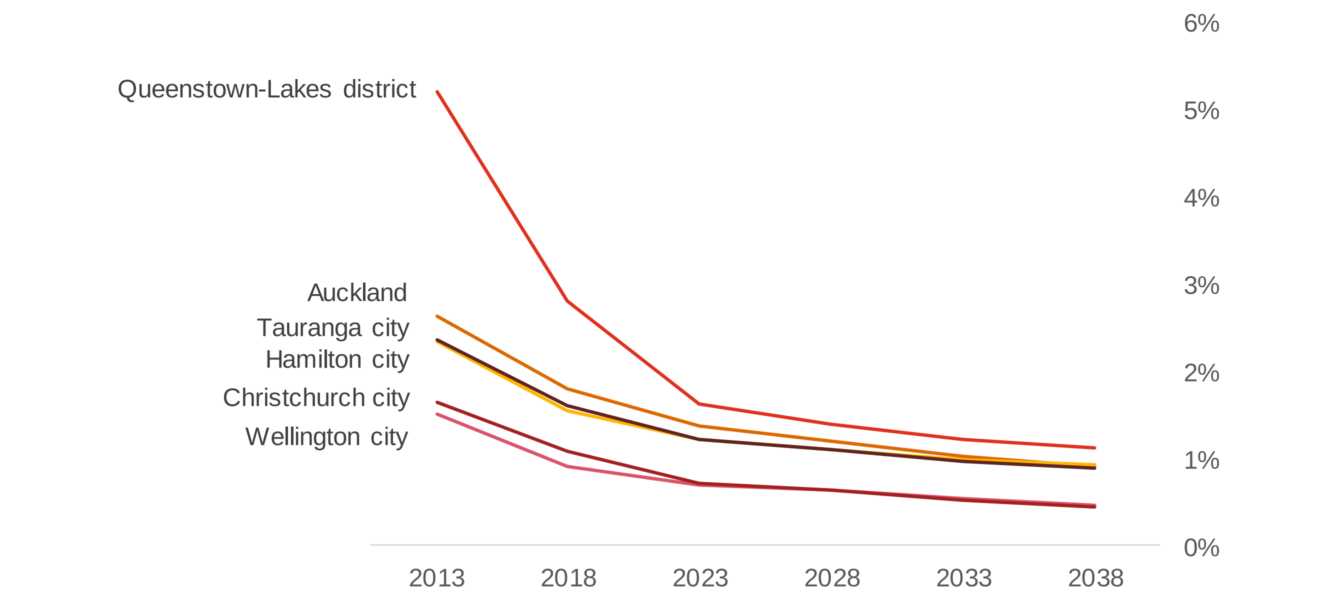


Source: Stats NZ, World Bank GDP deflator, PwC analysis.

Population projections

We take baseline population projections from Stats NZ area unit population projections, which use the 2013 census as a base, and project to 2043 by TA at three alternative levels: a low, medium, and high growth projection. These levels reflect corresponding assumptions about fertility, mortality, and net migration in each region. Our baseline scenario uses the medium level projection for each city. The Stats NZ medium-growth projection rates are provided in five-year intervals, shown in Figure 26.

Figure 26: Baseline population growth projections



Source: Stats NZ.

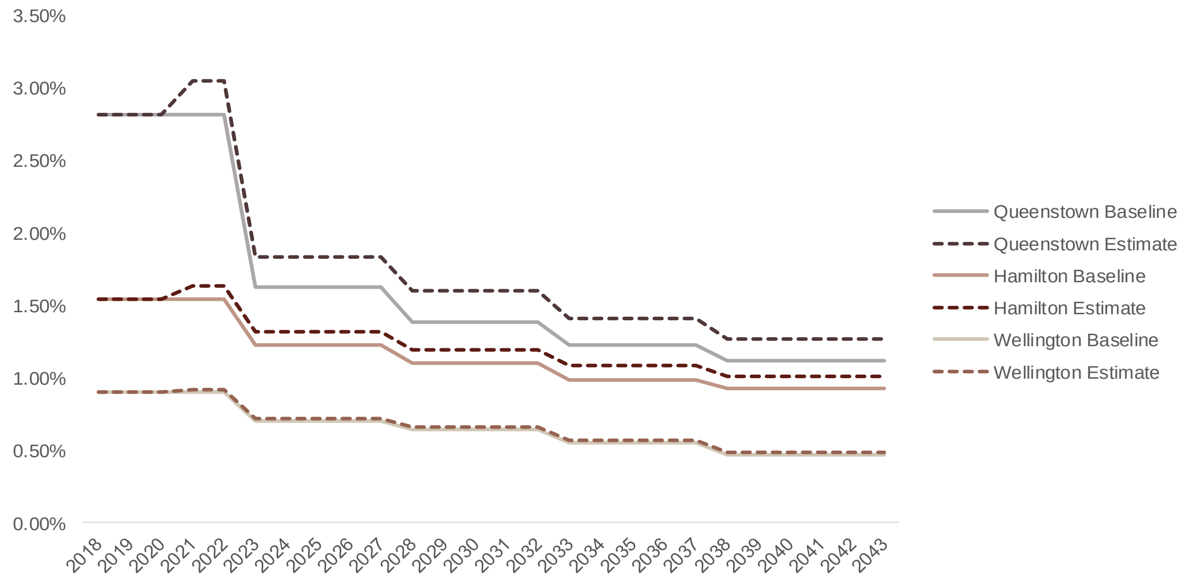
The convergence toward lower growth rates over the next two decades reflects declining birth rates and an aging national population in the Stats NZ model. To model NPS-UD policy impacts on population, we align growth rates in similar five-year periods so that two criteria are met:

- Our projected growth rate does not exceed the high-growth Stats NZ estimation in any five-year period.

- The resulting population impact comparing the medium projection to the modelled projection for the year 2043 is of the same order of magnitude as our supply elasticity and consumer surplus estimates imply.

Deviations from baseline projections are assumed to begin in year 2021, implying no policy impact until 2022. This leads to a mild range of expected deviation from the Stats NZ projections, with Queenstown and Auckland showing the strongest relative shift in growth rate and Wellington showing the weakest relative shift. Sample results for three MUCs are shown in Figure 27.

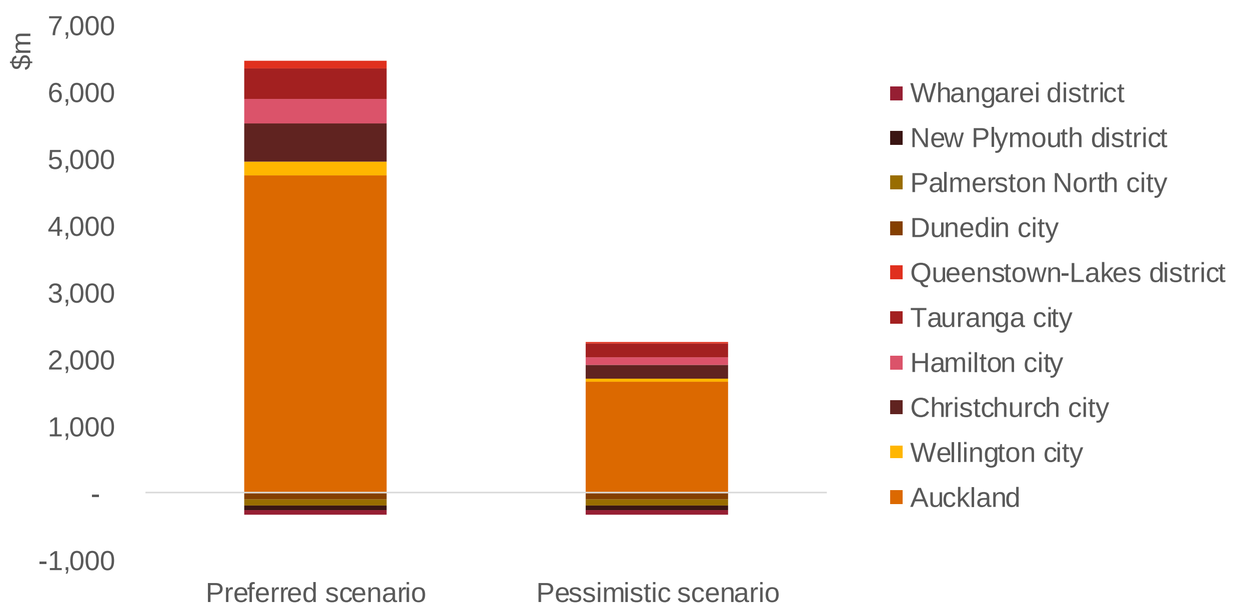
Figure 27: Modelled population growth rates versus Stats NZ baseline



Source: Stats NZ, PwC analysis.

We then convert these population impacts to household numbers using 2018 census data on household size by region. Applying the resulting impacts on households locating in each city, we estimate agglomeration benefits arising from the intensification policy for our ten cities using the equation defined above. Our estimates for agglomeration benefits in the preferred and pessimistic intensification scenarios are illustrated in Figure 28.

Figure 28: Present value of estimated agglomeration benefits – Preferred and pessimistic scenarios



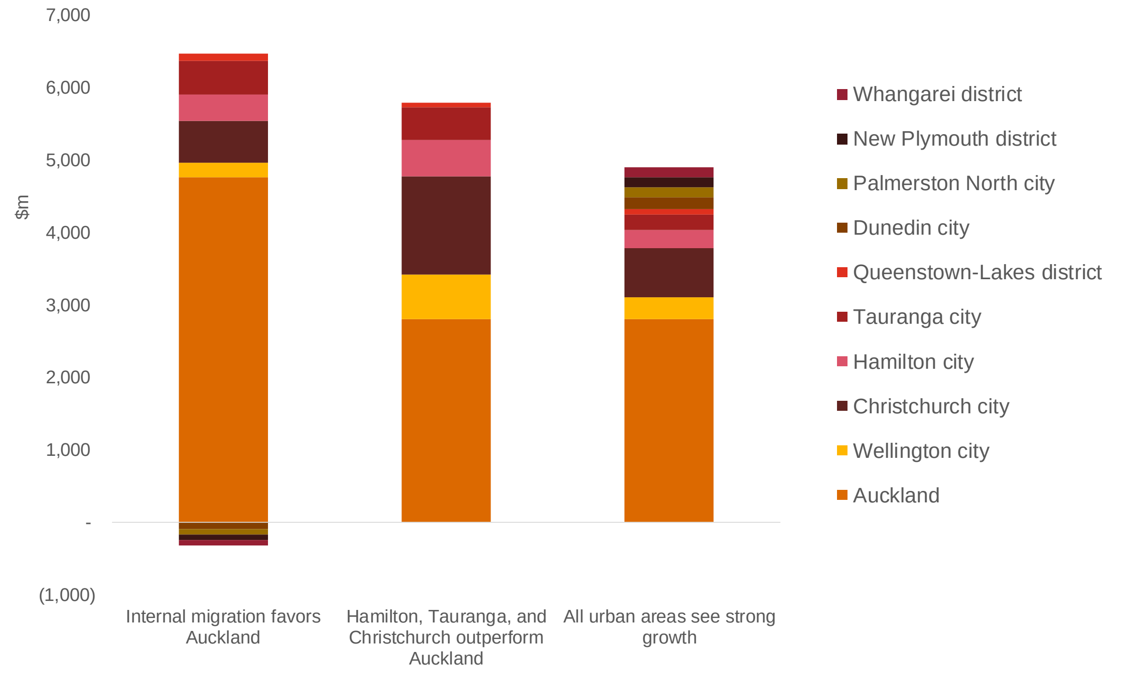
Source: PwC analysis.

The NPS-UD intensification policy may have cross-city effects as well as within-city impacts. For example, if Auckland's housing affordability improves relative to other cities, some smaller cities may experience weaker population growth than expected as more households choose to locate in Auckland. To examine this possibility, we include four second-tier growth cities in our model, and test three cross-city impact scenarios:

- Scenario 1 – Internal migration favours larger cities while the 2nd tier cities show slower growth than the baseline projection. This is to examine the possibility that improved affordability in the major cities has a negative impact on 2nd-tier city growth. This scenario uses the same assumptions for the six MUCs as our preferred estimate.
- Scenario 2 – Smaller MUCs outperform Auckland. In this scenario, Auckland shows stronger growth than baseline projections, but Tauranga, Hamilton, and Christchurch significantly outpace the country's largest city. This scenario may be likely if congestion in Auckland is poorly managed, mitigating the benefits of urban density. This scenario assumes no policy impact on growth in the 2nd tier cities.
- Scenario 3 – All urban areas see strong growth. In this scenario, all cities grow at rates halfway between their medium and high Statistics New Zealand projections.

Figure 29 summarises results for these three scenarios.

Figure 29: Agglomeration benefits under three alternate scenarios of inter-city migration



Source: PwC analysis

The results in Figure 29 emphasise the core implications of the model: that productivity increases at an increasing rate with respect to increases in workforce density. The effects of stronger growth in the larger cities overcome the foregone agglomeration benefits caused by weaker growth in smaller cities. This insight has strategic implications for national-level economic development. In aggregate, the returns to investing in encouraging well-managed growth and density in the largest urban economy are likely to be greater than if efforts were made to distribute urban growth evenly among regions.

Summary of costs and benefits of intensification

Our exploration of the costs and benefits of intensification imply the largest source of benefits comes from agglomerations in production, while the single largest source of costs is congestion. This is consistent in a broad sense with the idea that cities are attractive for their concentrations of opportunities to share, match, and learn but come at the cost of traffic, noise and crowds.[25] Table 10 and Figure 30 summarise our findings for the six MUCs.

Table 10: Summary of costs and benefits of intensification – Preferred scenario ($m)

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Consumer surplus benefits	1,817	83	256	21	73	40
Agglomeration benefits	4,766	204	573	361	462	109
External costs of urban growth						
Transport	-66	-9	-12	-1	-14	-4
Water / wastewater	-250	-24	-33	-10	-40	-7
Stormwater	-25	-2	-3	-1	-4	-1
Open spaces and community facilities	-20	-3	-4	0	-4	-1
Congestion	-576	-55	-75	-23	-92	-17
Overshadowing from tall buildings	-88	-4	-6	-6	-9	0
Blocked views from tall buildings	-91	-4	-7	-7	-9	0
Loss of peri-urban open space	-30	-4	-5	0	-6	-2
Air quality	-62	-5	-7	-3	-9	-1
Freshwater quality	-43	-4	-6	-2	-7	-1
Coastal water quality	-31	-4	-5	-1	-6	-1
Total external costs	**-1,281**	**-118**	**-163**	**-55**	**-199**	**-35**
Total benefits	**6,583**	**287**	**829**	**383**	**535**	**149**
Net benefits	**5,302**	**169**	**666**	**328**	**336**	**114**
Benefit-cost ratio (BCR)	5.1	2.4	5.1	7.0	2.7	4.3
Transfers to renters	20,131	1,116	2,008	670	1,363	792

Source: PwC analysis

For Auckland, Tauranga, and Queenstown, the modelled benefits outweigh the external costs even if agglomeration benefits are excluded, reflecting the significant constraints on housing supply relative to potential demand in those cities. For the other cities, benefits are two to seven times greater than costs when agglomerations are included. As discussed in the section above on consumer surplus benefits, these estimates rely on conservative assumptions at all points of discretion, and Wellington represents a special case due to its anomalous building consent patterns.

[25] This is also consistent with the Rosen-Roback model of Spatial Equilibrium developed by Rosen (1979), Roback (1982) and Gyourko and Tracey (1991)

Figure 30: Costs and benefits of intensification – Preferred scenario

Source: PwC analysis.

The value of transfers is not included in the net benefit or BCR calculations as it is a redistribution rather than a pure addition of benefit. To the extent that the NPS-UD aims to lessen transfers of wealth over time from renters to property owners, the transfers to renters in Table 10 may be considered an added benefit of the policy. The added surplus of renters may also have a greater multiplier effect on the local economy than the same surplus would have in the hands of property owners, but an exploration of this is beyond the scope of this study.

Case study: Transit-oriented development in Mount Eden

Mount Eden case study

The purpose of this case study is to demonstrate the costs of rigid supply and the benefits of removing constraints to intensification in one local area, describing in greater detail how these arise. The case study presents supply capacity in the Mount Eden and Karangahape Road precincts; an area proximate to the sites of ongoing construction for two future City Rail Link (CRL) train stations on the outskirts of Auckland's city centre. Once the CRL is complete, these stations will be less than 10 minutes from New Zealand's largest employment centre. Living and working in these locations is already highly sought after, but this is expected to intensify after CRL completion. The study seeks to establish how many people would live and work in the area if supply was unconstrained.

The designated case study area comprises 692 private properties over 70 hectares between the two precincts—an area equivalent to just under half of all private land in the Auckland city centre.[26] Existing density in the area is modest by Auckland standards. There are currently 6,930 residents and 8,700 employees. Existing gross floor area (GFA) is 731,000m^2 split between 249,000m^2 of residential GFA (34%) and 482,000m^2 of non-residential GFA (66%).

The outcomes of the study are shown in Figure 31 through Figure 33. The supply curve under the existing Unitary Plan capacity scenario (Scenario 1) is upward bending, indicating that developers are willing to provide less additional quantities as prices rise. The steeper the supply curve, the less added supply is provided for a given price change. The supply curve becomes a straight vertical line at the Unitary Plan capacity (estimated at approximately 2 million units of GFA).

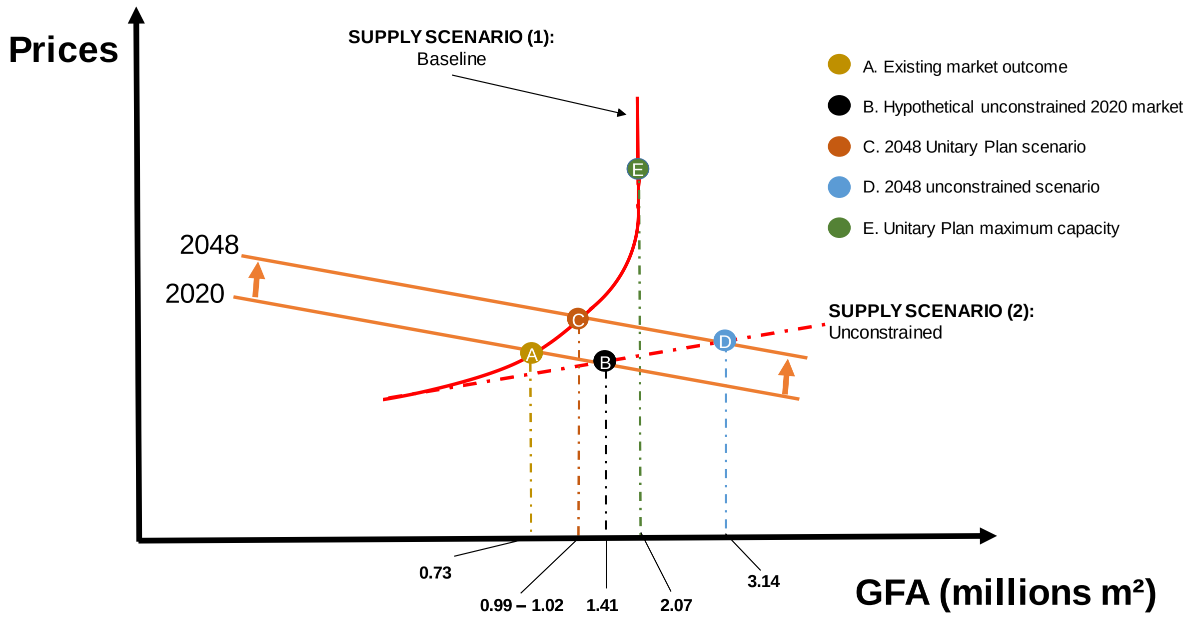
In relation to the Unitary Plan scenario:

- Developers have difficulty in taking up small additions in capacity. This is because demolishing an existing building to gain one or two floors or building on top of existing buildings (for instance, to maintain a protected heritage façade) is costly and requires higher prices to become economically feasible. There is evidence that existing constraints are already binding on development, meaning the supply curve is becoming more vertical.
- Consequently, the Unitary Plan may stipulate that capacity exists, but in practice prices are not high enough to entice the development of this capacity. Prices may never be high enough to develop all permitted capacity as there are better options either in Auckland, the rest of New Zealand, or abroad.

The unconstrained scenario has a flatter supply curve (consistent with supply responsiveness), which does not steepen to a vertical line because there is no stipulated binding maximum. The analysis of these points shows that the unconstrained scenario is associated with greater supply at a lower price than under the status quo (current Unitary Plan). This result reflects the exceptional access to amenity in and from the Mount Eden and Karangahape Road areas.

[26] Defined here as the Auckland city area bounded by State highways 1 and 16

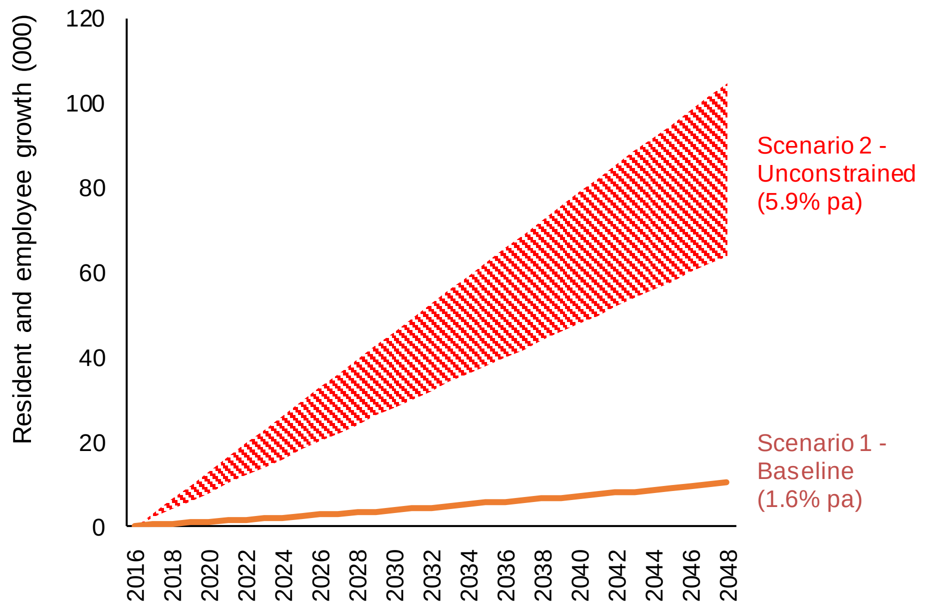
Figure 31: Supply impact of removing constraints on intensification in Mt. Eden and Karangahape Road



Source: PwC analysis.

Under the existing rigid framework, demand to 2048 under Auckland Council's land use assumptions implies approximately 1 million square metres of gross floor area (point C) and a growth rate of 1.6 percent per year as shown in Figure 32. Under a flexible and responsive planning framework, 2048 demand is estimated at 3.14 million square metres of gross floor area (point D) and a growth rate of 5.9 percent per year.

Figure 32: Annual growth rate scenarios for Mount Eden



Source: PwC analysis

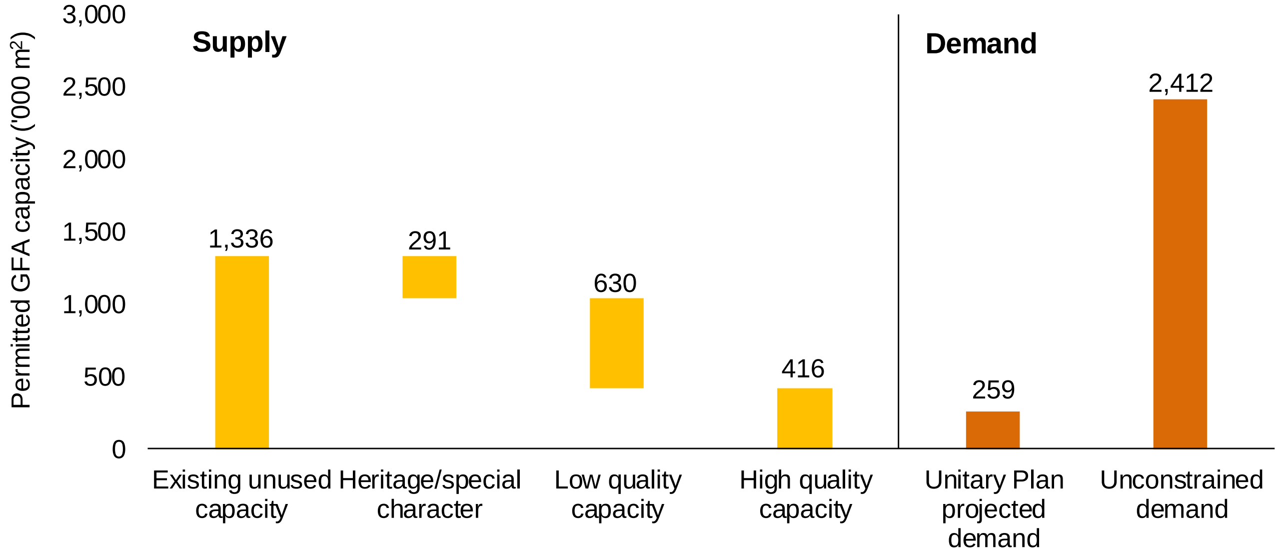
The divergence between the baseline and the unconstrained scenario occur because supply in the area is already highly constrained. Existing constraints are pushing up prices, creating the illusion that few people want to live and work in the area.

To estimate what demand for floor area could be under an unconstrained planning framework, we use two observed relationships in Auckland's development markets. The first is between height constraints and land value. Land value impacts in the Mt Eden area are estimated using this relationship when constraints are removed. A second observed relationship between development and land value is used to convert land value impacts to increased development. This increase in development, along with a forecast of unconstrained population growth, based on forecast population growth in less constrained areas, is used to estimate total unconstrained demand in 2048.

Under this flexible planning framework (Scenario 2 – Unconstrained), supply requirements are over five times higher than estimated high quality capacity[27] under the Unitary Plan (416,000m²).

Three methodologies are used to establish the degree of existing binding constraints. The first uses Cooper & Namit (2018) which establishes a large discontinuity for a viewshaft policy that bifurcates the project area (known as Viewshaft E10 in Auckland Council planning documents). The second establishes a land value premium associated with greater height allowances in the area (suggesting there is demand for more intensive development). The third shows a discontinuity in land value of an actual development that pierces existing constraints (because it was built prior to their introduction) and surrounding properties; further evidence that existing development is constrained.

Figure 33: Supply available by indicative feasibility, and additional demand forecasts to 2048 by scenario



Source: Auckland Council, PwC analysis
Note: Capacity totals indicate unused development capacity under existing regulatory constraints. Demand figures are net of the existing built GFA of 731,000m².

The analysis implies that the Unitary Plan provides enough capacity for a very modest growth scenario (estimated at 259,000m² according to planning models), where high prices push demand to other locations. Relative to the unconstrained scenario, this capacity would be exhausted by 2025 if constraints were removed.[28] If constraints are not lifted, the market will respond by clearing at higher prices.

To develop the case study area to its potential, front-loading permitted capacity is essential. While there is theoretically enough capacity in the very short term, adding permitted capacity in small increments over time will likely dampen the supply response and place upward pressure on prices. This is because developers are already building up to existing constraints. Taking up marginal increases in capacity (for example increasing the height of an existing building) when sites are heavily capitalised is typically uneconomic.

Evaluating supply quality in the Mount Eden catchment

It is important to differentiate enabled capacity in planning provisions by quality, since not all housing development opportunities are of equal value to a developer. The attractiveness of location of permitted capacity is one obvious differentiator; the existing level of capitalisation on a plot of land is another. While the value of land is a good measure of the former, the land ratio is a good measure of the latter:

[27] To estimate high quality supply, we start with total theoretical supply under existing planning rules and deduct supply associated with heritage buildings or designated a special character zone (since these areas are more costly to build in). The final step is to deduct supply (designated 'low quality supply') that is associated with properties that are already highly capitalised.
[28] Notwithstanding normal business cycle fluctuations.

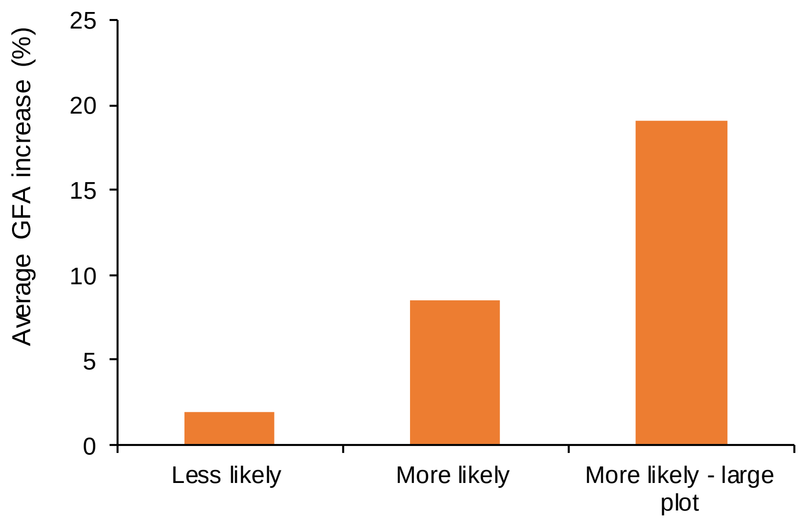
$$Land\ Ratio = \frac{Land\ Value}{Capital\ Value}$$

Properties with a low land ratio (close to 0) are highly capitalised and less likely to be redeveloped. In contrast, properties with high land ratios, where the value of land is a high proportion of the sale price, are more likely to be redeveloped. Figure 34 illustrates that parcels with a low land ratio (labelled "less likely") experienced an increase in GFA of just 1.9% between 2012-2018. In contrast, large plots with a high land ratio experienced a 19% increase in GFA - 10 times higher.

This makes intuitive sense. When the relative price of a land parcel rises, it is a signal that people want to live and work in that location. Land with low capitalisation is easier and more profitable to develop because most of the value is in the land. Put another way, it is costly to demolish an asset and start again or build on top of existing structures.

After accounting for supply on heritage or character overlays, Auckland's Unitary Plan provides for approximately 1.045 million square metres of additional gross floor area (low- plus high-quality supply in Figure 33). After removing land plots with a low land ratio however, just 40 percent of this remains (416,000 square metres). This is one measure of actual supply in the area that could be expected to be taken up at reasonable prices.

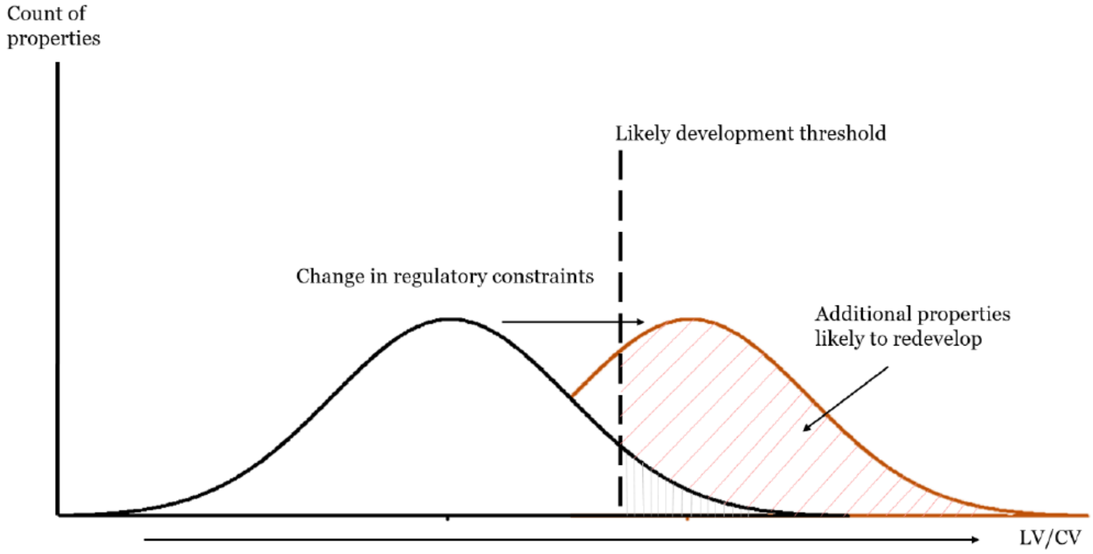
Figure 34: Empirical test of development between 2012 and 2018 by estimated likelihood of development



Source: Auckland Council, PwC analysis

Loosening regulations in high demand areas increases land values (holding all else constant) and therefore the land ratio (see Figure 35). This in turn increases the probability of redevelopment, enabling more supply and lowering the price of floor space. This is consistent with our discussion on the AMM model above.

Figure 35: Increase in development opportunities with fewer regulatory constraints

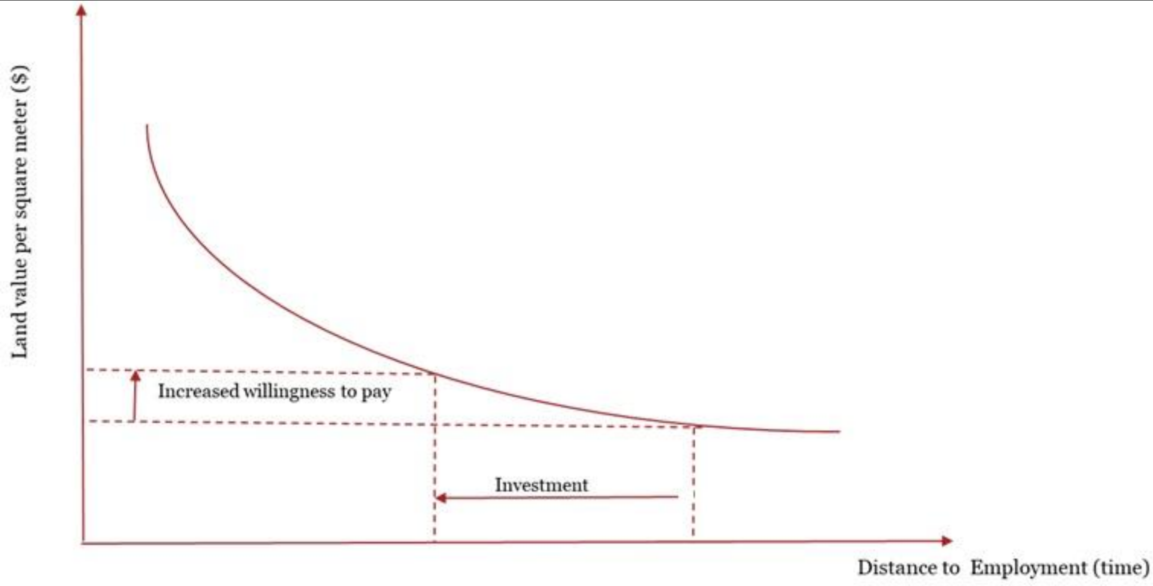


Source: PwC analysis

Case study: Rapid transit networks

The purpose of this case study is to demonstrate the value associated with rapid transit in New Zealand cities and show why intensification around these areas can benefit urban residents. Transport investment changes the relative value of land by improving access to amenities and employment opportunities. When a significant increase in access to amenity and employment results from improvements in transit access between two areas, an increase in land values near the transit nodes is expected, as illustrated in Figure 36. This occurs because the benefits of transport investment are often spatial. Since land is not substitutable (that is, not all land benefits from rapid transit), land values equilibrate, increasing as a function of proximity to a station and frequency of service, holding other factors constant.

Figure 36: Relationship between land value and distance to the city- where distance is represented by time



Source: PwC analysis

Wellington Rapid Transit Network

The relationship between accessibility to Wellington's transit network and residential land value was estimated using a hedonic pricing model (HPM).[29] HPMs are often used in real estate and urban economics to model property or land values based on a range of attributes that buyers consider to be important and which therefore drive value.[30] The models also account for the significance that buyers place on different attributes, or their willingness to pay (WTP) for a given attribute. The HPM used to model residential land values in Wellington is estimated via ordinary least squares (OLS) regression and has the following form:

$$Ln(Land\ Value\ per\ sqm) = \text{Constant} + \beta_{\text{T}} Transit\ Network\ Attributes_i + \beta_{\text{O}} Other\ Attributes_i + \varepsilon_i$$

Where:

- $Ln(Land\ Value\ per\ sqm)_i$ is the natural log of the land value per square metre of a given residential land parcel
- $Constant$ is a constant representing the natural log of land value per square metre when all other variables have a value of zero
- $Transport\ Network\ Attributes_i$ is a vector of variables identifying the transport network attributes of a given land parcel and β_T is a vector of coefficients on these variables
- $Other\ Attributes_i$ is a vector of variables identifying other attributes of a given land parcel and β_O is a vector of coefficients on these variables

[29] The HPM developed here is a simplified model intended to provide an indicative estimate of the possible impact of transit network attributes on land values in Wellington. It has not been fully developed and does not control for all relevant attributes. To provide a more robust estimate of the impact of transit network attributes on land value, a more comprehensive model would need to be developed.

[30] See for example: McIntosh, J., Trubka, R., & Newman, P. (2014). Can value capture work in a car dependent city? Willingness to pay for transit access in Perth, Western Australia. Transportation research Part A: policy and practice, 67, 320-339.

- ε_i is the error term.

Transport network attributes for Wellington residential properties include proximity to train stations, proximity to bus stations, proximity to state highways, and drive time to CBD. Table 11 summarises the results of the model.

Table 11: Results of the HPM

Transport attributes	A residential property being located …	… is associated with a change in land value per sqm of:
Rail	within 250m of a train station	15%
	between 250m and 500m of a train station	12%
	between 500m and 1500m of a train station	4%
Bus	within 100m of a bus station	22%
	between 100m and 250m of a bus stop	20%
	between 250m and 500m of a bus stop	12%
Highway	within 100m of a state highway	-12%
	between 100m and 250m of a state highway	-11%
	between 250m and 500m of a state highway	-7%
All roads	further from the CBD by 10%, in minutes of driving time	-6%

Source: PwC analysis

Impacts of other land attributes on land value include:

- A 10% increase in employment density is associated with a 2% increase in land value per sqm
- Being in a high earthquake hazard area is associated with a 2% decrease in land value per sqm
- A 10% increase in the deprivation index is associated with a 22% decrease in land value per sqm
- A 10% increase in distance to the coast is associated with a 2% decrease in land value per sqm

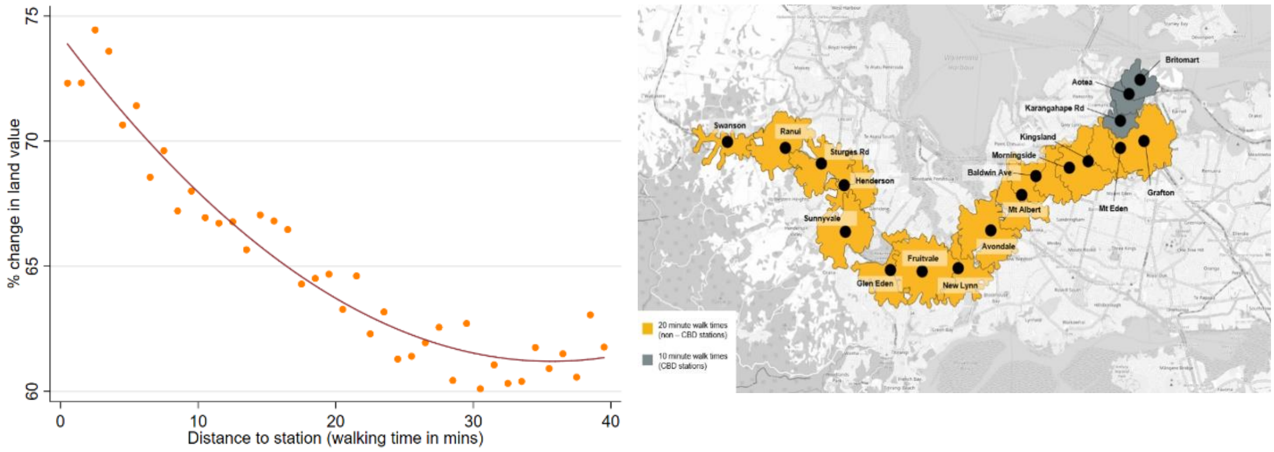
Auckland – Cross section: RTN and the frequency effect

A study by Trubka and McIntosh (2019) show a similar finding across the Auckland rail network. The authors use a similar hedonic pricing approach to evaluate the influence of proximity to a station and rail frequency (over a three hour peak period) on land values. The results demonstrate a positive relationship between land values and proximity to Auckland rail stations, and this effect is strongest for stations with high service frequencies. For all properties within 400 metres of a rail station in Auckland, land values range from 6.2 percent to 24.9 percent higher. For stations with roughly a four-minute frequency (~30 services in the AM Peak), land values range from 6.4 percent higher for properties within 1,600m to 15.2 percent higher for properties within 400m.

Auckland – Time series: CRL announcement effect (Western rail line)

The impact of new transport infrastructure can be capitalised into urban land prices upon project announcement – and therefore have fast-emerging impacts on urban form. One demonstrated example of this is the CRL in Auckland. According to a 2019 study by PwC, the announcement of the CRL caused land values of properties proximate to existing and future stations to increase. This is illustrated in Figure 37, where land parcels within 10 minutes' walk from a station increased at a faster rate than those further away. In monetary terms, using a difference-in-difference approach, the estimated appreciation of land proximate to western line rail stations, after the announcement of the CRL, amounted to more than $3 billion in excess of secular trends. There are good reasons to expect that this will increase further as the project becomes operational. Grimes and Young (2013) find similar effects for rail upgrades in Auckland.

Figure 37: Increase in land value after the announcement of the CRL – Western Line



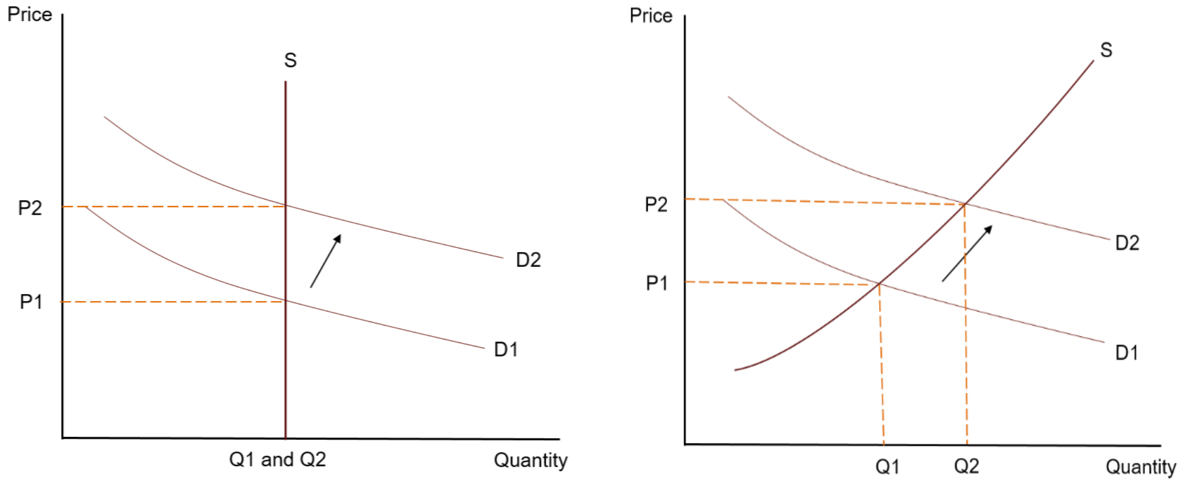
Source: PwC analysis.

Rapid Transit proximity and house prices

Value uplift associated with accessibility improvements shows that RTN proximity is commonly associated with higher land values but stops short of decoupling land values and dwelling prices, which depends crucially on the planning framework. To show the consequences of RTN proximity on dwelling prices, we consider two extreme outcomes. The first is with rigid planning rules (the single dwelling zone for instance), the second with flexible planning rules (the city centre for instance).

In the rigid planning case, higher land values arising from RTN proximity are passed on to house prices in full because land that benefits from the RTN access is scarce. This is illustrated in the left graph in Figure 38, where GFA is fixed and prices rise. In contrast, under responsive planning rules (Figure 38, right side), higher land prices generate a development response. Under this scenario, the number of people able to access housing within the station catchment is higher and local prices are lower than they would have been otherwise. This holds clear policy implications. Allowing flexible development around rapid transit nodes can help reduce house prices.

Figure 38: Planning rules that result in rigid supply vs elastic supply

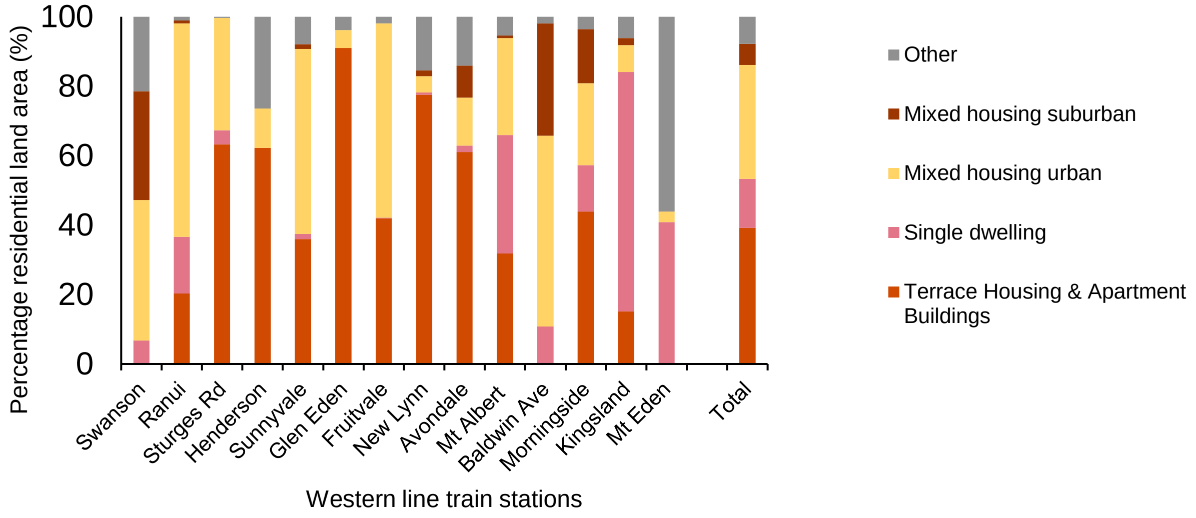


Source: PwC analysis.

Zoning compositions of Western line precincts

Since zoning is a critical component determining how amenity and transport benefits affect prices and urban form, it is important to understand the zoning rules around areas of rapid transit. Figure 39 depicts the zoning make-up of land within an 800m catchment area around each station along Auckland's Western line. For example, land within the Mount Eden station catchment is almost all zoned single dwelling or other (heritage and special character). Overall flexible zoning (Terrace Housing & Apartment Buildings) makes up just 40% of residential land around western line stations. Improving the flexibility of supply around these stations—a combined area of over 2,700 hectares—would significantly improve housing affordability alongside investment in the rail network. This is strong justification for the intensification policies of the NPS-UD.

Figure 39: Zoning by Western line station for 800-metre catchment



Source: PwC analysis

Part 2: Responsive planning for development

Intended outcome

Urban areas are dynamic and complex, continually changing in response to wider economic and social change. The current planning system can be slow to respond to these changing circumstances and opportunities, which in turn can lead to a mismatch between what is plan-enabled and where development opportunity (or demand) exists. This can lead to delays in supply or incentivise land banking. The intent of the responsive planning provisions in the NPS-UD is to:

- enable a responsive planning system to work toward more competitive development markets, through developments at scale
- ensure that plan change requests are considered on their own merits, irrespective of infrastructure funding constraints
- ensure that decision-making supports developments that are of scale and contribute to well-functioning urban environments.

Key findings

The primary impacts of the responsive planning policy come from changes to how greenfield expansion of urban areas is managed by local councils.

While greenfield developments can have **positive effects on housing affordability**, their **costs to the public can vary widely according to where and how they are implemented**. High quality greenfield developments have the potential to enhance urban outcomes while improving affordability and encouraging modal shift. Low quality greenfield developments could create more costs than affordability benefits.

The benefits of greenfield expansion **depend in part on the success of intensification policies**. All else equal, the benefits of greenfield expansion are greater for a city operating a rigid planning framework. If intensification policies are optimised, the demand for greenfield expansion is likely to be reduced. If upward pressure on housing prices remains strong, so does the potential case for greenfield expansion. It is important to take interaction effects between the two policies into account:

- effectively coordinating greenfield expansion policies with housing intensification in a city will compound the positive impacts of greenfield expansion on housing affordability
- ineffective intensification policies can mitigate the positive benefits that a greenfield expansion would otherwise have brought to housing consumers by weakening price competition among suppliers of housing. In other words, the benefits of competitive land markets are strongest when residents have more choices, both up and out.

Key costs of greenfield development include:

- driving-related externalities (especially congestion)
- infrastructure-related externalities
- opportunity costs of foregone agglomeration benefits.

The relative magnitude of impact is specific to individual cities and locations within each city. Because the impact of greenfield expansion is case specific, we do not take a position on the efficacy of relaxing urban limit protections at a national level, but emphasise the importance of careful, evidence-based planning when it comes to urban expansion.

Benefits of greenfield expansion

The mechanism through which greenfield expansion benefits housing consumers is clear. Housing supply is increased, which pushes down prices and improves housing affordability for both homebuyers and renters. This is closely related to the intensification policy, which pushes down house prices through the same supply-side mechanism.

When implemented effectively, both policies contribute to increasing the consumer surplus available to homebuyers and renters. Examples include:

- the additional benefit that brownfield renters enjoy when greenfield developments drive down rental prices across the city
- the value gained by greenfield homebuyers when prices drop due to competition from new inner-city apartments.

Effectively coordinating greenfield expansion policies with housing intensification in a city will compound the positive impacts of greenfield expansion on housing affordability (by increasing the competitiveness of land markets across a city). On the other hand, ineffective intensification policies may significantly undermine the positive benefits that a greenfield expansion would otherwise have brought to housing consumers.

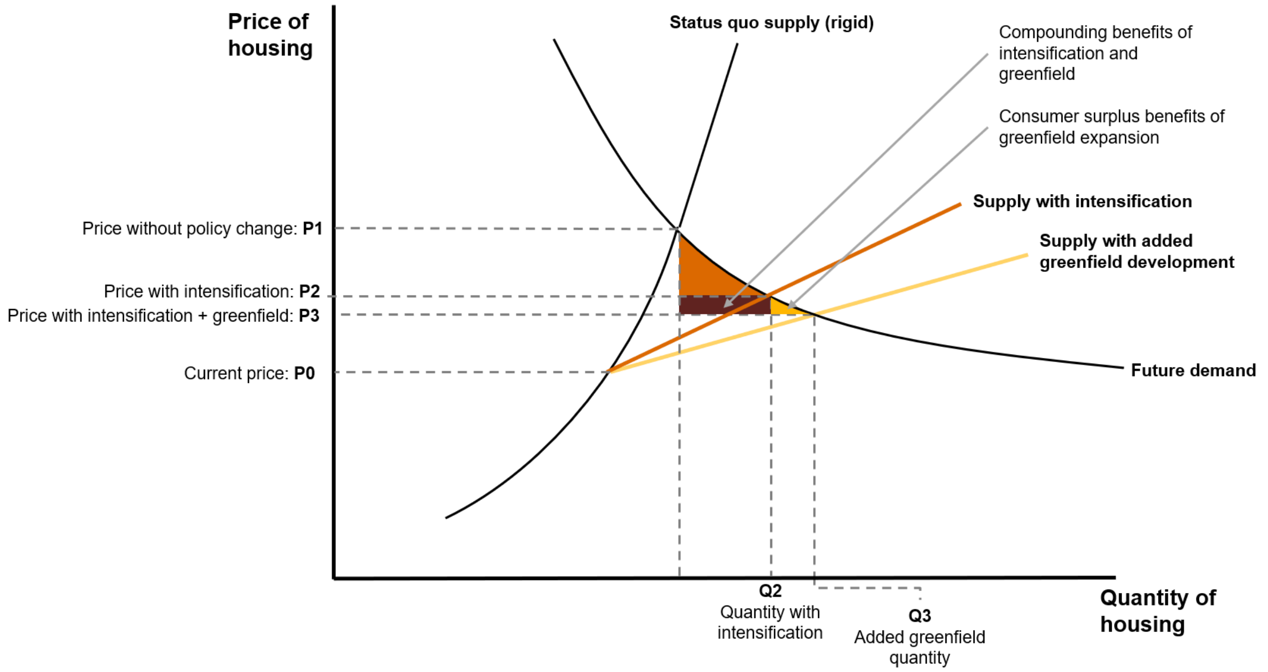
Because of the interaction between greenfield expansion and intensification, policy attribution is challenging. To aid policy attribution in our analysis, we separate the consumer surplus impacts into three categories:

1. impacts clearly attributable to greenfield expansion
2. impacts clearly attributable to intensification
3. impacts resulting from an interaction between greenfield expansion and intensification.

The first two impacts are likely to be proportional to the number of new households expected in greenfield versus brownfield areas. The third category captures interaction impacts between the two policies. More greenfield supply provides competition for brownfield suppliers and vice-versa, benefitting all consumers of housing in the city regardless of where they choose to live.

Figure 40 below presents the three types of consumer surplus impacts arising from greenfield expansion and intensification visually. The dark rectangle represents compound benefits shared by newcomers in both greenfield and brownfield areas. The two shaded triangles represent benefits clearly attributable to one policy or the other.

Figure 40: Consumer surplus effects of combined intensification and greenfield policies

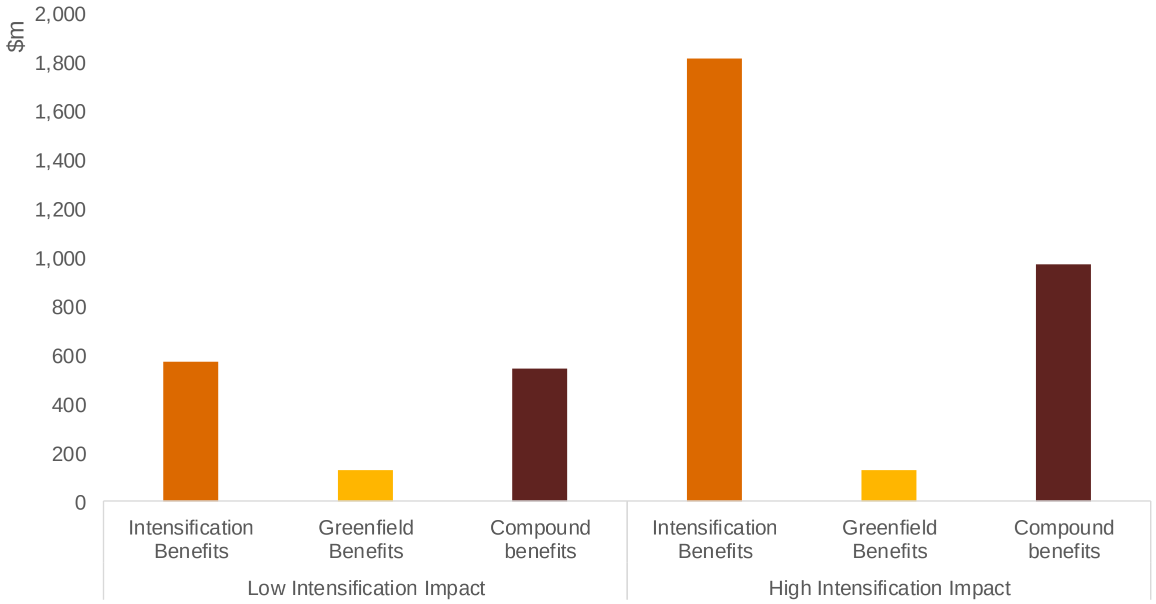


Source: PwC analysis.

To provide further context to the three types of consumer surplus effects, Figure 41 quantifies these for Auckland. The chart demonstrates how the same greenfield expansion policy could result in different benefits depending on the intensification policy. The analysis is undertaken for a high- and a low-intensification scenario.

Benefits derived from the greenfield expansion policy remain constant, while intensification benefits nearly triple between the two scenarios. However, most importantly, the compound benefits also rise strongly, almost doubling from the low- to high-intensification scenario.

Figure 41: Auckland greenfield benefits - Interaction with intensification effects



Source: PwC analysis.
Note: Assumptions for status quo supply elasticity and low and high scenarios for policy impact on supply elasticity are described in the intensification section of this report. Marginal impact of the greenfield policy on supply elasticity is adjusted to match the modelled estimates of additional greenfield dwellings attributable to the policy as shown in Table 12 below.

To model the low intensification scenario, we assume that the impact on the base elasticity is equal to the minimum standard error observed over the study period for all six cities, adjusted for constraint conditions in Auckland. We model the high intensification scenario by using a base elasticity impact equal to the maximum standard error, with the same adjustment for local constraint conditions. This difference in intensification impact is well within the level of variation in outcomes we expect between cities. This range is chosen to illustrate both the level of uncertainty in greenfield policy benefits and the potential of the policy to enhance the overall impact on housing affordability.

As suggested by the analysis above, benefits from greenfield expansion can be significant, especially when coupled with effective intensification policies. However, greenfield expansion policies can also carry sizeable costs, which reduce or even eliminate these benefits. Costs associated with these policies are discussed in detail below.

Costs of greenfield expansion

Greenfield expansion brings a range of different types of costs. For the purposes of this analysis, we are concerned only with the incremental costs of greenfield expansion, over and above the costs that would have been in place even under brownfield expansion. We classify these costs, or "negative externalities," under three broad categories:

1. **driving-related externalities,** which tend to be higher for greenfield residents relative to brownfield residents due to higher vehicle ownership rates and vehicle kilometres travelled. In this chapter, we depart from the average congestion per household estimates used in our intensification chapter to examine in greater depth the effects on modal choice of locating on the edge of the city as opposed to near a public transit node in a brownfield area.

2. **infrastructure-related externalities,** which cover incremental greenfield costs for water supply, wastewater and stormwater management, and the loss of open spaces. These are over and above the direct infrastructure costs borne by both greenfield and brownfield sites, which tend to be covered by higher rates and development contributions

3. **opportunity costs of foregone agglomeration benefits,** which arise when greenfield residents are diverted from brownfield locations, diluting the external benefits of density in high-productivity areas and leading to more distributed patterns of employment.

The magnitude of these costs is driven by two key factors:

1. the total number of new homes constructed in the additional greenfield urban expansion areas under the policy

2. the degree to which the added greenfield homes are occupied by residents who would otherwise have moved to or stayed in a brownfield location in the same major urban centre (MUC). These are termed "diverted" as opposed to "additional" households.

We model the number of new greenfield units resulting from the policy by taking ten percent of a given council's current plans for greenfield expansion. Therefore, new greenfield expansion reflects expansion over and above the opportunities already developed in councils' plans. For councils that completed housing and business assessment (HBA) studies in compliance with NPS-UDC, those figures are used instead.

To differentiate between diverted and additional households, we assume a diversion ratio of 50%. This means it is assumed that 50% of new greenfield households would otherwise have moved to or stayed in brownfield locations in the same MUC; 50% of households are assumed to move to the greenfield areas from outside of the MUC.

We note that policy impacts are likely to be greater where cities face more severe constraints to urban expansion in existing plans. For example, Wellington City expects to fulfil almost 90 percent of new housing demand in brownfield locations, so the impact of a policy shift in favour of greenfield development is likely to be particularly large. This contrasts with Queenstown, where planned greenfield units are more than double the total growth in household units projected by Statistics New Zealand.

To capture this effect in our modelling, we adjust the starting estimates by a constraint ratio, which represents the ratio of total projected growth in households to the number of planned greenfield units. The higher the ratio, the more constrained the MUC is, and the greater the policy impact is likely to be. Table 12 presents the resulting estimates for each MUC, which are used as starting assumptions for our cost benefit assessment.

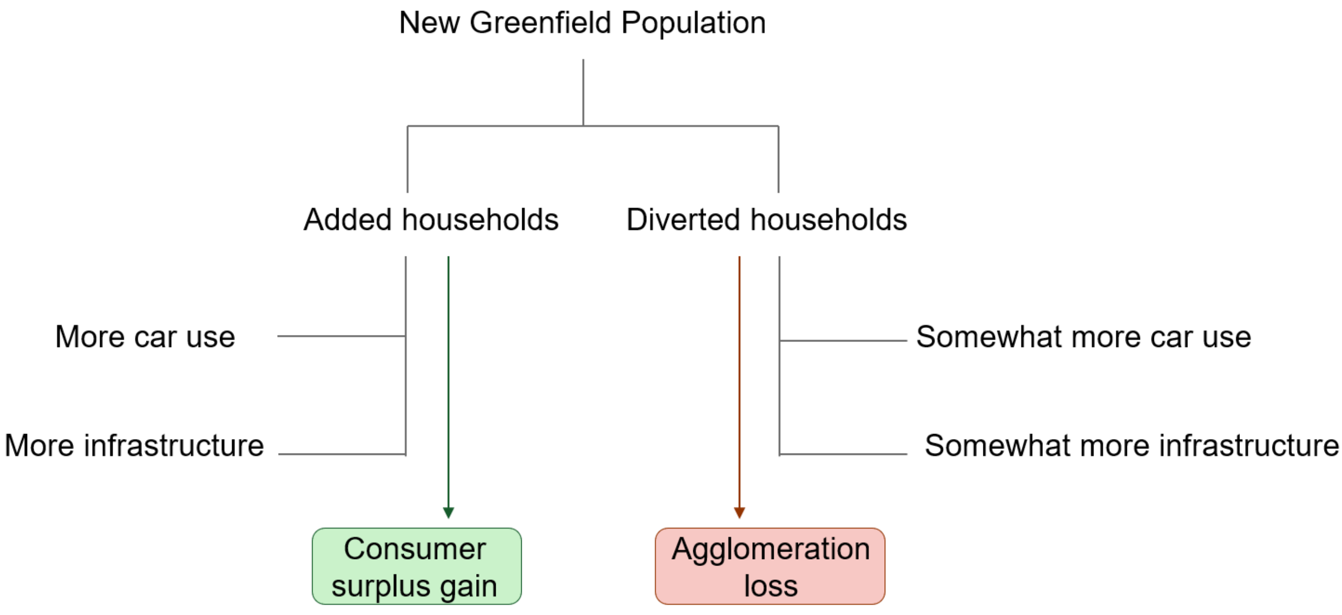
Table 12: Greenfield policy impact assumptions for added and diverted households

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Total projected population growth, 2019-2043	885,462	78,730	65,410	60,970	135,192	24,938
Household size	3.19	2.97	2.72	2.78	2.72	3.43
Added households - High growth scenario	277,727	26,527	24,088	21,920	49,682	7,275
Planned greenfield dwellings	147,672	33,140	22,559	2,300	30,288	18,590
Starting impact assumption	10%	10%	10%	10%	10%	10%
Constraint ratio (Potential growth in households/Planned greenfield units)	1.88	0.80	1.07	9.53	1.64	0.39
Estimated policy impact	19%	8%	11%	95%	16%	4%
Added greenfield households with policy	27,773	2,653	2,409	2,192	4,968	728
Diverted	13,886	1,096	2,484	1,326	1,204	364
Additional	13,886	1,096	2,484	1,326	1,204	364

Source: Stats NZ data, local council zoning plans, HBA studies, PwC analysis.

The division between diverted and additional households is important because it affects the external costs imposed by a greenfield expansion policy. Figure 42 illustrates the relationship between external costs and diverted versus additional households at a high level. The subsections that follow describe this in greater detail for each cost category.

Figure 42: Costs and benefits of greenfield expansion



Source: PwC analysis.

Driving-related externalities

This part of our analysis draws on work carried out by Todd Litman at the Victoria Transport Policy Institute, which provides comprehensive estimates of internal and external costs of common modes of transportation used in cities around the world.[31] We adjust Litman's estimates to align with New Zealand's currency and inflation rates, which results in the cost estimates per vehicle-kilometre for an average car shown in Table 13.

Table 13: Internal and external costs per vehicle-kilometre of an average car

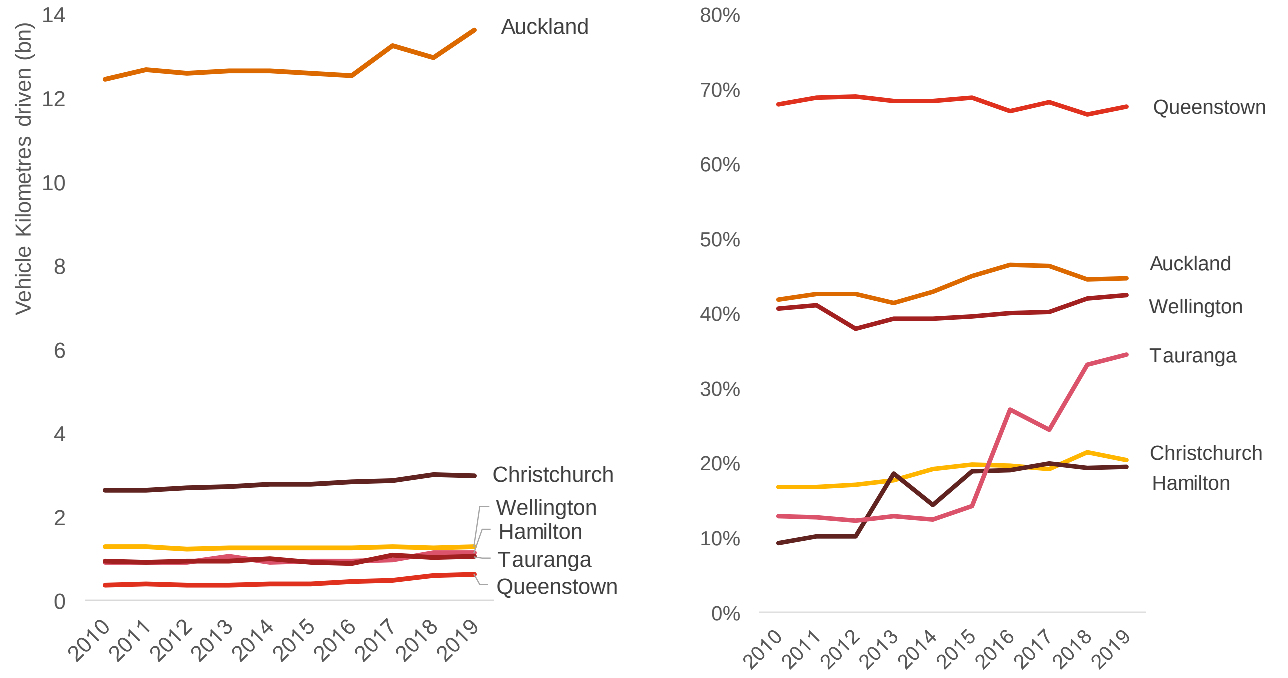
Mode	Distribution	Urban Peak	Urban Off-Peak	Rural	Weighted Avg. Urban
Average Occupancy		1.1	1.5	1.5	1.4
Vehicle Ownership	Internal-Fixed	0.313	0.313	0.313	0.313
Vehicle Operation	Internal-Variable	0.223	0.194	0.165	0.203
Operating Subsidy	External	0.000	0.000	0.000	0.000
Travel Time	Internal-Variable	0.363	0.129	0.108	0.200
Internal Crash	Internal-Variable	0.105	0.143	0.143	0.132
External Crash	External	0.063	0.063	0.063	0.063
Internal Health Ben.	Internal-Variable	0.000	0.000	0.000	0.000
External Health Ben.	External	0.000	0.000	0.000	0.000
Internal Parking	Internal-Fixed	0.092	0.092	0.046	0.092
External Parking	External	0.172	0.057	0.029	0.092
Congestion	External	0.149	0.023	0.000	0.061
Road Facilities	External	0.030	0.030	0.018	0.030
Land Value	External	0.039	0.039	0.039	0.039
Traffic Services	External	0.023	0.015	0.008	0.017
Transport Diversity	External	0.008	0.008	0.008	0.008
Air Pollution	External	0.071	0.060	0.005	0.063
GHG	External	0.022	0.020	0.017	0.020
Noise	External	0.015	0.015	0.008	0.015
Resource Externalities	External	0.053	0.046	0.039	0.048
Barrier Effect	External	0.026	0.017	0.009	0.020
Land Use Impacts	External	0.095	0.095	0.048	0.095
Water Pollution	External	0.016	0.016	0.016	0.016
Waste	External	0.000	0.000	0.000	0.000

Source: Victoria Transport Policy Institute, World Bank CPI deflator, Reserve Bank of New Zealand, PwC analysis.
Note: Weighted average urban numbers assume 30 percent of vehicle-km driven during peak hours.

To determine total driving-related external costs for each of the six MUCs, we combine these estimates with a range of additional data. First, we apply Litman's estimates to historical data on urban and rural vehicle kilometres at the TA level from 2010 to 2019, provided by the Ministry of Transport (presented in Figure 43 below).

[31] A spreadsheet model describing these estimates in detail is publicly available at www.vtpi.org.

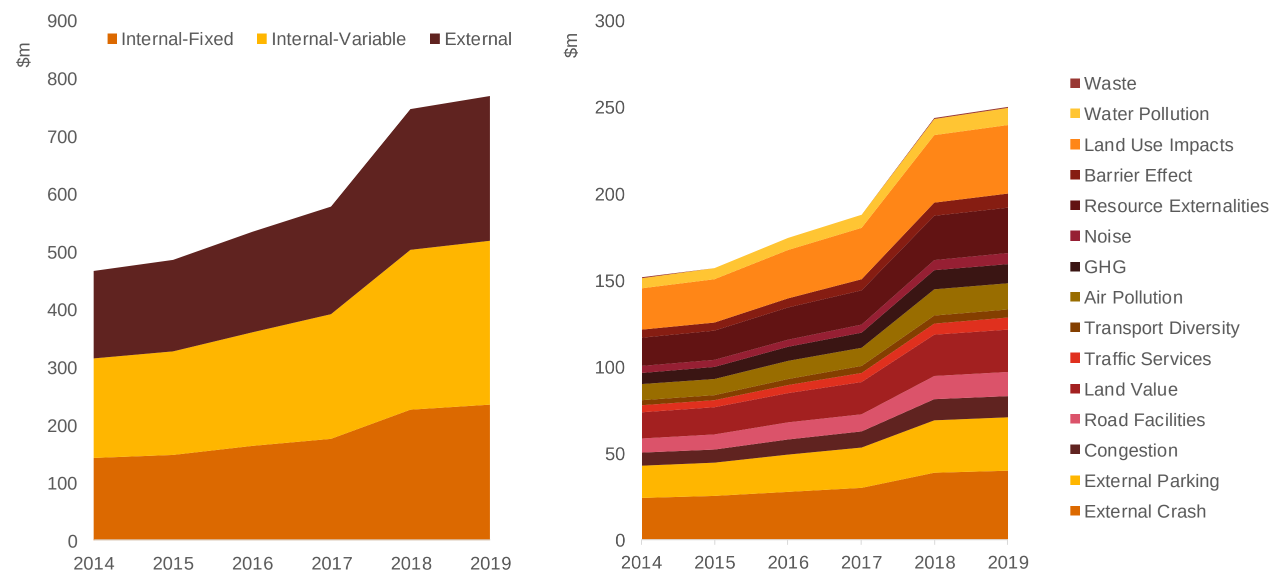
Figure 43: Total light vehicle kilometres driven (left) and proportion driven in rural areas (right)



Source: Ministry of Transport data.

As an example, Figure 44 presents the implied costs of vehicle usage in Queenstown between 2014 and 2019. In 2019, Queenstown's light vehicle motorists[32] imposed an estimated $250 million in external costs to the public, an increase of nearly $100 million relative to 2014.

Figure 44: Total costs (left) and external costs (right) of vehicle kilometres driven in Queenstown – All households, 2014-2019



Source: Ministry of Transport, Victoria Transport Policy Institute, PwC analysis.

We next estimate the likely contribution to vehicle kilometres driven by representative households from greenfield development areas and more densely developed brownfield areas. There is substantial evidence to suggest that both vehicle ownership rates as well as kilometres driven are higher in greenfield areas relative to brownfield areas. Several examples of such evidence are outlined below.

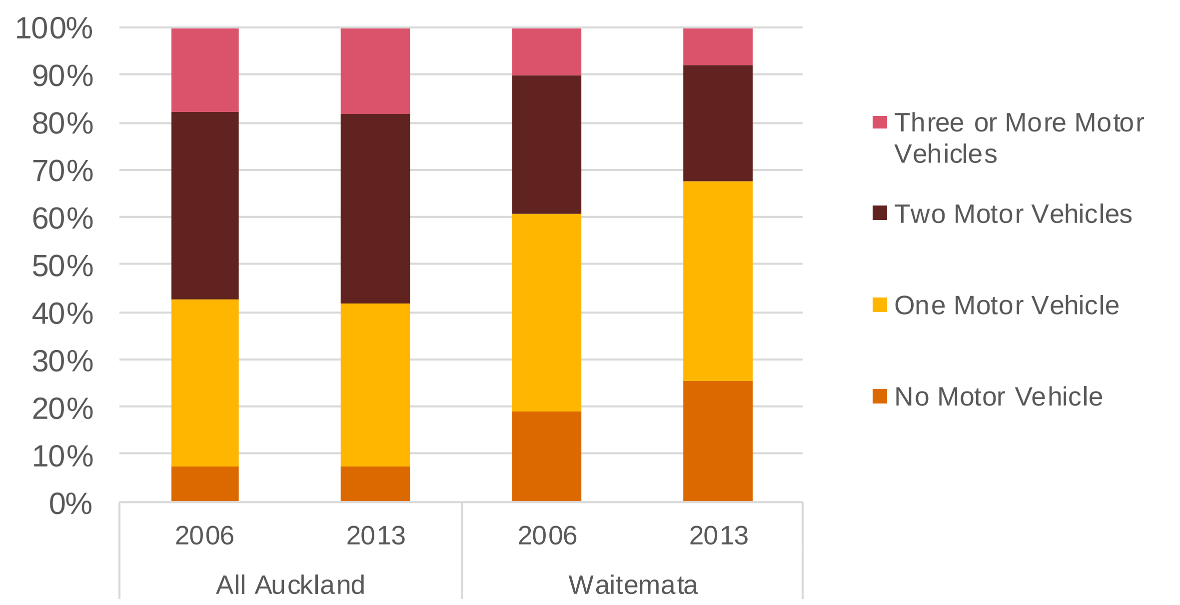
[32] Light vehicles were 91 percent of the total New Zealand vehicle fleet and growing as of 2017 (Ministry of Transport vehicle fleet statistics).

- Vehicle fleet statistics from the Ministry of Transport show that the average annual kilometres driven per vehicle has declined from around 13,300 in 2001 to a low of 11,500 in 2014 and has since remained relatively stable to 2019. As this long-term decline coincided with a period of rapid growth in New Zealand's major cities, we hypothesise that city growth is a contributing factor to the decline in vehicle use per household. As a greater share of households live in areas where alternatives to driving are available, the number and distance of motor vehicle trips per household decreases.

- Observed differences in motor vehicle ownership between local board areas within Auckland further support this. As Figure 45 shows, the Waitemata Local Board Area, which includes the Auckland CBD, has a far higher percentage of households owning one or zero motor vehicles than the Auckland-wide average. While this difference may be partly explained by demographic differences between residents, the availability of transport alternatives, shorter average trips, and higher cost of parking per trip will all incentivise substitution away from car use in denser urban areas as higher value activities squeeze out alternatives uses. The observation that vehicle ownership rates have further declined in the Waitemata Local Board Area over time as it has intensified lends additional support to this argument.

- NZTA reports that walking and cycling trips as a share of all trips were twice as high in Wellington City relative to Hamilton City (where density is lower and infrastructure is more car-oriented) between 2014 and 2018.[33]

Figure 45: Motor vehicle ownership per household in Auckland



Source: Statistics New Zealand.

We use these observations to help develop two assumptions regarding vehicle ownership and kilometres driven by households in greenfield areas versus brownfield areas that are targeted by the intensification policy (i.e areas with good public transport alternatives):

1. Households locating in these new brownfield developments will have lower vehicle ownership rates relative to those in greenfield areas, which we approximate based on the observed difference between Waitemata (which has the highest level of public transit access in Auckland) and the Auckland-wide average, that is, 27.9% fewer vehicles per household.

2. Kilometres driven per vehicle will also be lower in high-accessibility brownfield areas than in greenfield areas, reflecting that vehicle-owners in dense urban areas drive shorter distances and choose alternative transport modes more often than those on the urban fringe. In the absence of granular data on modal choices as a function of distance from city centres, we impose the conservative assumption that new households in brownfield areas will drive 15 percent fewer kilometres per vehicle per year

[33] NZTA. 2019. *Keeping Cities Moving: Increasing the wellbeing of New Zealand's Cities by growing the share of travel by public transport, walking and cycling*. Waka Kotahi NZ Transport Agency.

compared to those in greenfield areas. For comparison, MRCagney, BECA & Covec (2016) estimated that commutes for new residents in greenfield urban developments would be 55 percent longer than commutes for residents of brownfield developments. Our number reflects that this difference will likely be far less for the smaller cities.

We calculate a baseline estimate for vehicles per household in greenfield areas using Ministry of Transport data on vehicles per person by region and Stats NZ data on average household size, as presented in Table 14.

Table 14: Vehicles per household - modelled estimates

City	People per household	Vehicles/Person (Region-wide)	Assumed vehicles/household in greenfield areas
Auckland	3.19	0.7253	2.31
Wellington city	2.78	0.6493	1.81
Christchurch city	2.72	0.9051	2.46
Hamilton city	2.97	0.7559	2.24
Tauranga city	2.72	0.8734	2.37
Queenstown-Lakes district	3.43	0.7478	2.56

Source: Ministry of Transport, Stats NZ, PwC analysis.

We then determine the additional vehicle kilometres per household attributable to the policy; we do this separately for additional and diverted households. Diverted households would have driven at inner city (brownfield) levels had they not chosen to locate in greenfield areas. Therefore, only the difference in average distance driven between brownfield and greenfield households is attributable to the policy for those households. Table 15 presents the resulting estimates.

Table 15: Added vehicle kilometres per year per household - modelled estimates

City	Additional households	Diverted households (marginal increase)
Auckland	27,035	10,455
Wellington	21,113	8,165
Christchurch	28,794	11,135
Hamilton	26,227	10,143
Tauranga	27,727	10,723
Queenstown	29,968	11,589

Source: PwC analysis.

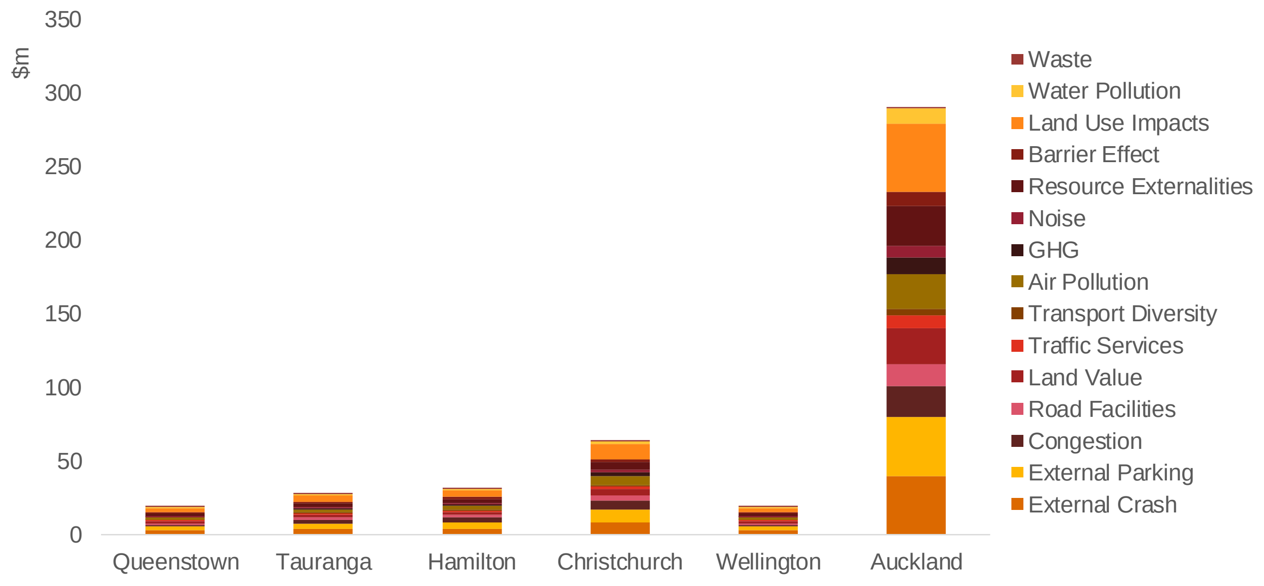
We project the rural share of vehicle-kilometres driven by assuming that the current trend will continue for 1 year, before levelling off to a steady state.[34] This reflects that the rural-urban driving share tends to change at a decreasing rate with decreasing volatility over time.

Finally, we apply the urban and rural costs imposed per vehicle kilometre to our projections of urban-rural driving shares over the study period to arrive at average costs per year per vehicle kilometre for each city. We assume that new greenfield development will reach its targeted steady state density within 15 years of 2018, at which time most of the HBA studies were completed. These figures allow us to estimate the change in vehicle-related external costs to the public on an annual basis to 2043.

Given the assumptions described above, the greenfield policy's impact on vehicle-related externalities is summarised in Figure 46.

[34] An exception was Queenstown, the fastest growing of the six cities, for which we allow 3 years of decrease in rural share at 1.7 percent per year (equal to the 2015 to 2019 compound average rate of decline) before reaching steady state. This primarily reflects Queenstown's plans for significant expansion of its urban footprint.

Figure 46: Summary of vehicle-related external costs



Source: PwC analysis.
Note: figures in present value at 4 percent discount rate over the study period.

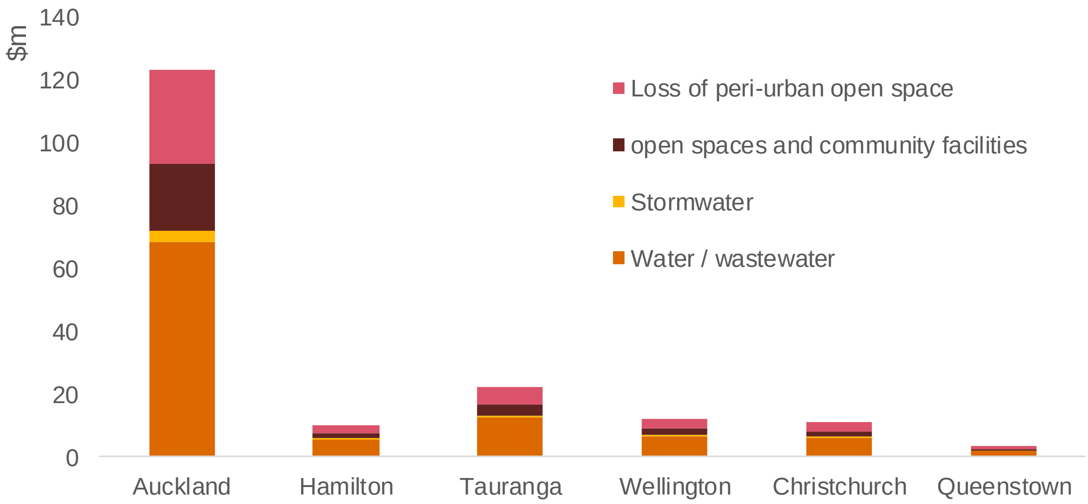
Infrastructure-related externalities and costs from loss of open space

The analysis described in this section estimates the external costs of water, wastewater, and stormwater infrastructure and the loss of urban or peri-urban open spaces resulting from greenfield expansion. These estimates represent the portion of costs not covered by development charges or user fees. For example, they may relate to additional maintenance costs or foregone capacity in the existing wastewater management network arising from added connections, net of user fees and development charges.

We rely on the infrastructure externalities estimated in MRCagney, BECA & Covec (2016), which put infrastructure externalities at higher levels per household for greenfield expansion relative to urban infill and provided both a high and low estimate for each category.

Our model makes use of the higher estimate in each category and weights the policy-related increase in population according to local council plans for urban infill versus greenfield expansion. We then adjust the weighted average to reflect the increase in greenfield units resulting from the responsive planning policy as described above. The resulting change in external costs of water infrastructure and loss of open spaces is summarised in Figure 47.

Figure 47: Greenfield policy external costs of water infrastructure and loss of open spaces



Source: MRCagney, BECA & Covec (2016), PwC analysis.

Opportunity costs of foregone agglomeration benefits

When cities pursue greenfield development concurrently with intensification efforts, there is a risk of diluting the positive externalities created through agglomeration. This is because it becomes more costly to access highly concentrated areas of employment and consumption, which are associated with agglomeration benefits.

As described elsewhere in this assessment, the literature on agglomeration economies suggests that these benefits:

1. are higher in industries that rely on highly skilled labour and rapid access to information
2. increase at an increasing rate as economic density rises.

To approximate the foregone benefits of diverting households from productive urban centres to greenfield developments on the urban fringe, we adjust the policy-driven population impact projections in our agglomeration benefits model to reflect our estimates of diverted households described above. Because workers in many of the diverted households will still commute to the economically dense parts of the city, we must make an assumption about how much dilution will take place in terms of full-time equivalent (FTE) workers are diverted to less concentrated working arrangements, including effects of longer commutes on productivity spill-overs. For our model, we assume that 20 percent of the FTE associated with the diverted households will be lost to agglomeration effects. In other words, 80 percent of the productive time of diverted workers remains in economically dense areas and contributes to agglomeration benefits. Sensitivities of this assumption are discussed below. Figure 48 compares the estimated agglomeration benefits with and without this adjustment for the six MUCs.

The location of greenfield development sites as well as the quality of transport links is likely to affect the magnitude of foregone agglomeration benefits.

Figure 48: Agglomeration benefits with and without greenfield diversion

Source: Stats NZ, Mare and Graham (2009), MRCagney, BECA & Covec (2016), PwC analysis.

Summary of costs and benefits

A summary of the costs and benefits associated with the greenfield development policy is presented in Figure 49. As illustrated in the chart, the affordability benefits in Auckland outweigh the costs of externalities, while in other MUCs we expect a small net negative impact, even with benefit levels including the advantage of higher (preferred scenario) intensification effects.

Figure 49: Summary of costs and benefits under base case assumptions

Source: PwC analysis.

However, the overall net effect of increasing greenfield expansion is highly sensitive to several key assumptions in our modelling. For example, in cities expecting steeply rising housing prices in coming decades, the benefits could potentially be several times higher. This is a key point. While these assumptions are important in understanding the limitations of the model, they also provide insights on how policies can be designed to achieve the best outcome possible. Key assumptions and how they influence the analysis are outlined below:

- **Gross impact of policy on the number of new dwellings built on the edges of the city**: this will affect the sensitivity of outcomes to all other assumptions. An increase in this impact will improve housing affordability for both greenfield and brownfield consumers. These benefits are concentrated among new homebuyers and renters, while many of the costs described below are broadly diffused among the public.

- **Degree to which households moving to new greenfield units are diverted from brownfield locations**: an increase in this number will mitigate vehicle-related costs and infrastructure externalities, while worsening foregone agglomeration benefits. A further sensitivity concerns the degree to which workers in diverted households spend less of their productive time in centres of urban productivity. In Auckland's case shown in Figure 49 above, a move from 20 percent to 30 percent FTE diversion is enough to result in a net negative for overall modelled results of the responsive planning policy.

- **Projected demand conditions at different price points in the housing market**: our model uses a linear demand curve equation for simplicity, but actual demand may not be linear. We expect that this design decision errs on the side of underestimating consumer surplus effects arising from lower-than-status-quo prices, because the consumer response to lower prices often increases at an increasing rate as prices decrease. This is likely to be the case with housing, as it comprises a major portion of expenditure for most households.

- **Elasticity of supply estimates from our econometric models,** both for status-quo and with-policy scenarios: these influence estimates of intensification impacts on population and consequently our calculations of greenfield impacts. For example, Wellington's status quo elasticity is significantly higher than the other cities, dampening the effect of a given change in elasticity arising from the policy. This affects the magnitude (though not the direction) of all cost and benefit estimates derived from population impacts.

- **City-specific assumptions**: Several of the MUCs studied exhibit unique characteristics that require adjustments to be made in our assumptions or methodology. In particular:

    - Queenstown Lakes District Council has planned capacity for new greenfield dwellings that is more than double the total increase in households projected by Statistics New Zealand during the same period. To reflect this, we have assumed infrastructure costs for Queenstown at greenfield levels for all new households.

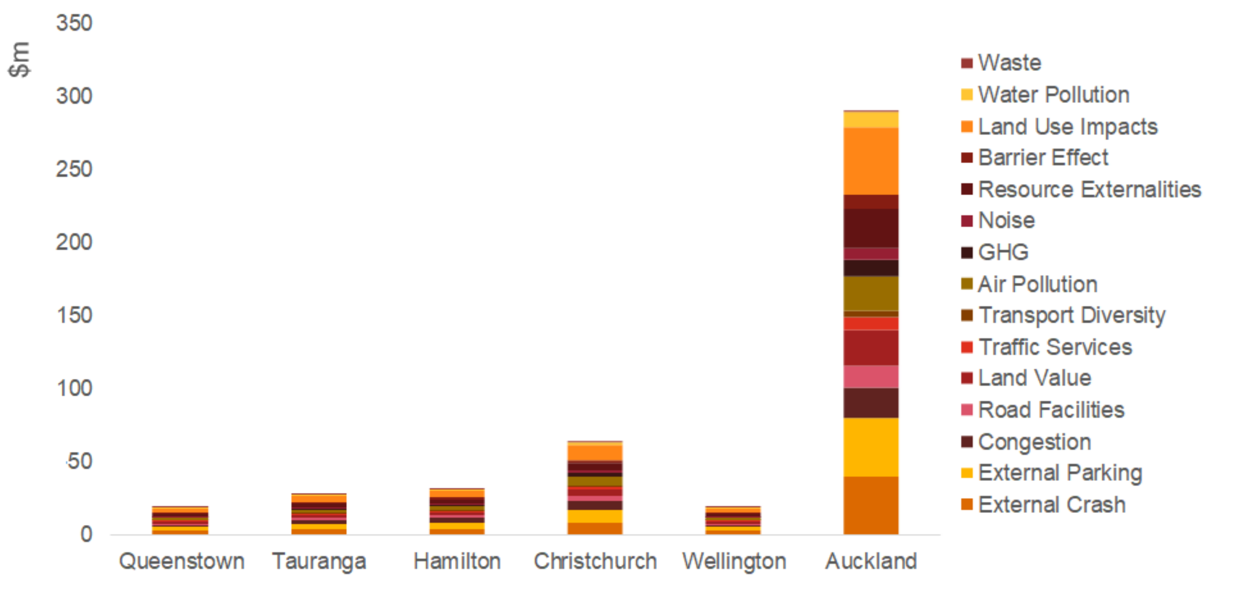
    - Due to its low population growth rates and unusually volatile building consent cycle, Wellington's starting elasticity assumption is significantly higher than the other cities, dampening price and housing quantity impacts for any given elasticity change. However, Wellington's housing prices have begun to rise steeply in recent years, suggesting that demand may be pushing up against constraints that were previously non-binding. For our model, this would mean a lower status quo elasticity and greater price impact for both the intensification and responsive planning policies.

    - Wellington City also plans a far lower level of greenfield expansion than the other cities, implying a greater potential impact of the responsive planning policy. We have weighted infrastructure cost projections accordingly.

- **Base case vehicle cost assumptions:** the base case assumes that new greenfield developments will maintain the levels of driving distances per household at current region-wide averages, and that costs per vehicle-kilometre will remain stable. This does not account for potential changes in the vehicle fleet, such as proliferation of electric vehicles in coming decades. It also does not consider that councils may impose congestion charges (or subsidise electric vehicles) to price in some of these externalities; may implement other policies to ensure that new greenfield developments have access to multiple transit modes; or may zone some greenfield developments at higher density than current plans imply.

The modelling assumptions we have made, including those outlined above, may significantly affect the net benefits of the policy. To explore this further, Figure 50 illustrates the change in costs that would result if new greenfield developments experienced the same levels of vehicle use per household as our estimates for brownfield households. Relative to the results presented in Figure 46, the development of higher-density, transit-enabled greenfield residential areas would generate around half the external costs to the public.

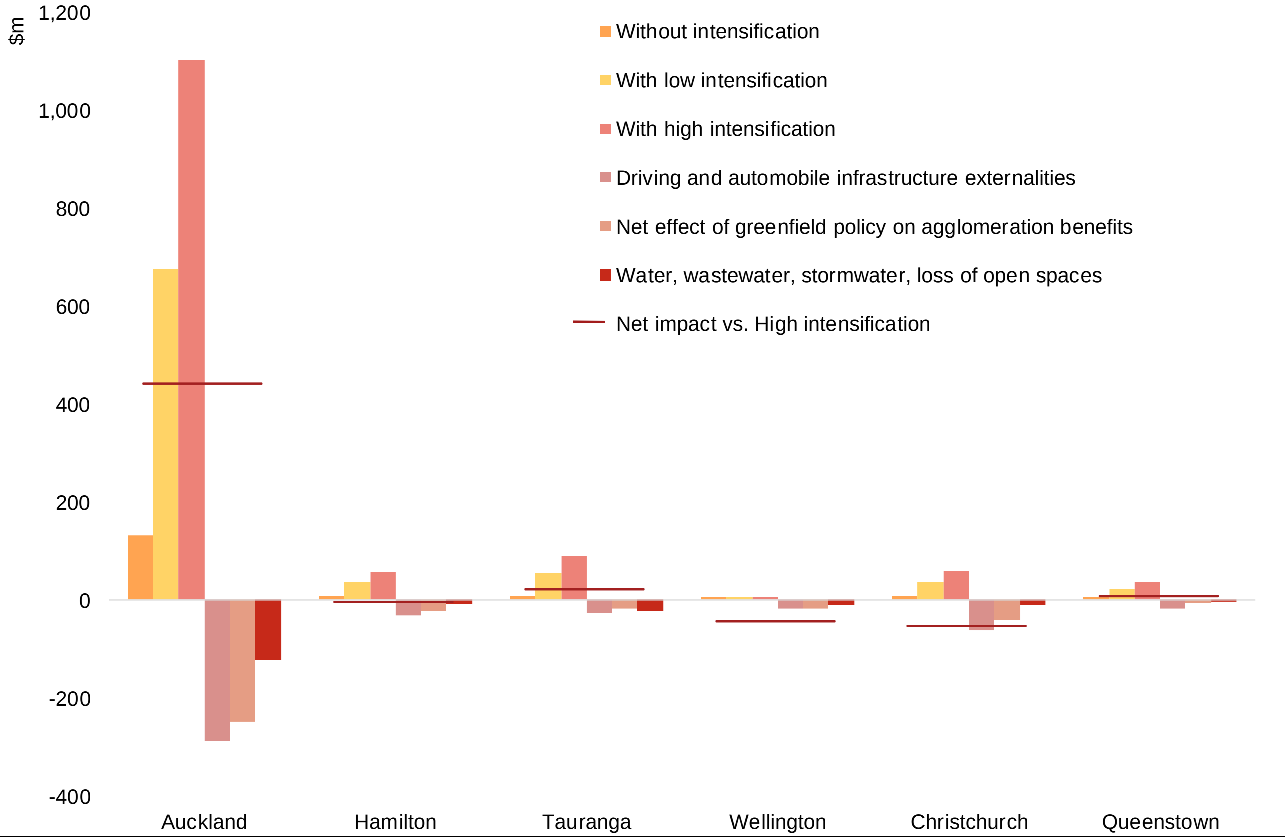
Figure 50: Vehicle-related costs under lower motor vehicle use assumptions



Source: Victoria Transport Policy Institute, Ministry of Transport, Stats NZ, PwC Analysis.

Figure 51 shows the adjusted net impact of the greenfield policy given the lower motor vehicle use assumptions described above. The implications of this are significant. Under the adjusted assumptions, net benefits in Auckland are approximately six times greater, and Tauranga and Queenstown move from a net loss to a net gain. Hamilton, Wellington, and Christchurch remain at a mild net negative.

Figure 51: Costs and benefits under lower greenfield motor vehicle use assumptions



Source: PwC analysis.

We conclude that while greenfield developments do have positive effects on housing affordability, their costs to the public can vary widely according to where and how they are implemented and other policy considerations. High quality greenfield developments have the potential to enhance urban outcomes while improving affordability and encouraging modal shift. On the other hand, low quality greenfield developments could cost the public more than the affordability benefits they create. Consequently, we emphasise the importance of careful, evidence-based planning when considering urban expansion.

Part 3: Minimum car parking requirements

Problem statement

The NPS-UD seeks to shift the provision of car parking from minimum car parking requirements (MPRs) to a market-based approach to ensure that parking supply matches demand at a price that reflects the scarcity of urban land and building space and gives weight to alternative, and possibly more valueable land use.

Intended outcome

The intent of the car parking provisions of the NPS-UD is to achieve more efficient land use, provide more space for housing, and reduce development costs.

Minimum parking requirements - Key findings

Empirical estimates in the five cities for which data is available show that **MPRs are preventing efficient allocation of scarce land and building space**, depressing land values while imposing an effective tax on floor area, borne by businesses and consumers including those who do not drive. The observed effect is **most severe in Auckland, Queenstown, and Hamilton**, though no estimate was possible for Tauranga due to lack of data.

Removing MPRs in mixed-use and commercial areas carries significant net benefits. If we assume that councils will need to take on additional parking management activities to mitigate congestion effects of lower parking provision, our calculations show that **benefits outweigh costs by a multiple ranging from 2 to 13**. Hamilton stands out as having the greatest potential net benefits of those included in the study, in the order of $100 million to $300 million.

To the extent that councils take action to shift the full social cost of parking onto users of parking, the costs to councils of removing minimums will approach zero.

Since costs seem to decline proportionally with benefits as we examine cities with less severe existing constraints, **consideration should be given to removing MPRs for smaller urban areas as well as the six major urban centres (MUCs)**.

Theory of minimum parking requirements

Current use of MPRs

MPRs dictate the minimum number of off-street car parks a new development must provide. There is considerable variation and complexity in how and where they are applied across New Zealand's cities. Generally, the regulatory mechanism appears to be based on estimated average near-peak demand for unpriced parking, depending on the size and type of the new development. Demand can be calculated in various ways including gross floor area, gross leasable floor area, or number of staff or sports courts. As this estimate is based on demand for 'free' parking, an oversupply of parking typically occurs.[35]

MPRs aim to prevent parking in undesignated areas and traffic congestion caused by people on the road looking for on-street parking. They can also be a mechanism for local government to reduce parking management costs.

The costs of MPRs compound as cities grow and land becomes scarce. The current state of regulation generally appears to view the demand for parking independently of location, opportunity cost, and dynamic market changes. This creates inefficient pricing, both of parking and land, and broad economic costs.

[35] Varghese, *Economic Development through Parking Reform*, 2011.

Minimum parking requirements constrain efficient land-use

All six of the MUCs have MPRs in their district plans. Table 16 below defines the current state of MPRs, focusing on their presence in central business districts (CBD).

Table 16: Current minimum parking regulation

City	MPR
Auckland	Removed in CBD but exist elsewhere
Hamilton	No parking requirements in the CBD, minimums elsewhere
Tauranga	Extensive use of minimum car parking requirements
Wellington	Removed minimum car parking in the CBD in the 1990's, but in place elsewhere.
Christchurch	Minimums used extensively, but not in the CBD (removed post-earthquake).
Queenstown	Onsite parking discouraged in zones where alternative modes of travel are available

Source: PwC analysis.

To provide a sense of the granularity of how MPRs are applied in urban spaces, Table 17 provides an example of Tauranga City Council's current regulations. The level of prescription appears well-intended to allow for variation in parking needs depending on the type of establishment, but it also contributes to rigidity in the allocation of scarce land and building space in important ways:

- Car parks experience peak demand for only a fraction of the day (or a few times per year), and alternative uses during low-demand periods are limited.
- Buildings used for an establishment requiring one level of parking might be converted to a different use with a different requirement. For example, a trade supply site might be converted to "Other low-intensity bulk retailing," implying a 25 percent increase in regulated parking supply level. This creates an added cost for the incoming business that may deter the transaction.
- No mention is made of proximity of alternatives, either for parking (such as a dedicated parking structure), or for transport mode. This inhibits incentives for investment in public transport and effectively subsidises private vehicle use. We note that through the planning and approvals process, these factors can be presented through transport assessments and accepted at the discretion of councils, but these deviations themselves are not costless to development.

Table 17: Tauranga City Council MPR example

Retail Activities and Services			
Activity	**Residents/ Visitor**	**Staff**	**Loading Space**
Supermarkets, Shops and Malls or Shopping Centres	10,000m^2 or less GLFA 4.5 spaces/ 100m^2 10,001m^2 or more GLFA 3 spaces/ 100m^2	1 space/ 200m^2 GLFA	1 HGV bay/ 1500m^2 GLFA for the first 5,000m^2 GLFA, then 1 HGV bay/ 5000m^2 GLFA
Garden Centres	1 space/ 100m^2 site area	1 space/ 200m^2 GFA	1 HGV bay
Building Improvement Centres, Trade Suppliers and Yard Based Suppliers	2 spaces/ 100m^2 GFA	1 space/ 100m^2 GFA	1 HGV bay/ 1500m^2 GFA for the first 5,000m^2 GFA, then 1 HGV bay/ 5000m^2 GFA
Other Low-Intensity Bulk Retailing	2.5 spaces/ 100m^2 GFA		1 HGV bay/ 1500m^2 GFA for the first 5,000m^2 PFA, then 1 HGV bay/ 5000m^2 GFA
Vehicle, Boat, Machinery Showrooms and Sales yards	1 space/ 100m^2 of indoor showroom and outdoor display area		1 HGV bay
Community facilities and Recreation and Leisure Facilities			
Activity	**Residents/ Visitor**	**Staff**	**Loading Space**
Places of Worship	1 space/ 10 seats	N/A	1 space for a 90-percentile car
General (including non-Licensed Clubrooms)	1 space/ 4-person capacity	N/A	1 space for a 90-percentile car
Licenced Clubrooms	Refer to Restaurants, Cafes, Bars or Taverns		
Gymnasiums/ Sports Halls (for public or private club use)	5 spaces/ 100m^2 GFA	N/A	1 space for a 90-percentile car
Public Sports Courts	3 spaces/ court	N/A	N/A
Sports fields and Golf Courses	15 spaces/ hectare of pitch area or fairway area	N/A	N/A
Public Swimming Pools	1 space/ 10m^2 of pool area	1 space/ 200m^2 of pool area	1 HGV bay
Libraries/ Museum/ Galleries	1.5 spaces/ 100m^2 PFA	1 space/ 250m^2 PFA	1 HGV bay

Source: Tauranga City Council.
Note: GLFA = gross leasable floor area; HGV = heavy goods vehicle; GFA = gross floor area; PFA = public floor area.

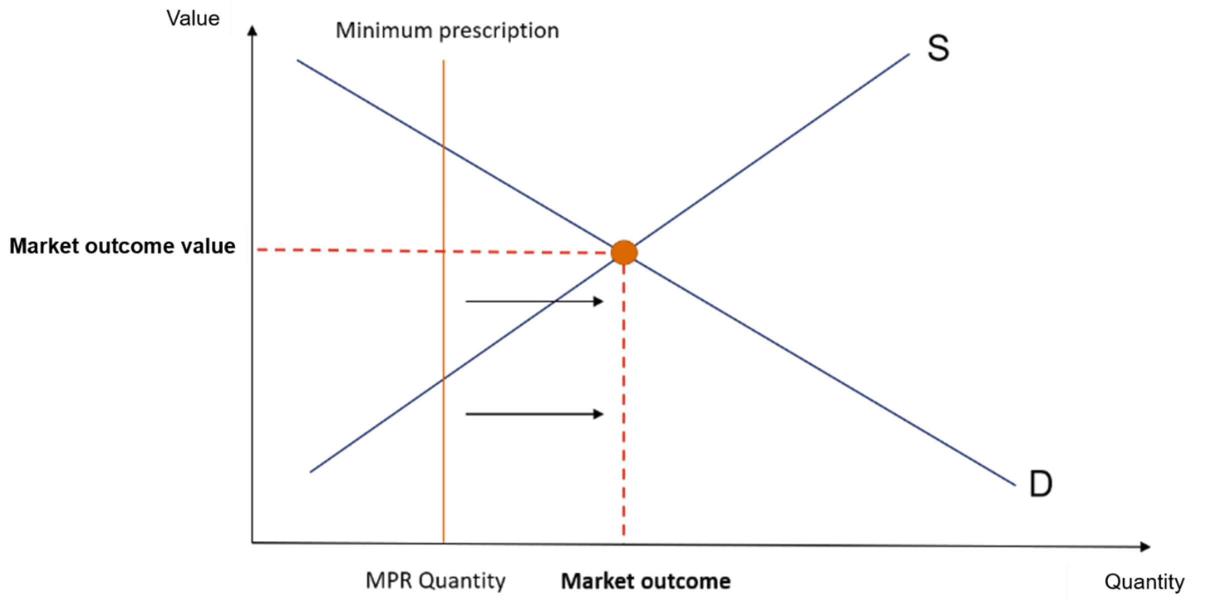
As an influence on markets for and use of land, MPRs are effectively a constraint to maximisation. In this way many of the concepts from our intensification chapter apply. When MPRs are removed, the AMM model predicts that in areas of high demand, the value of land will increase while the price of building space becomes more affordable.

Setting an MPR: Theoretical economic evaluation

A regulatory minimum can either be set below, at, or above the 'naturally' occurring market outcome. This section explores these possibilities from the perspective of microeconomic theory in three cases:

- Case 1 – The minimum requirement is set at or below the market outcome
- Case 2 – The minimum requirement is set above the market outcome, inducing a change in developer behaviour.
- Case 3 – An alternative approach aimed at reaching the socially optimum outcome.

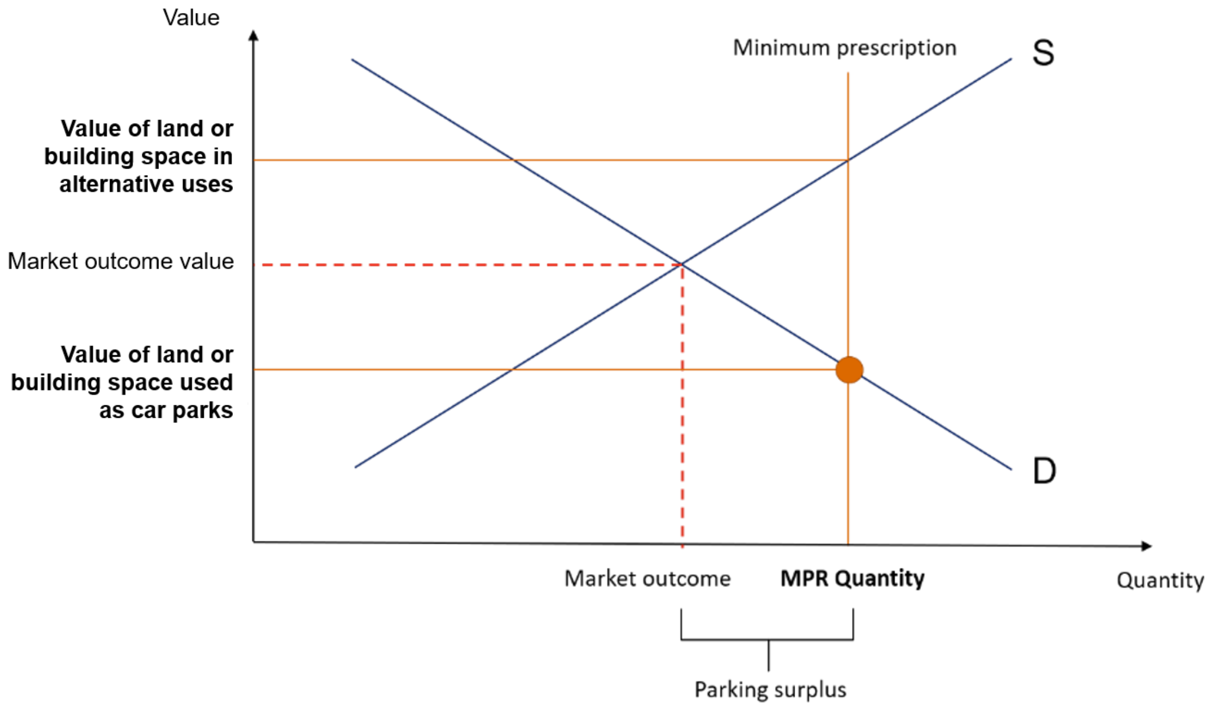
Figure 52: Case 1 – MPR set at or below free market outcome



Source: PwC analysis.

In Case 1, the minimum prescription has no effect on the outcome of parking. Market actors freely choose to provide more than the required minimum. This is equivalent to having no regulation. This situation is most likely in areas of low relative land values where demand-side competition between potential uses of land and building space is weak.

Figure 53 - Case 2: MPR set above market outcome

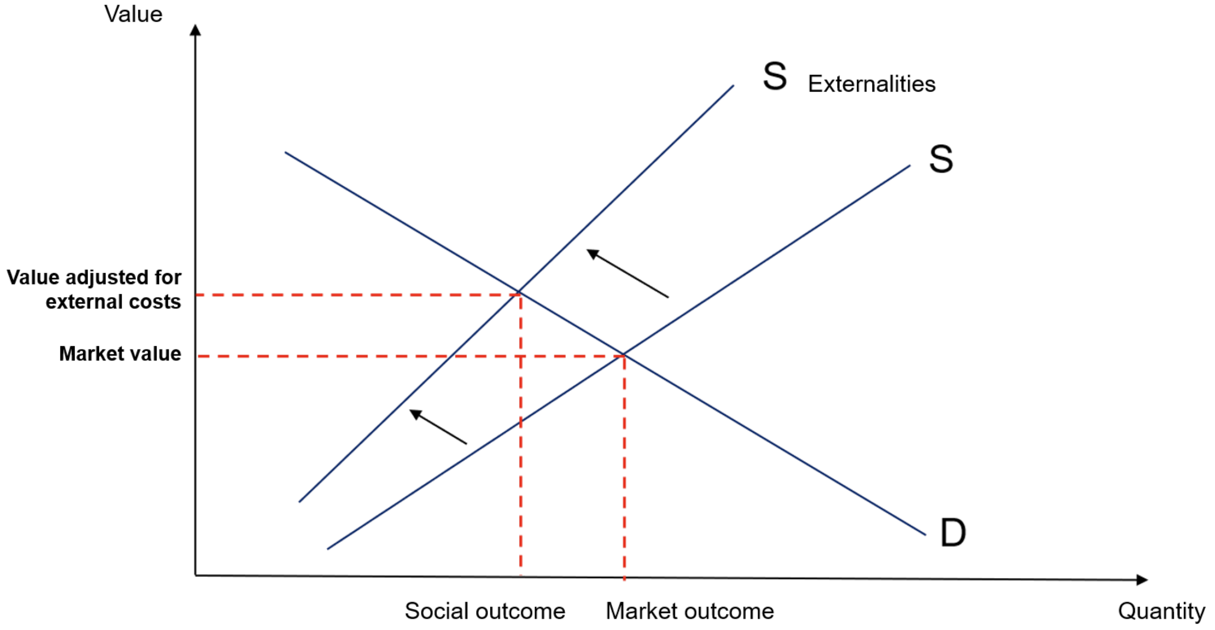


Source: PwC analysis.

In Case 2, the minimum prescription affects the outcome of parking as developers must legally provide the minimum. Unlike in markets for manufactured goods, supply in land and building space markets is determined less by inputs than by opportunity cost. The supply curve thus reflects the value of alternative uses for the space. Figure 53 illustrates the surplus of parking that exists between market outcome and MPR quantity. With an oversupply of free parking, paid-parking prices fall for surrounding vendors of parking, making private provision less valuable than alternative uses of land. We test this effect in our case study on Christchurch below.

In urban areas where land values are high, allocating land or building space to car parking over more valuable uses creates a significant economic cost. MPRs act as an effective tax on floor area, which is subsequently passed to consumers whether they require carparking or not.

Figure 54 - Case 3: Accounting for the social cost of externalities (agglomeration/congestion)



Source: PwC analysis.

Case 3 takes the cost of the negative externalities of driving as a mode choice into consideration for the price of parking. In cases 1 and 2, the supply curve was a strict representation of the cost of providing car parking to the developer, ie opportunity costs and construction costs. Developers do not price for externalities such as negative health effects and traffic congestion as it does not affect them or their operations directly. If regulations were designed to tax developers for the full cost of inducing greater vehicle use (for example, through parking maximums), the supply curve would shift to the left to reflect the social opportunity cost of parking provision. This would reduce the quantity of free parking supplied and make dedicated parking structures more commercially viable.

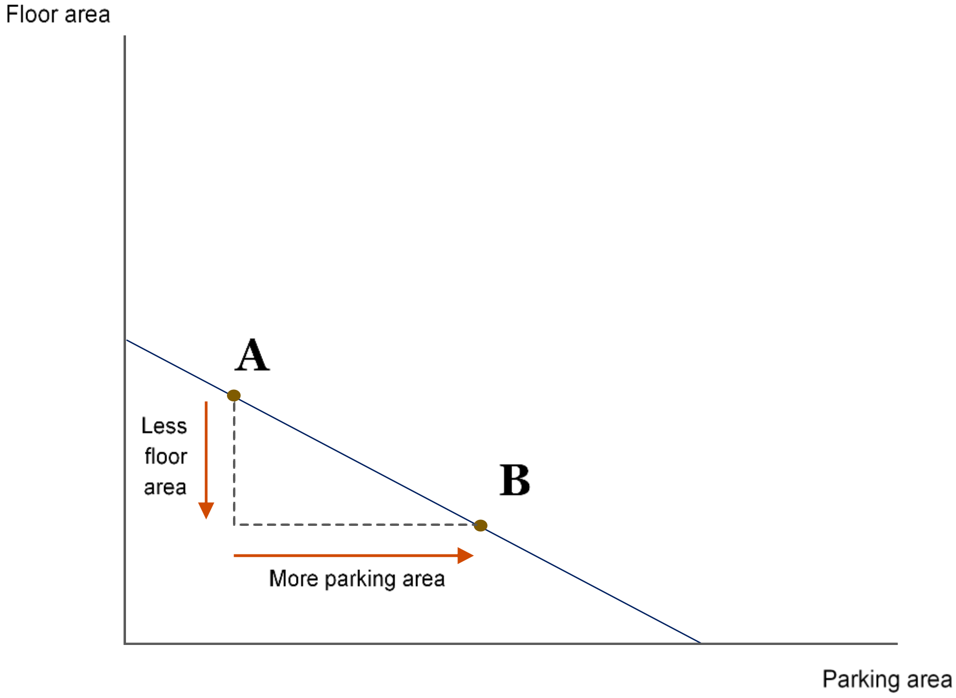
Alternative uses of space: Floor area vs parking area

Our assessment of the costs and benefits of removing MPRs begins with a simplified case where land values are high, building dimensions are fixed, and developers must give up a constant amount of floor area for each additional parking space.

Figure 55 illustrates the choice facing developers when allocating limited building space between parking and other uses. The rate at which parking area can be substituted for floor area and vice-versa during construction design approaches 1-to-1 when space is valuable and building dimensions are regulated. The total floor and parking area of the planned building can be thought of as a "budget". Adding a unit of parking requires giving up an equal unit of floor area, which can be costly. This relationship is depicted in Figure 55 where moving from point A to point B requires giving up floor area for more parking. This movement can at times be forced to happen through binding MPR policies. Parking minimums will have the greatest effect in areas where building dimensions are constrained.

The straight downward-sloping line in Figure 55 represents the developer's budget of building space or physical constraint. Developers can produce a combination of floor and parking area anywhere on this line or below it.

Figure 55: Trade-off between floor area and parking area



Source: PwC analysis.

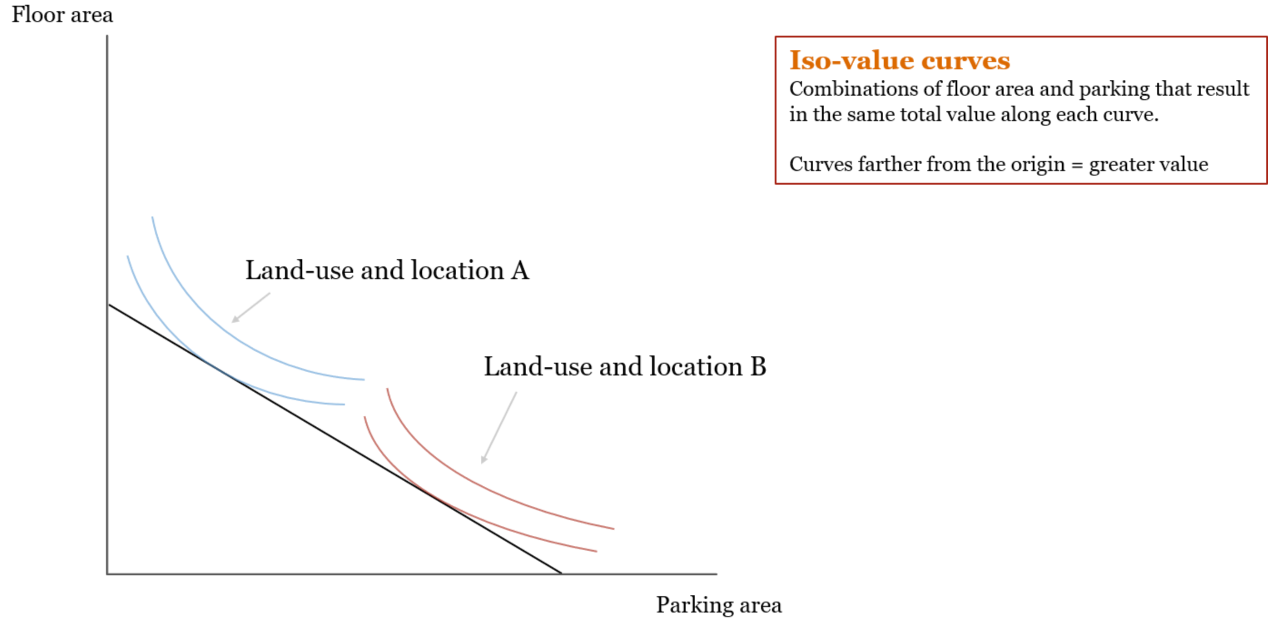
The chosen combination of floor area and parking area will affect the final value of the building. The rate at which one unit of foregone parking area can be compensated with an equally valuable amount of floor area is not constant but varies according to several factors. These factors include:

- Land-use: Different types of land and building uses have different needs.
- Location: Nearby parking and amenities, access to public transport nodes, and residential density within walking distance will all have an effect.
- Demand dynamics: areas with strong competition between alternative uses of space will place a higher opportunity cost on allocating space to car parks.

Figure 56 shows a physical constraint line with iso-value curves. Each individual curve represents a set of combinations of floor area and parking area such that the value of a combination at any point on the curve is the same as the value at any other. The curves that are tangent to the budget line are 'affordable' for the developers, meaning they have enough building space to produce the combination marked by the point of tangency. Curves that are not tangent to the line are of greater value but are unreachable given physical constraints.

In general, we expect diminishing returns to specialisation; that is, an additional unit of parking will be worth relatively less as the planned level of parking units increases. This is implied by the convexity of the iso-value curves.

Figure 56: Trade-off between floor area and parking area with Iso-value curves



Source: PwC analysis.

Value maximisation theory

Value is maximised where the marginal rate of substitution (the ratio of marginal values) between floor area and parking area is equal to the "price ratio," or the marginal cost of one in terms of the other. "Value" is a representation of the net present value (NPV) of potential future revenues per m^2 over the life of the building:

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

Where:

R_t = net cash inflow – outflows during a single period (t)

i = discount rate or return that could be earned in alternative investments

t = time period in terms of number of periods from zero

n = total number of time periods

To represent the changes in expected future cash flows (and present value) resulting from different allocations of parking and floor area, we use a model based on a Cobb-Douglas utility function:

$$Value = L \cdot Parking^{\beta} \cdot Floor^{\alpha}$$

Where:

Value = the NPV of expected future cash flows for the building

L = a constant term representing the effects of location and distance from city centre

Parking = building area allocated to parking in square metres

Floor = building area allocated to non-parking uses in square metres

β = the value elasticity of parking

α = the value elasticity of floor area

The maximisation condition

Profit for the developer is maximised when the marginal value of parking area relative to the price of parking is equal to the marginal value of floor area relative to the price of floor area:

$$\frac{MV_{ParkingArea}}{Price_{ParkingArea}} = \frac{MV_{FloorArea}}{Price_{FloorArea}}$$

Given the assumption of a constant 1-to-1 substitution rate for a given building, profit is maximised when the marginal value of parking area is equal to the marginal value of floor area as both denominators are equal to one.

$$MV_{ParkingArea} = MV_{FloorArea}$$

Or:

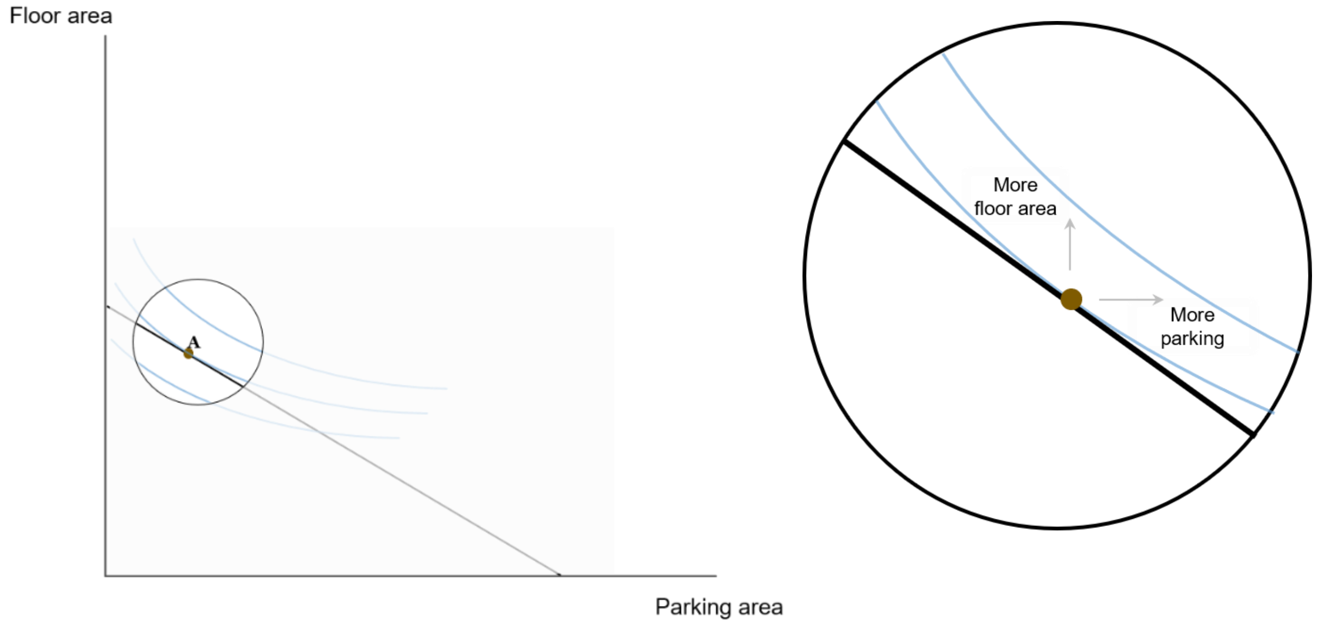
$$\frac{\partial Value}{\partial ParkingArea} = \frac{\partial Value}{\partial FloorArea}$$

Where ∂ represents the partial derivative of value with respect to parking area and floor area. With our Cobb-Douglas model above, this reduces to equality between the value elasticity of parking and the value elasticity of floor area:

$$\beta = \alpha$$

This means that developers will adjust their allocation of parking and floor area until an additional unit of either is worth the same amount. This is represented by point A in Figure 57, where the budget constraint lies tangent to the highest possible iso-value curve it can reach.

Figure 57: Trade-off between floor area and parking area without MPRs



Source: PwC analysis.

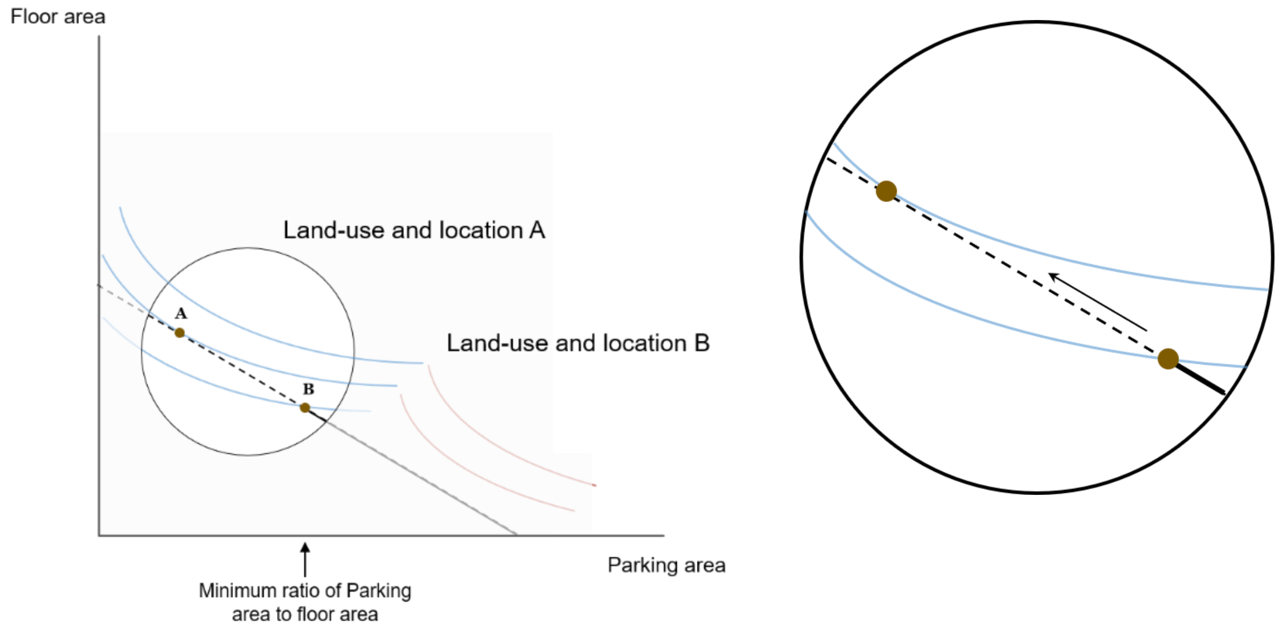
Efficient allocation in the absence of minimums

Without MPRs, developers can allocate building area to maximise value, so will choose the point where the physical constraint line is tangent to the greatest possible iso-value curve (Point A on Figure 57). At the point of tangency, the value of more floor area is equal to the value of more parking area. Given enough information and the freedom to allocate space to maximise value, developers will find a balance such that the value gained from another unit of floor area is equal to the value that would be given up by sacrificing another unit of parking.

Efficient allocation in the presence of minimums

When a regulatory minimum is in place, the possible bundles of parking and floor area along part of the budget constraint line are no longer available to developers, as illustrated in Figure 58. Allocation choices are limited to a certain range of parking/GFA ratios, so developers will choose the highest possible iso-value curve within that range (Point B below). In this scenario, the value of an additional unit of floor area is greater than the value of an additional unit of parking.

Figure 58: Trade-off between floor area and parking area with MPRs



Source: PwC analysis.

For some buildings, such as land-use and location B above, the bundle that maximises value is still within the permitted range. With a regulatory minimum, some building choices will be unaffected—those with iso-value curves that lead them to maximise value at a permitted ratio of parking to floor area (Land-use and location B Figure 58).

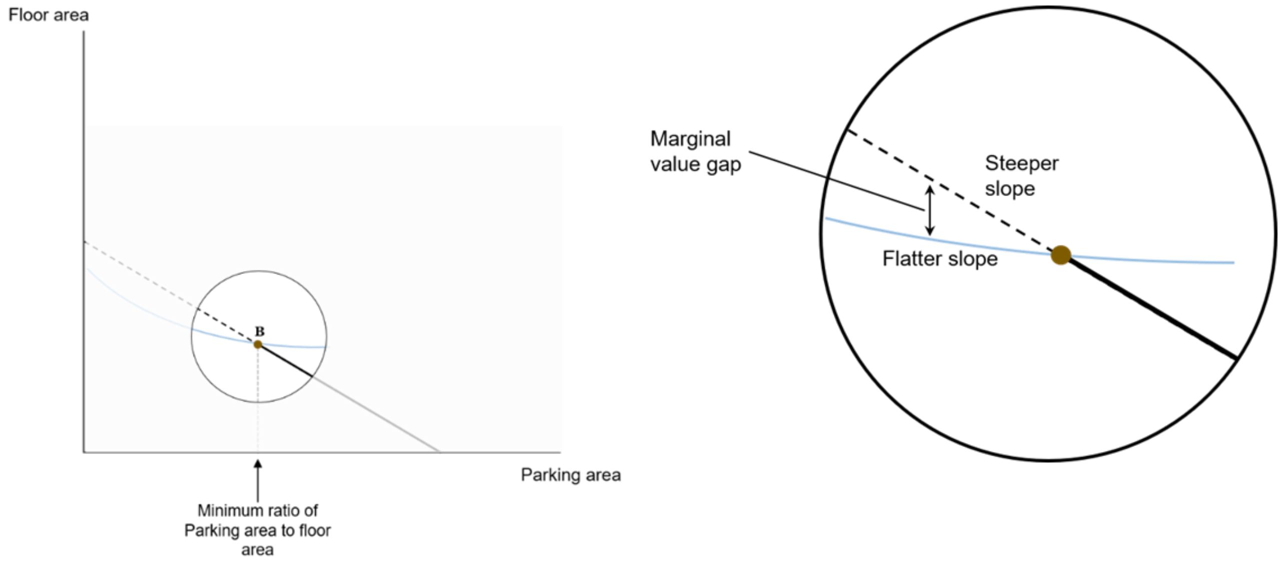
Those that are affected will be forced to settle for a less valuable allocation (Point A and callout above). Therefore, minimum parking rules will either prevent value maximisation or have no effect, depending on the property.

Minimum parking induces inefficient allocation

When regulations induce inefficient allocation outcomes between parking and floor area, we expect to find a significant gap between the marginal values of the two variables, illustrated in Figure 59.

This provides the theoretical basis for our empirical assessment: a significant gap between the marginal value of additional parking and that of additional floor space provides evidence of regulatory constraint and inefficient allocation.

Figure 59: Inefficient allocation between floor area and parking area



Source: PwC analysis.

In the following section we apply these concepts to estimate the extent to which MPRs are driving inefficient land and building space allocation in the MUCs.

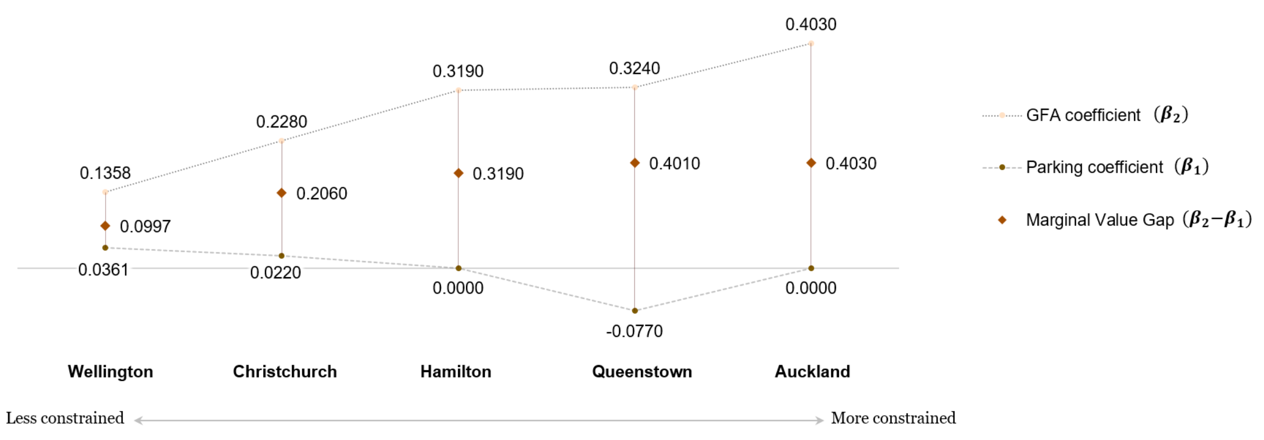
Estimating the benefits of removing MPRs

Using property valuation data provided by the Ministry of Housing and Urban Development, we estimate the expected change in capital value for a given change in parking area and floor area for five MUCs.[36] Our model controls for the land area of a plot and its distance from the city centre:

$$ln(CapitalValue_i) = c + \beta_1 \cdot ln(Parking) + \beta_2 \cdot ln(FloorArea) + \beta_3 \cdot ln(LandArea) + \beta_4 \cdot \ln(Distance) + \varepsilon$$

The coefficients of interest are β_1 and β_2, which are estimates of the value elasticity of parking and the value elasticity of floor area. Recall that the maximisation condition is $\beta_1 = \beta_2$.

Figure 60 – Regression results: Marginal value of GFA vs marginal value of parking



Source: PwC analysis.
Note: Coefficients are presented as zero where model estimates are not statistically different from zero.

The base model data includes all commercial properties in areas subject to parking minimums in each city. Our regression results in Figure 60 show significant gaps between marginal values of parking versus floor area. This suggests that MPRs are forcing businesses to allocate too much space to parking, decreasing potential capital

[36] Data on parking area was not available for Tauranga.

values through an effective tax on floor area. The greater the gap in marginal values, the more consumers and the public are subsidising the cost of storing cars.

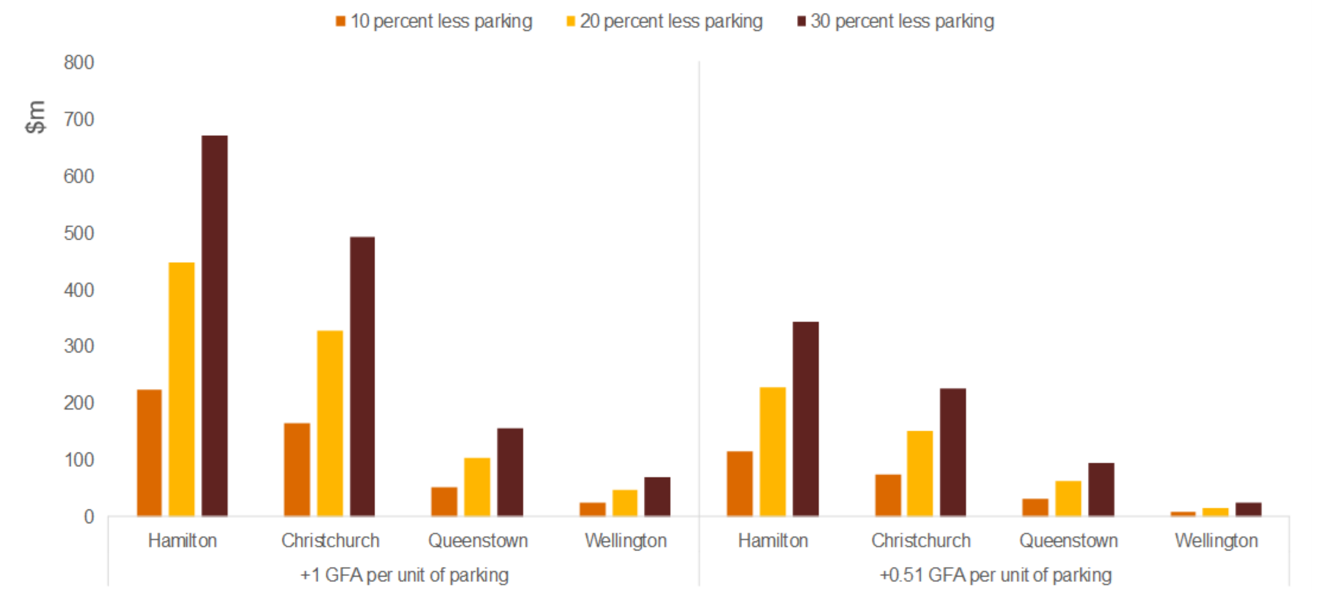
The weakest constraints are observed in Wellington, where parking minimums have been out of use for decades in the CBD, and Christchurch, where parking minimums were abolished in the CBD following the Christchurch earthquake (see the Christchurch case study below).

These regression coefficients are used to estimate the potential benefits of removing minimum parking requirements as follows:

- We calculate benefits for a hypothetical average property based on our sample for each city – this property has both capital value and parking area equal to the sample mean.
- Under the 1-to-1 budget constraint assumption above, the net percent change in value of this property for a given percent change in parking area is equal to the marginal value gap. For the Christchurch estimate above, this would mean a one percent change in allocated parking area is associated with a 0.206 percent change in the present value of the property.
- If we relax the budget constraint to allow for developers to give up less than an equal amount of floor area per added parking space, this value change would decrease proportionally to the new assumption.
- Using the total area and total capital value in our sample for each city, we calculate the implied change in total value for three policy-outcome scenarios: 10, 20, and 30 percent reduction in mean parking area per building.

Figure 61 summarises the resulting value change totals for all commercially zoned properties subject to parking minimums. These magnitudes reflect local land values and differences in gross commercial area subject to minimums as well as our estimated levels of constraint.

Figure 61: Estimated benefits of removing MPRs under selected scenarios



Source: PwC analysis.

The right side of Figure 61 shows the same calculation if we were to relax the assumption of a 1-to-1 trade-off between parking area and floor area. Here we have used the substitution rate estimated by MRCagney (2012) for the Takapuna, Onehunga, and Dominion road commercial areas in Auckland.[37]

These zones in Auckland feature primarily surface parking, and MRCagney's data ignored indoor parking areas, whereas our HUD data features only indoor parking and ignores surface parking. This makes our data most suitable for dense areas where off-street surface parking is minimal, thus the choice of a 1-to-1 assumption.

The actual benefits for the measured scenarios are likely to fall between the two estimates.

[37] MRCagney. *The Economic Impacts of Minimum Parking Requirements: An Analysis of Dominion Rd, Takapuna and Onehunga*, 2012.

Estimating the costs of removing MPRs

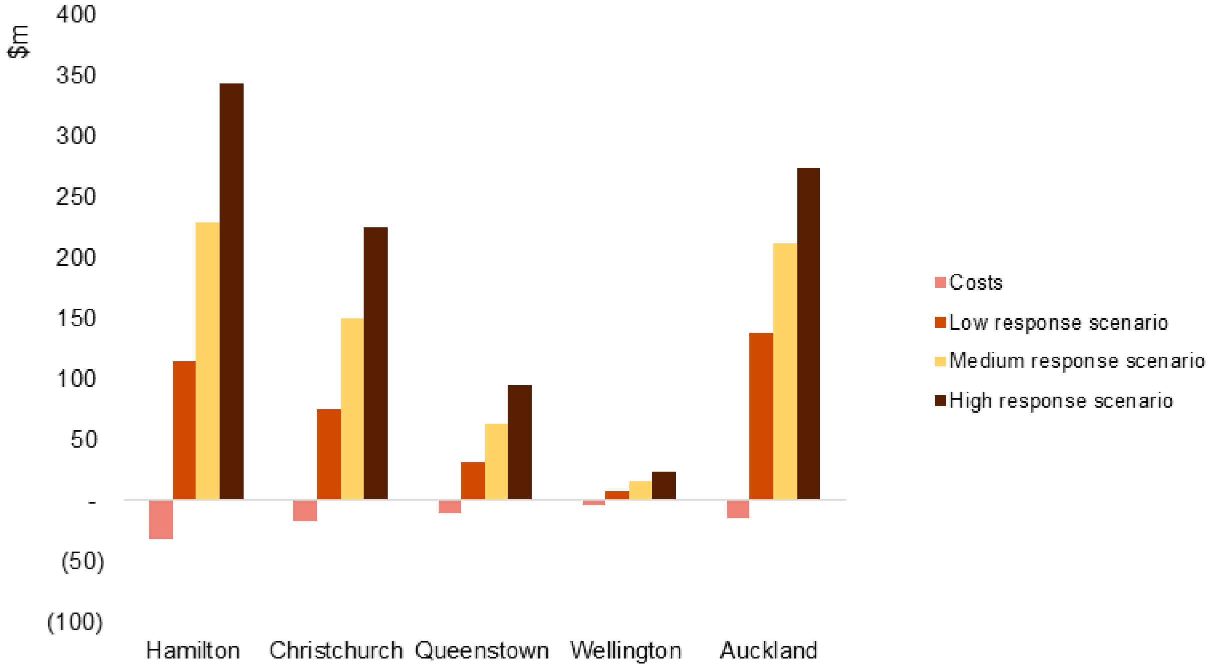
To estimate the increased costs of parking management to councils as a consequence of removing minimum parking requirements, we follow the approach used by MRCagney (2012).[38]

This approach does not consider potential revenue increases from parking management and thus may be an overly pessimistic estimate. To the extent that councils take action to shift the full social cost of parking onto users of parking, the costs (to councils) of removing minimums will approach zero.

MRCagney's approach is based on a study of three 'town centre' areas in Auckland: Dominion Road, Takapuna, and Onehunga. We scale our assumptions in proportion to existing floor area density, parking area subject to minimums, and estimated levels of marginal value gap to reflect the expected increase in parking management costs in the areas covered by our study in each city. The results are summarised in Figure 62 alongside MRCagney's original estimates for three chosen town centres in Auckland (not for all of Auckland).

Note that this method only considers the costs of parking management to councils without incorporating estimates of potential increases in revenue from MPR removal. In 2019, revenues exceeded operating expenses for parking management in Auckland, Wellington, Christchurch, Hamilton, and Queenstown.[39]

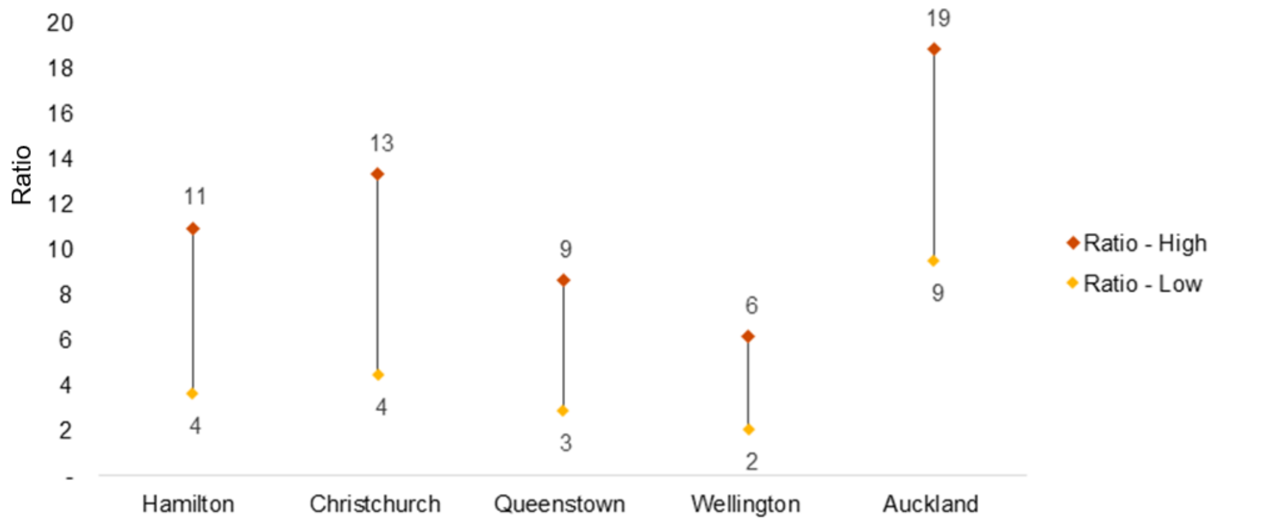
Figure 62: Cost-benefit summary for removing minimum parking requirements



Source: PwC analysis.
Note: Estimates based on valuation data for all commercial and mixed-use properties for all cities except Auckland, current as of August 2019. CBD districts for Hamilton, Christchurch, and Wellington where minimums are already removed have been excluded. The Auckland estimate is taken from the CBA for NPS-UDC 2016 and includes only the selected test areas (Dominion Road, Takapuna, and Onehunga). Because the Auckland study employs a different data set and methodology, results are not directly comparable and are presented here for reference only.

[38] MRCagney, *The Economic Impacts of Minimum Parking Requirements: An Analysis of Dominion Rd, Takapuna and Onehunga*, 2012.
[39] Local authority annual reports. Annual reports in Tauranga do not provide a direct comparison of parking revenues with parking management costs. Parking-related revenues were about 3.2 million in 2019.

Figure 65: Cost-benefit summary



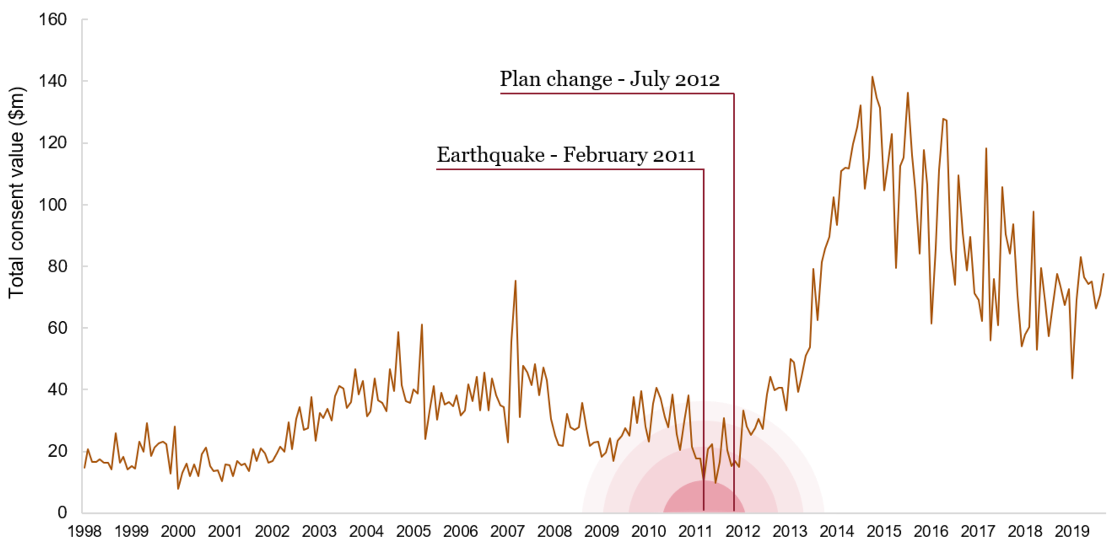
Source: PwC analysis.

We conclude that removing MPRs in mixed-use and commercial areas carries significant net benefits. Moreover, costs seem to decline proportionally with benefits as we examine cities with less severe existing constraints. The removal of minimum parking requirements should also be considered for smaller urban areas as well as the MUCs, since these requirements may not be costly today, but could become so in the future.

MPR Case Study: Christchurch

Christchurch is a unique case for analysing the effects of removing MPRs as the removal of minimums coincided with the construction boom triggered by recovery from the 2011 earthquake, allowing the built environment to be adapted to the regulatory change faster than usual. Figure 63 shows the magnitude of the rebuild through the increase in total building consent value after the earthquakes.

Figure 63: Christchurch building consents - monthly



Source: PwC analysis.

Christchurch has dense commercial zones both inside and outside the CBD and similar to each other in most other respects, allowing for a natural experiment between treatment and control groups. With property-level spatial data, we split all commercially zoned properties in Christchurch into four groups:

- Group 1 – Non-CBD properties with parking ratios[40] within the range likely to be affected by MPRs. These properties correspond to land-use and location A in Figure 58 above.
- Group 2 – CBD properties with parking ratios within the range likely to be affected by MPRs.
- Group 3 – Non-CBD properties with parking ratios well above the range where MPRs apply. These properties correspond to land use and location B in Figure 58 above.
- Group 4 – CBD properties with parking ratios well above the range likely to be affected by MPRs.

We use property-level valuations data from HUD to examine differences in the relationships between floor area, property value, and parking area between these groups. While our data includes gross floor area (GFA) and number of car parks at the level of rateable units, Christchurch regulations are expressed in terms of number of spaces required in ratio to gross leasable floor area (GLFA) or public floor area (PFA). When converted to a ratio of parking area to floor area, most are in the range of 0.3 (1 parking space per 100m^2 of GFA) to 1.4 (1 parking space per 21.5m^2 of floor space or 4.7 parking spaces per 100m^2 of floor space), although limits for guest accommodation and certain other categories are much lower.[41] Accordingly, we place all properties with parking ratios of less than 1.5, or about 1 parking space for every 20m^2 of GFA, in groups 1 and 2—buildings within range of the effect of minimums. Buildings with parking ratios above 1.5; that is, more parking spaces than are required by the MPRs, are divided into groups 3 and 4. Descriptive statistics for the parking ratios of the four groups are presented in Table 18.

Table 18: Parking ratios – Descriptive statistics by group

Group	Description	# of properties	Mean parking ratio	Standard deviation	Min parking ratio	Max parking ratio
1	Non-CBD, low parking ratio	1,889	0.1834	0.2774	0	1.497
2	CBD, low parking ratio	1,113	0.1755	0..2834	0	1.495
3	Non-CBD, high parking ratio	40	5.979	8.932	1.514	39.898
4	CBD, high parking ratio	41	17.73	67.54	1.516	426.06

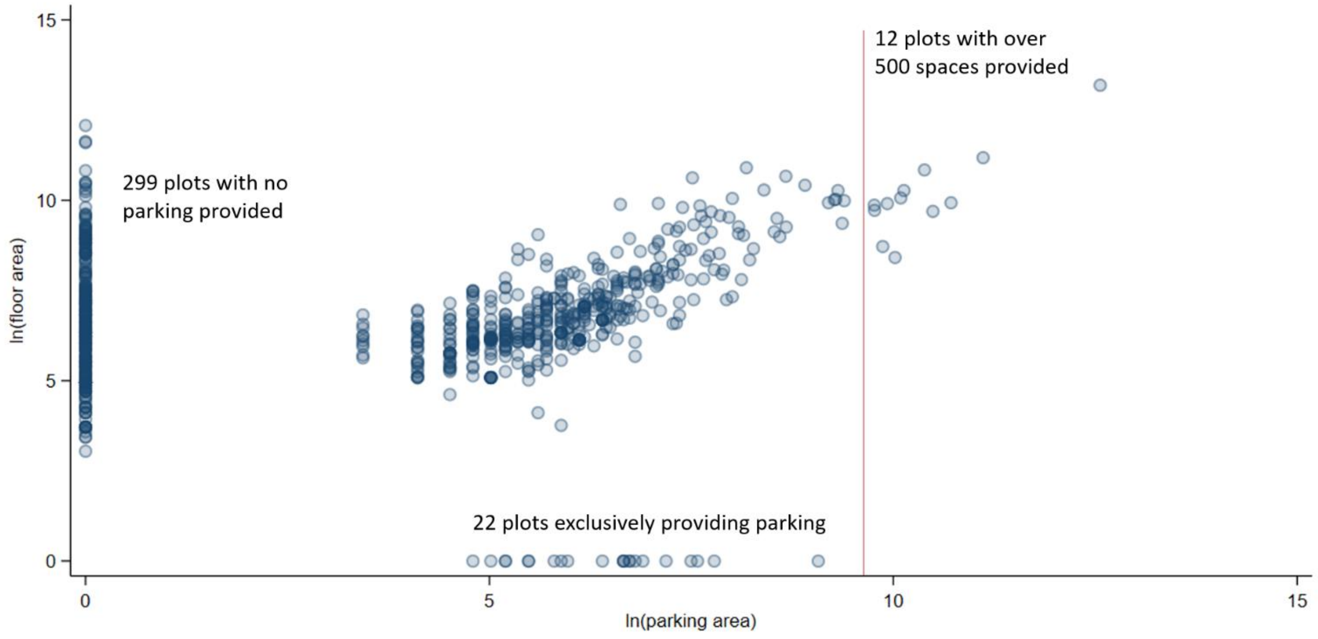
Source: HUD data, PwC analysis.

As Table 18 shows, the parking ratio of groups 1 and 2 have almost the same mean and standard deviation. However, for the high-parking-supply groups (groups 3 and 4), both the mean parking ratio and the standard deviation are far higher inside the CBD than outside it. This demonstrates that buildings with high amounts of parking area inside the CBD (reflected in very high parking ratios) are more likely to be fully specialised in parking or close to it than those outside the CBD.

Figure 64 below shows the parking and floor area allocations of the commercially zoned properties inside the CBD.

[40] Parking ratio is defined as the area in square metres dedicated to parking divided by the GFA in square metres.
[41] See Christchurch district plan Appendix 7.5.1 for specific MPRs. Parking area is assumed to be 30 m^2 per space including aisleway allocations (following MRCagney 2012), PFA is assumed at 50% of GFA for Food and Beverage outlets.

Figure 64: Distribution of parking in Christchurch CBD – 2018



Source: HUD data, PwC analysis.
Note: Data excludes street parking.

Figure 64 demonstrates that in the absence of MPRs, around 27 percent of rateable units in the Christchurch CBD today have no parking provided, while large amounts of parking are concentrated in small numbers of buildings. Some of these buildings are specialised structures that charge users for parking, meaning parking management has become a source of revenue rather than a cost to the local council. This suggests that in areas of high demand for floor space, MPRs may be more effective at preventing spatial specialisation than preventing under-supply.

Effects on allocation within buildings

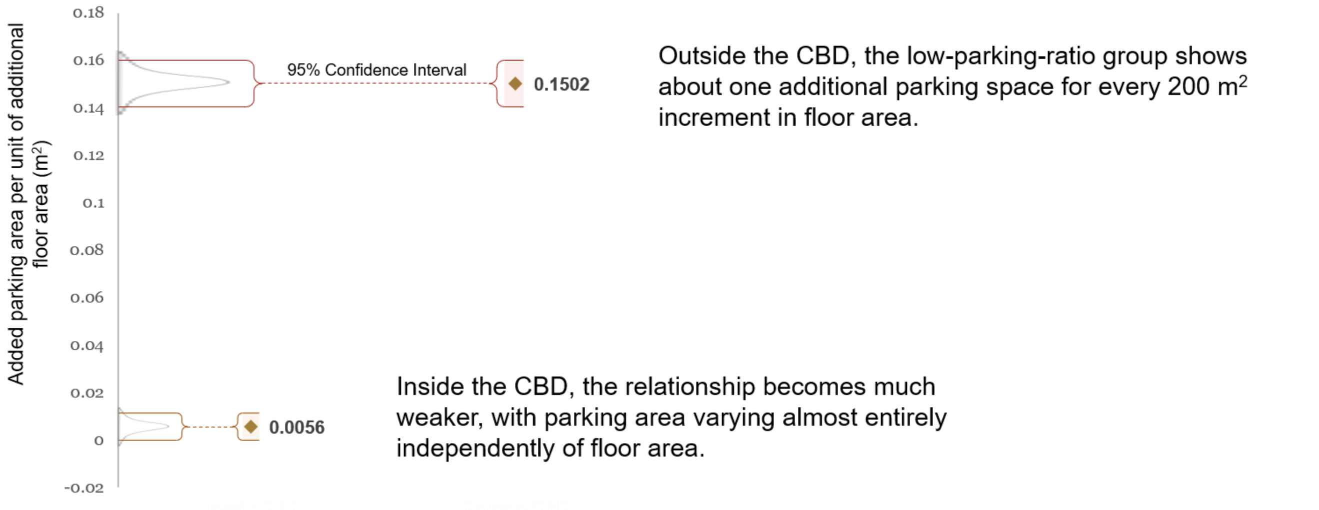
To further explore the evidence that the regulations, as opposed to some excluded variable, are inducing these differences of allocation, we test properties both inside and outside the CBD to determine how well the amount of space allocated to parking can be predicted by the amount of floor area on the property. We use a linear OLS regression:

$$ParkingArea = c + \beta_1(FloorArea) + \beta_2(LandArea) + \beta_3(Distance) + \varepsilon$$

The coefficient of interest is β_1 as we want to estimate how parking responds to a change in an additional square meter of floor area, with and without the presence of MPRs.[42] Figure 65 compares this relationship for properties with parking to floor area ratios below 1.5. Figure 66 compares the same relationship for properties with parking to floor area ratios above 1.5.

[42] The presence of land area and distance in the equation allow us to isolate the effect of floor area while holding these two variables constant (known as controlling for variables). This is a standard statistical technique used to separate the relationship of interest (here between floor area and parking area) from those between the dependent variable and other variables known to affect the outcome.

Figure 65: Regression results – Relationship between parking and floor area (parking ratio below 1.5)

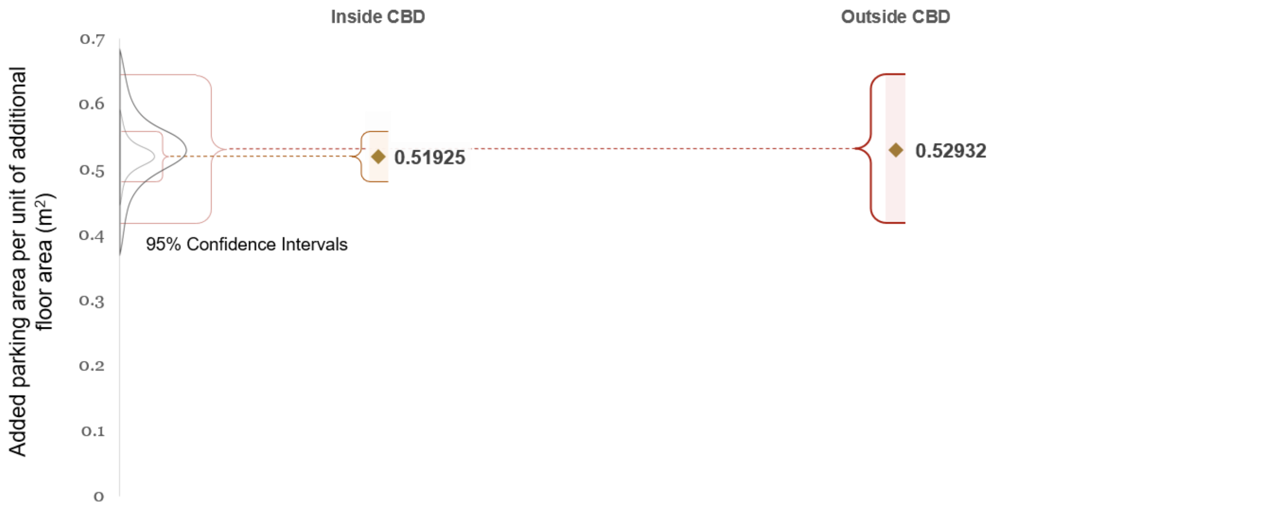


Source: PwC analysis.

Figure 65 shows that outside the CBD, for buildings with parking allocations in the range affected by minimums, we observe about one additional parking space for every 200m^2 increment in floor area, a level similar to the MPR requirement for commercial retail parks. The variation around this point is narrow, as shown by the small 95 percent confidence interval, meaning few buildings will stray from this ratio and those that do will not stray far. Inside the CBD, the relationship becomes much weaker, with parking area varying almost entirely independently of floor area; that is, the coefficient is statistically nearly indistinguishable from zero.[43] Therefore, without minimums, the amount of parking provided is far less dependent on the amount of floor area, building our confidence that minimums have affected allocation decisions between parking area and floor area in Christchurch.

For properties that have parking areas well above the minimums, the difference between those inside and outside the CBD disappears, illustrated in Figure 66.

Figure 66 - Regression results: Relationship between parking and floor area (parking ratio above 1.5)



Source: PwC analysis.

On average, these more parking-intensive buildings show about 1 added parking space (approx. 30m²) for every 60m^2 of added floor area, both inside and outside the CBD.[44] As we would expect for buildings with

[43] The proportion of variance in the data that is explained by the model (r-squared) also drops from 0.4 outside the CBD to 0.15 inside the CBD. This means that inside the CBD, differences in parking area are determined by variables other than those in our regression to a much greater degree than outside the CBD.
[44] Example calculation: a coefficient of 0.5 implies 0.5 metres of parking area for every added metre of floor area. At 30 m^2 per parking space, this equates to 1 space per 60 m^2 of floor area.

parking provisions well out of range of the minimums, the difference between CBD and non-CBD properties disappears. This reinforces our confidence that the difference in allocation of space between parking area and floor area between groups 1 and 2 is influenced by parking minimums.

Value effects of parking minimums

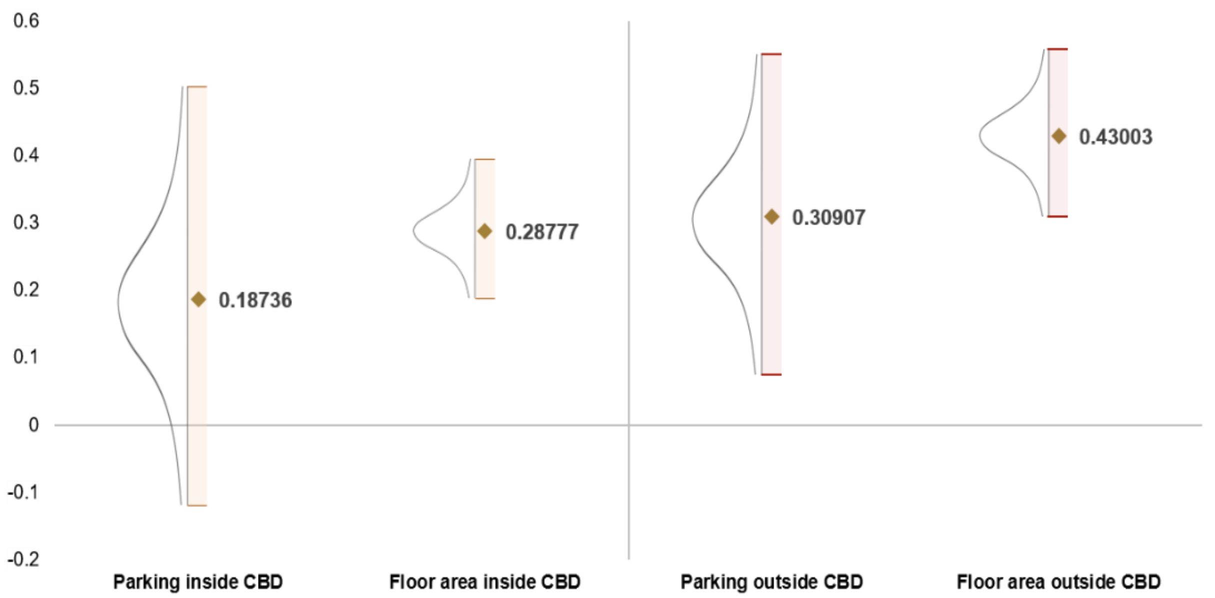
Now we examine the effects of parking area on capital values separately for the four groups, using the same regression model used in our cross-city estimate above (Figure 60).[45]

Outside the CBD, we find that for buildings within range of minimums, a doubling of parking area has no statistical effect on the value of the property, while the same increase in floor area is associated with a 22 percent increase in property value. For low parking ratio buildings inside the CBD, a doubling of parking area leads to a 5 percent decrease in property value, while a doubling of floor area is associated with a 20 percent increase in property value, a similar effect to that outside the CBD.

This means that in both groups, a significant marginal value gap still exists. Some buildings are still overproviding parking from a market-based land use perspective despite the absence of minimums. As development continues, we expect this to slowly change as more structures are built or rebuilt with their parking needs outsourced to specialised carparks.

For properties with concentrations of parking above the range affected by minimums, we find two notable results. First, that effects on property value of increases in parking area and floor area have overlapping sample distributions both inside and outside the CBD, meaning the marginal value gap begins to close for buildings out of range of parking minimums. Figure 67 below illustrates this.

Figure 67: Regression results – Value elasticities and 95 percent confidence intervals for parking and floor area in properties with concentrations of parking above the range affected by minimums



Source: PwC analysis.

Second, that the degree to which the gap closes is statistically greater inside the CBD. Buildings with large amounts of space dedicated to parking are less likely to exhibit the marginal value gap (described in Figure 59 above) inside the CBD than outside it. This is apparent from an examination of the confidence intervals illustrated in Figure 67. To show this statistically, we conduct an F-test for difference to test the null hypothesis that there is no statistical gap between value elasticities for parking area and floor area (Table 19). This implies that the oversupply of parking induced by MPRs may be having a spill-over effect on the value of surrounding parking-specialised structures.

[45] $ln(CapitalValue_i) = c + \beta_1 \cdot ln(Parking) + \beta_2 \cdot ln(FloorArea) + \beta_3 \cdot ln(LandArea) + \beta_4 \cdot \ln(Distance) + \varepsilon$

Table 19: F-test for difference between parking effects and floor area effects on land value

Inside the CBD		Outside the CBD	
$\beta_1 - \beta_2 =$	0	$\beta_1 - \beta_2 =$	0
$F(1, 36) =$	0.31	$F(1, 35) =$	0.79
$Prob > F =$	0.5838	$Prob > F =$	0.3795

Source: PwC analysis.

The F-test results in Table 19 show that the observed probability of a value-efficient allocation between floor area and parking area is 20% higher inside the CBD. In other words, high-parking area buildings appear to close the marginal value gap more effectively inside the CBD compared to outside.

Conclusion

Without minimums, the amount of parking provided in the CBD is far less dependent on the amount of floor area. Developers are making a broader range of decisions regarding the choice between parking and floor space. While some evidence of over-supply remains inside the CBD, we also see evidence that the removal of minimums has made specialised parking buildings more economically viable.

MPRs exist due to a concern that without them, developers will under-supply parking and let city councils deal with the problem, but this is only the case under the assumption that parking should be free for those who park. This case study shows evidence that demand alone can be enough to induce parking provision (in conjunction with publicly provided parking controls), and that developers will be better able to respond to demand in the absence of over-supply of free parking.

Part 4: Housing and business assessments

Intended outcomes

Providing enough development opportunities

The first intent of the Housing and Business Assessment (HBA) policy is to require urban local authorities to provide more realistic capacity for development opportunities in their plans. This means that feasible development capacity must be provided to meet or exceed diverse demands for housing and commercial land.

Under the NPS-UD, councils must still respond to any shortfalls in development capacity but must also set minimum bottom lines for development capacity to meet demand in planning documents.

Evidence-based decision making

The intent of the monitoring market indicators that comprise the HBA is to ensure that urban councils are well informed about their housing and business markets and can respond to both gradual and rapid changes in indicators of demand and supply. This monitoring will help councils become more responsive to market changes, including demand shocks.

MUCs, where demand pressures are highest, would also be required to monitor price efficiency indicators to help them provide enough supply for competitive land and development markets.

Competitive margins are also included in the HBA requirements for MUCs, to ensure they provide development capacity that exceeds demand. This would help ensure choice and competition for developers and facilitate competitive land markets.

The HBA polices in the NPS-UD are designed to reduce the cost and complexity of doing a comprehensive market assessment. They aim to do so by only requiring MUCs to complete a full HBA and providing more modelling flexibility, especially over the long term.

HBA – Key findings

The HBA policy generates benefits through better monitoring and analysis of local data, which enhances the effectiveness of the intensification and responsive supply policies through a better understanding of where development is most likely to be taken up and where barriers to feasibility may exist. Specific sources of benefit are lower average infrastructure costs per household, lower average housing prices, and prevention of periods of rapid increase in housing prices.

HBA costs in the first year of reporting were estimated at $150,000 to a maximum of $300,000. We use the maximum number for cost-benefit analysis in all MUCs.

In the six MUCs, it would require marginal change in housing supply elasticity of 0.000035-0.031 to generate $300,000 worth of consumer surplus benefits arising from more affordable housing. The baseline expected change is from 0.13 to 0.37. The city most at risk of a net loss from policy compliance is Wellington, where the required elasticity change is still small compared to historical variation.

The potential benefits of HBA compliance are greatest in larger cities with constraints to flexible housing supply and strong demand growth. Unexpected increase in growth rates would make the HBA monitoring and reporting requirements more valuable, including reports from years before the acceleration in growth.

The HBA requirements create benefits to cities through enhancing the other policy streams. The market insight gained through better monitoring and analysis of local data under the HBA will help councils focus their planning efforts effectively and stay aware of impending shortfalls in housing supply.

The specific expected sources of benefit include lower average infrastructure costs per household, lower average housing prices, and prevention of periods of rapid increase in housing prices. These benefits would arise as the HBA enables councils to:

- Better avoid underinvestment in development capacity due to higher than expected growth – thus avoiding higher capital expenditures and financing costs associated with retrofitting or upgrading infrastructure that is operating at capacity.
- Avoid over-investment in development capacity beyond what growth pressures and development markets are likely to need.
- More accurately adjust development contribution and targeted rate policies to allow a greater portion of funding to ultimately come from beneficiaries of infrastructure investments.

Costs of compliance with the HBA policy arise primarily from use of the labour resources of council staff and the hiring of consultants to assist in fulfilling the analytical and reporting requirements.

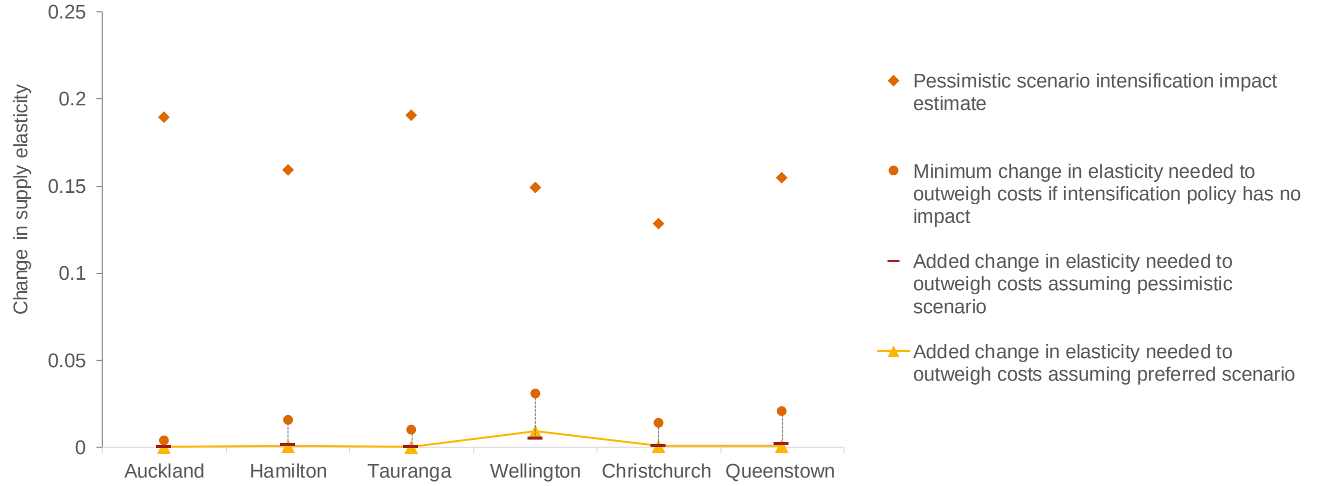
Costs observed for HBA reporting under the NPS-UDC 2016 for six high growth councils range from $150,000 to $300,000 for the first reporting year. We assume that costs for subsequent years would decline slightly as the process becomes routinised. These costs are low compared to potential benefits, as described below.

Figure 68 shows the elasticity impact needed for consumer surplus benefits from improved housing affordability to outweigh $300,000 in reporting costs (equal to the highest reported cost figures from surveyed high-growth councils under NPS-UDC) in each MUC. Our baseline elasticity change for the pessimistic intensification scenario is included for comparison.

As we make more pessimistic assumptions about the effectiveness of the intensification policy itself, the marginal impact needed for the HBA policy to generate more benefits than costs will increase. More effective intensification means less marginal impact from the HBA will cover the same costs.

In the most pessimistic case, if we assume zero impact from the intensification policy on its own, the required effect of the HBA is still less than half of our low-impact estimates in each city. This implies that where supply constraints exist, the intended outcomes of the HBA requirements are likely to be worth the costs.

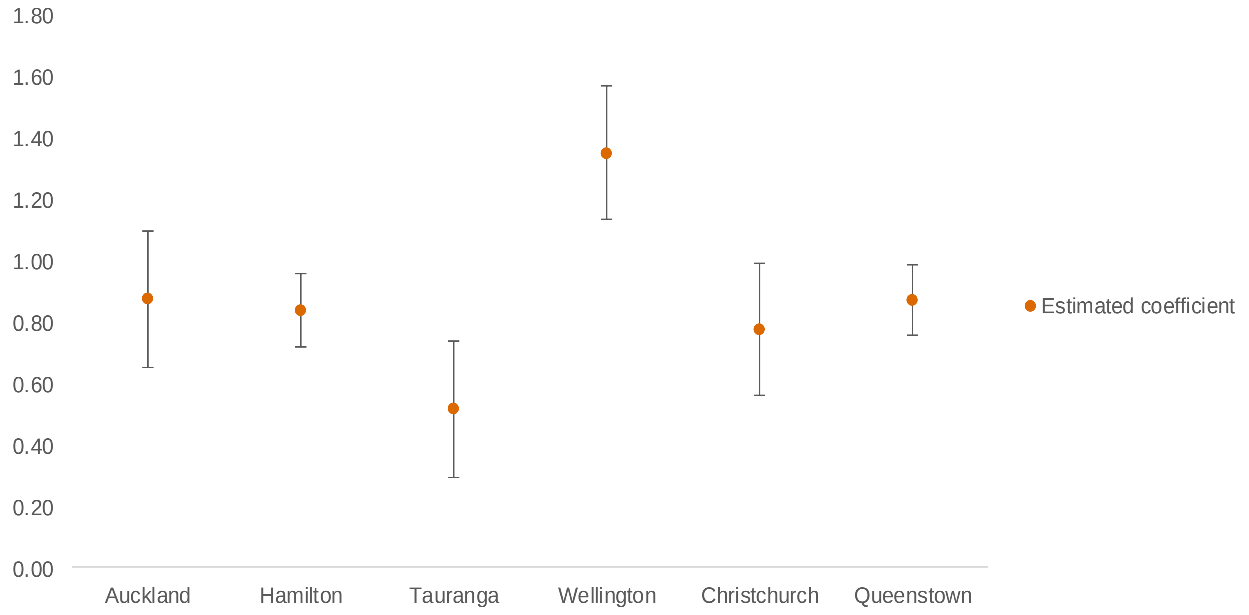
Figure 68: Supply elasticity response needed to outweigh $300,000 in reporting and monitoring costs (consumer surplus benefits only)



Source: PwC analysis, MfE survey of high-growth councils under NPS-UDC provided by HUD.

Figure 69 shows our status-quo elasticity estimates for each MUC, along with an indication of the standard errors observed in the data. Note that in all cases, the elasticity impact needed to outweigh reporting costs is less than half of one standard error for responsiveness measured from 1998-2018. In Auckland's case, an impact of 1/30th of a standard error would generate $300,000 in benefits assuming the intensification policy has no impact on its own.

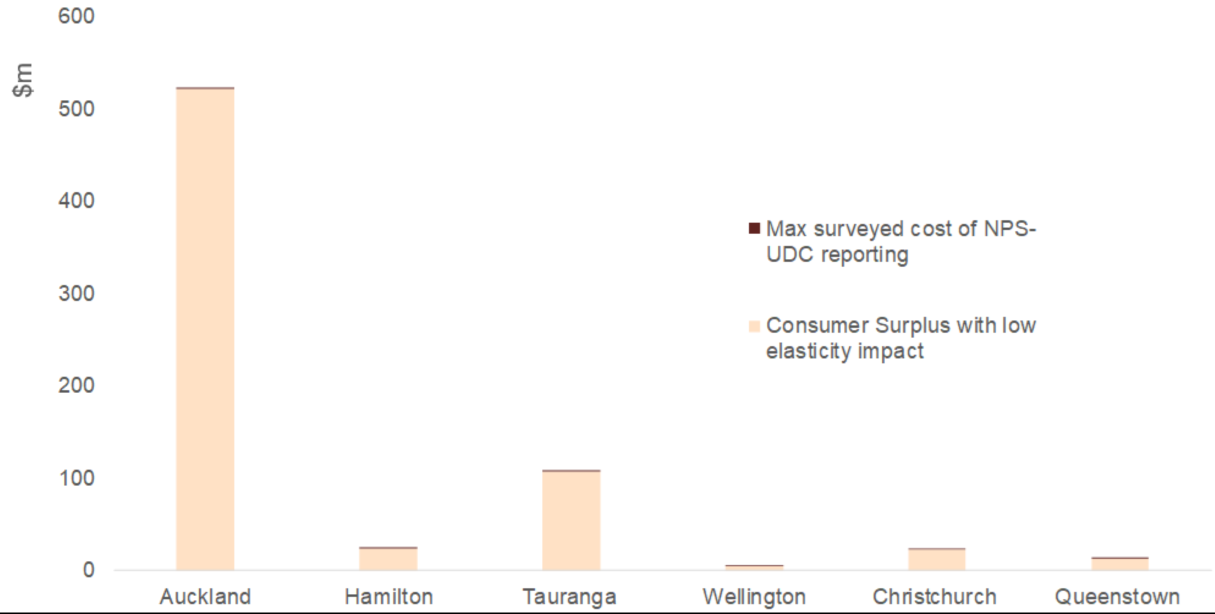
Figure 69: Baseline supply elasticity estimates with standard errors



Source: PwC analysis.
Note: Standard errors provide an indication of the variation in housing supply responsiveness observed from 1998 to 2019. While this provides an indication of the potential range of impact one might reasonably expect from a policy change, it does not predict the actual impact nor provide a probability for any expected impact.

Figure 70 provides an alternate way to visualise the costs and benefits of the HBA requirements. While for larger cities with high existing constraints, the costs are immaterial compared to the potential benefits, this becomes less certain as cities get smaller, less constrained, or face lower demand growth.

Figure 70: Added reporting costs of HBA compared with consumer surplus benefits in the low-impact scenario



Source: PwC analysis.

The calculations above consider only direct consumer surplus benefits of intensification. This ignores the potentially large benefits arising from agglomeration economies, but those benefits are also expected to be much lower and less certain for smaller, lower density, or less constrained cities.

That the costs of HBA requirements reduce much less than intended benefits as cities become smaller and less constrained implies a threshold at which the benefits of the policy can no longer be expected to outweigh the costs of compliance.

We conclude that the HBA requirements are likely to generate net benefits in the six MUCs. We are less confident in the net positive outcome for non-MUC cities, although this potential clearly exists.

Part 5: Future development strategies

Intended outcome

The NPS-UDC (2016) introduced a process called Future Development Strategy (FDS), which sought to deliver a strategic planning process for ensuring that planning processes provide sufficient development capacity to meet future growth needs.

The NPS-UD intends to strengthen and broaden the existing requirements of the NPS-UDC in order to:

- move toward better spatial planning in the current system (including by better aligning land-use and infrastructure planning)
- strengthen the role of the FDS to inform Resource Management Act 1991 (RMA) plans and strategies prepared under other legislation
- ensure that urban development promotes a well-functioning urban environment and is informed by the values and aspirations of iwi and hapū
- improve ongoing practice and implementation of FDSs.

Key findings

Estimates of costs for FDS compliance indicate a range from levels similar to HBA expenses up to $2 million for councils engaging consulting firms for large parts of the process.

The expected **sources of benefit include lower average infrastructure costs per household** and **prevention of severe rises in housing prices** for the FDS as for the HBA. The FDS also creates benefits from **better timing of land-use review** to avoid premature redevelopment of high-potential areas.

Ultimately, these benefits are realised by enhancing the mechanisms intended by the intensification and responsive development policies. We thus compare costs and benefits of the FDS policy in terms of the minimum marginal increase in housing affordability necessary for the added benefits to outweigh the indicative costs.

We find that small enhancements to the impact of the NPS-UD on supply responsiveness result in benefits that far outweigh the costs of compliance. The case of Wellington is closest to neutral: a marginal enhancement equivalent to a change from our pessimistic intensification scenario to our preferred scenario (an elasticity shift of approximately one standard error relative to historical variance) would generate enough benefits to justify a payment of $2.1 million every three years between now and 2043. For Auckland, it would take over $160 million in triennial payments to outweigh the benefits of the same shift.

Because the policy allows for councils to comply in less expensive ways if necessary and higher cost cases are likely to see costs decline as compliance becomes routinised, we are confident that the policy will be net beneficial for the six MUCs.

Like the HBA requirements, the updated FDS policy creates benefits to cities through enhancing the same outcomes intended by the other policy areas. The transparency and collaboration gained through the stakeholder engagement and strategic processes of the FDS aims to keep councils informed of market perspectives on development potential, and better alignment of infrastructure planning. In addition, more strategic identification and planning of future locations for development will improve uptake and reduce the risk of expensive retrofitting later in the lives of infrastructure assets.

The expected sources of benefits associated with the FDS include lower average infrastructure costs per household and prevention of severe rises in housing prices, similar to those for the HBA. However, the role of

FDS in long-term planning of the locations and alignment of urban development add benefits from better timing of land-use review to avoid premature redevelopment of high-potential areas.

Costs of the FDS process arise primarily from use of the labour resources of council staff and the hiring of consultants to assist in fulfilling stakeholder engagement, strategic assessment, and reporting requirements. At the time of writing, there is limited evidence from councils on the costs of completing the FDS process. Estimates drawn from current strategic processes indicate costs could range from a few hundred thousand dollars to as high as $2 million for councils that have relied extensively on consultants to develop evidence or drive stakeholder engagement. As with the HBA requirements, costs for subsequent years are likely to decline as the process becomes routinised.

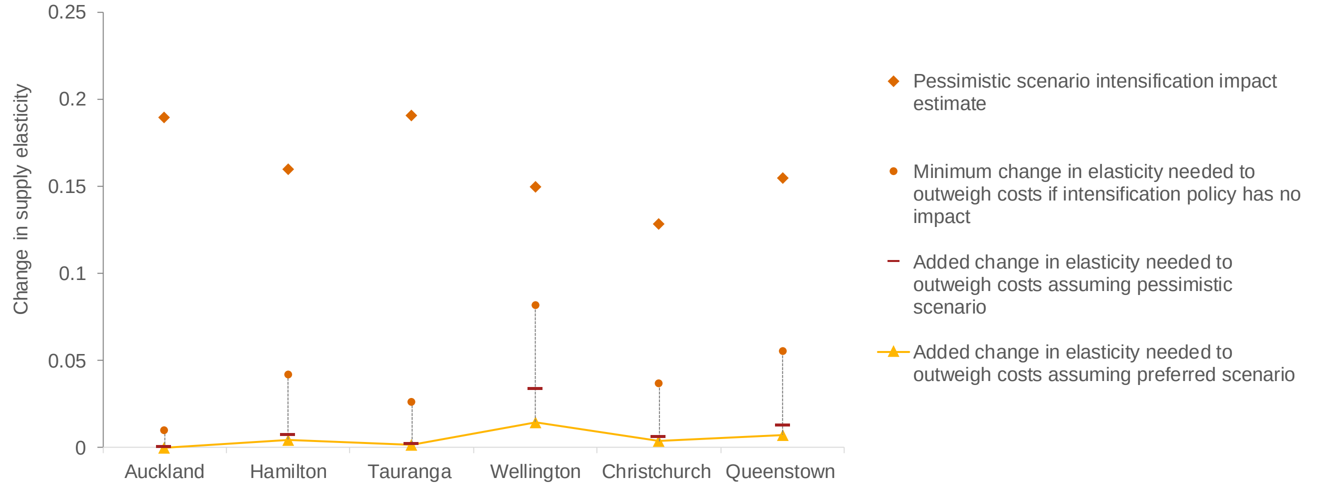
Because the intent of the FDS policy is to enable integrated, strategic long-term planning that will enhance the affordability outcomes of the intensification and responsive planning policies, we assess benefits attributable to the FDS policy in terms of potential marginal increase in the latter two.

Figure 71 shows the elasticity impact needed for consumer surplus benefits from improved housing affordability to outweigh $2 million for each MUC. Our baseline elasticity change for the pessimistic intensification scenario is included for comparison.

If we change our assumptions about the effectiveness of the intensification or responsive planning policies, the marginal impact needed for the FDS to generate more benefits than costs also changes. More effective intensification means less impact from FDS will cover the same costs, and the FDS policy is more likely to be net beneficial.

If we assume zero impact from the intensification policy on its own, the required effect of the FDS is still significantly lower than our pessimistic impact estimates in each city.

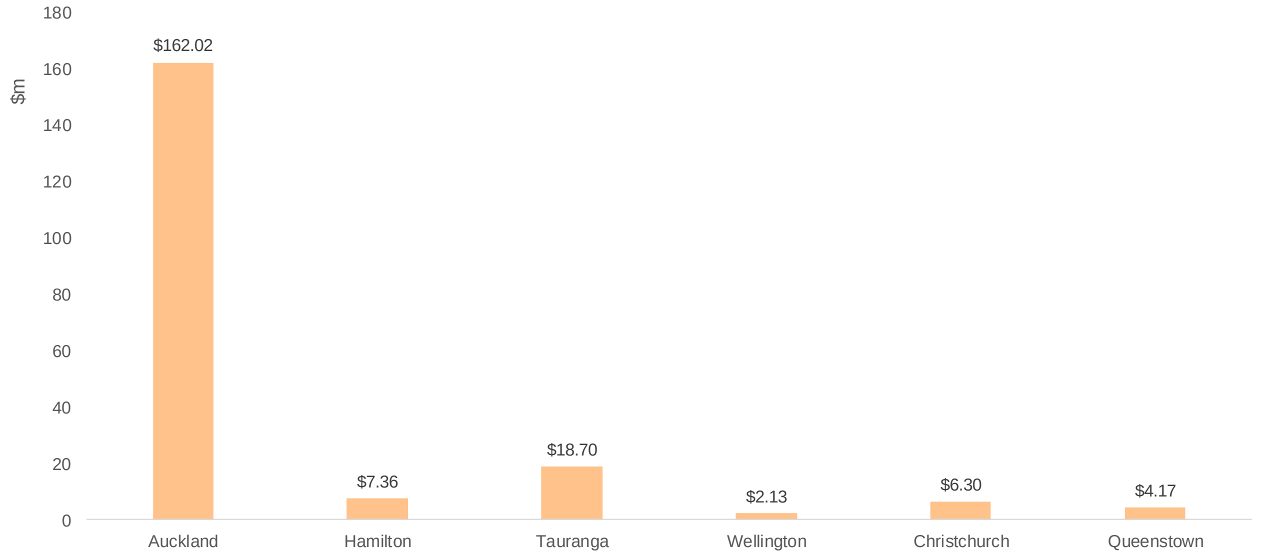
Figure 71: Supply elasticity response needed to outweigh $2 million in consulting fees (consumer surplus benefits only)



Source: PwC analysis, MfE survey of high-growth councils under NPS-UDC provided by HUD.

Figure 72 provides an alternate way to illustrate the potential benefits of the FDS process if it succeeds in enhancing the effects of the other NPS-UD policies. In Wellington for example, a triennial payment of $2.13 million from 2020 to 2043 would have a total present value of about $10.8 million—or roughly equal to the added consumer surplus the city would gain by moving from the pessimistic to the preferred scenario for intensification impact on housing affordability.

Figure 72: Triennial payments justified by the marginal increase in benefit from the pessimistic to the preferred scenario



Source: PwC analysis.
Note: Marginal benefit and triannual payments discounted at 4 percent from 2020 to 2043.

The calculations above compare FDS costs to the consumer surplus benefits of intensification, but the FDS process aims to increase the effectiveness of other policy areas and drivers of benefit, especially the responsive planning policy. This implies broad potential benefits for the FDS as a mechanism to enhance NPS-UD benefits overall.

We conclude that the FDS requirements are likely to generate net benefits in the six MUCs if they achieve the intent of the policy. Potential benefits to these cities are in the order of tens to hundreds of millions. Benefits for cities with less severe demand constraints are less certain, although the FDS process may have benefits in other areas for such cities. For non-MUC cities required to conduct the FDS under the existing requirements of the NPS-UDC, implementation costs are likely to be lower in future years, and lowered further by changes in the new policy that make the process more flexible and better able to integrate with existing council processes. There is a strong case for these cities to be included in the policy unless local councils view the costs as prohibitive. Other urban areas should be encouraged to adapt the long-term strategic development and stakeholder engagement approaches defined in the FDS policy as appropriate.

Part 6: Targeting

Problem statement

The NPS-UDC (2016) targeted its policies by establishing different tiers. Councils were assigned to these tiers on a dynamic basis as modelled growth rates and other factors changed, with different tiers having different requirements.

Although flexible, this system had disadvantages; particularly a lack of certainty for councils about what is required of them when population projections changed, and the costs and risks associated with this.

Intended outcome

To address this issue, the NPS-UD proposes to focus the most directive policies on the faster growing areas with the largest urban pressures. These cities are; Auckland, Hamilton, Tauranga, Wellington, Christchurch, and Queenstown. This is to ensure that the NPS-UD captures those urban environments where meeting the proposed objectives will have the greatest impact.

Note:

After feedback on the NPS-UD consultation document and analysis of the 2018 census population data, a number of smaller councils also are expected to face population growth pressures. These areas are; Dunedin, Palmerston North, Whangarei, New Plymouth, Rotorua, Nelson-Tasman and Napier-Hastings. To reduce the risk of growth pressures becoming acute, these local authorities may need to do a less comprehensive HBA and an FDS. However, given this CBA is a “point in time” analysis based on the consultation document, the impacts on these smaller, second tier cities are only addressed indirectly below.

Targeting – Key findings

- The six targeted cities all appear to benefit from the policies.
- Smaller cities generally benefit less from these policies, probably because constraints on land use efficiency are less urgent, but still important.
- The benefits to second tier cities are certainly less, and less certain.
- Land use flexibility is valuable when development pressures are higher than expected. Policies that strengthen the ability of councils to prepare for this uncertainty, such as the HBA and FDS, should be strongly considered for second tier cities.
- Because demand is dynamic and can change, a mechanism to refresh the targeting of cities should be considered.

Overview and approach

There are three categories of cities to consider in the targeting of NPS-UD, based on the existing targeting of the NPS-UDC. These are:[46]

- Category 1 – Cities included under NPS-UDC requirements but excluded under the most prescriptive NPS-UD requirements, such as Gisborne, Marlborough, Palmerston North, Whangarei, and New Plymouth.
- Category 2 – Cities included under the most prescriptive requirements of both NPS-UDC and NPS-UD. This includes Auckland, Hamilton, Tauranga, Christchurch, and Queenstown.
- Category 3 – Cities not included under the NPS-UDC requirements but included as MUCs under NPS-UD. This category comprises Wellington alone.

For each of the three categories, we consider the costs and benefits of the policy against a status-quo situation in which the NPS-UDC policies and targeting remain in place.

The intended types and mechanisms of benefits of the NPS-UD are similar to those of the NPS-UDC as assessed in the 2016 cost benefit analysis of the latter. For the cities targeted under each NPS, the policy intent is to improve the affordability of housing and the quality of urban outcomes while minimising external costs and maximising external benefits. The NPS-UD introduces greater clarity and emphasis (e.g. quality urban outcomes) and more prescriptive policy mechanisms (e.g. prohibition of minimum parking requirements) for some of these intents.

The NPS-UD includes an improvement over the new status quo as an implied intended outcome; that is, over the assumed benefits of the NPS-UDC in cities where it applied. Accordingly, we estimate benefits in the present study as assumed deviations from the status quo, whether that involves NPS-UDC effects or not.

The implications of this assumption for the three categories of cities are discussed below.

Category 1 – Cities included under NPS-UDC but not NPS-UD

Cities in category 1 above will regain any costs they would have incurred under the NPS-UDC if it were to remain in force. They will also forego any expected benefits to the extent that they choose not to continue with changes established under the NPS-UDC.

The portion of those foregone benefits attributable as costs to the new policy depends on the degree to which continuing NPS-UDC policies (not NPS-UD) is infeasible without a national-level mandate. Wherever the dissolution of that mandate makes achieving its benefits less likely or more costly, a cost is incurred by the decision to dissolve.

The magnitude of these costs is necessarily between zero—in the case where all intended benefits can still be achieved—and the best estimate at the moment of dissolution of benefits expected to arise from continued compliance with the NPS-UDC but no longer achievable without the mandate.

If the intent of the NPS-UD is achieved, cities in this category will be able to continue compliance with the NPS-UDC at the discretion of local councils, implying no costs of removing the national mandate. Calculation of the degree to which this is likely in practical political terms is beyond the scope of this analysis. However, based on the insights provided by our modelling of land and housing market dynamics and urban spatial structure, the sections that follow provide recommendations by policy area regarding the risks and benefits of extending NPS-UD targeting to smaller or slower growing cities.

Category 2 – MUCs included under both policies

Cities in category 2 above experience the full benefits of the policy, and a reduced cost of compliance as much of the necessary transition has already been made under the NPS-UDC. Moreover, changes in the new policy ease some of the reporting costs of the NPS-UDC, as discussed in the HBA and FDS requirements sections. Our modelling results indicate that even under pessimistic assumptions, the policy effects as intended carry strong net benefits in these cities.

[46] This analysis was completed based on the consultation document for the proposed NPS-UD policies circulated in August 2019. Later revisions to the targeting approach have not been reflected here.

Category 3 - Wellington

Wellington is unique, since it was not previously included under the NPS-UDC requirements that would be subject to full compliance with the NPS-UD. This implies that the full cost of compliance with the NPS-UD should be weighed against marginal benefits to determine the net benefit of the policy.

In our data and modelling, Wellington also presents the weakest case for NPS-UD policies among the MUCs. As discussed elsewhere, Wellington has an unusually high status quo elasticity of supply that may not account for recent changes in constraint patterns. The city also has weaker historical population growth than the others—the reason given for its exclusion from the most prescriptive requirements of the 2016 policy. These two factors contribute to low projected price impacts and housing supply response for the city compared to its MUC peers. While there are reasons discussed in other chapters to consider the outcome pessimistic, Wellington is the closest MUC to a case of net disbenefit for the policy package.

Despite this, the expected magnitude of intended policy benefits net of costs ranges from about $20 million to $50 million for the intensification policy, $22 million to $24 million for the responsive planning policy, and $8 million to $70 million for the removal of minimum parking requirements. These estimates give us confidence that the decision to include Wellington is the right one on balance, and that a marginal enhancement of the same effects contributed by the HBA and FDS processes would generate enough benefit to outweigh the costs of compliance over the period to 2043. If population growth in Wellington is faster than existing projections, it stands to benefit more.

Recommendations by policy

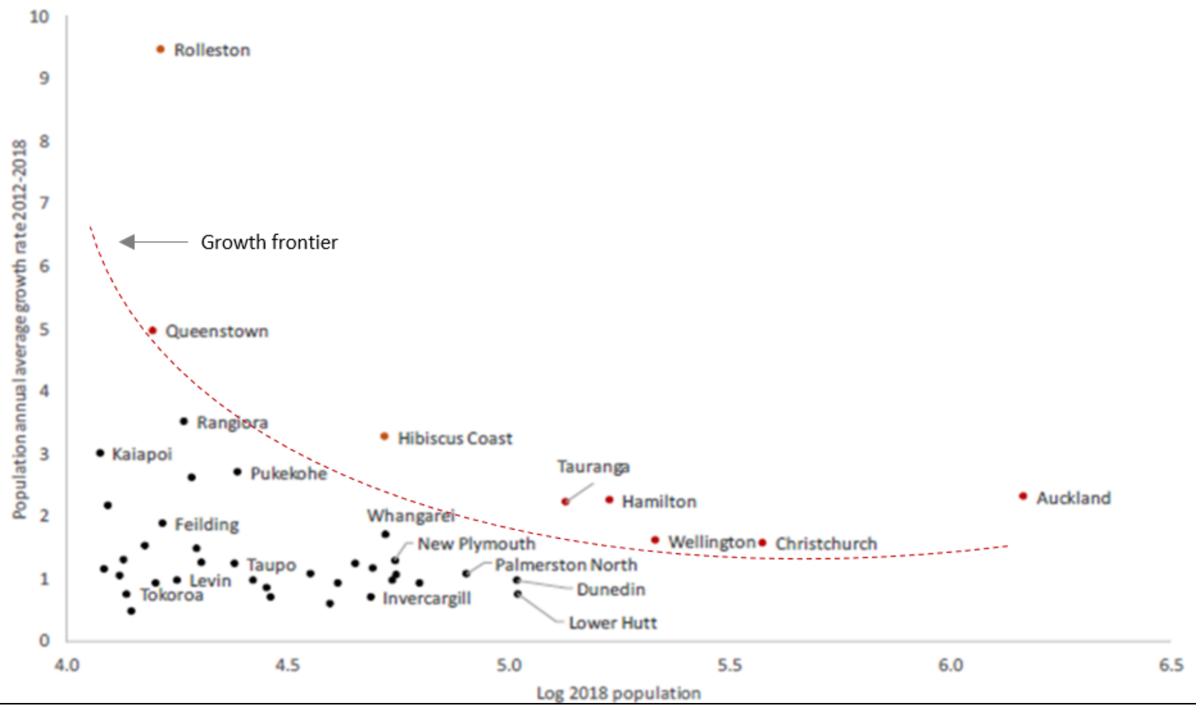
The differences in attributable cost between the categories discussed above are most relevant for cities where constraints to urban density are not expected to significantly affect development outcomes. In these cities, which are smaller, are not growing as fast, or have weaker regulatory constraints than New Zealand's major cities, the expected benefits of relaxing constraints are low enough that they may be outweighed by the costs of compliance with the policy.

In the following subsections, we address the implications for this class of city as implied by our model results for intensification, responsive planning, minimum car parking, and the HBA and FDS requirements.

Intensification and responsive planning

As a starting point to examine the chosen target cities for NPS-UD, we observe that all six MUCs fall along what can be described as a "frontier" between cities with existing populations large enough that even low rates of growth add large numbers of households, and cities growing fast enough that severe constraints could arise in the medium to long term if investment does not keep up. Figure 73 demonstrates this frontier as of 2018.

Figure 73: The "growth frontier" – New Zealand cities over 10,000 inhabitants by growth rate and 2018 population

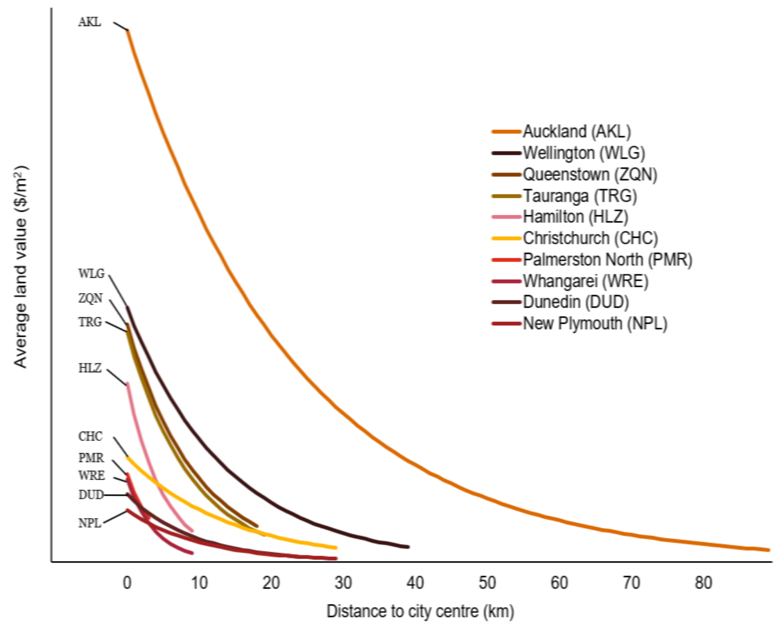


Source: Stats NZ data, PwC analysis.
Note: Rolleston, Rangiora, Pukekohe, and Hibiscus Coast appear separately as urban areas with over 10,000 inhabitants but are included under the policy within the larger urban areas of Christchurch and Auckland. Lower Hutt is included within the Wellington area.

Cities approaching the growth frontier but not listed as major urban centres in the NPS-UD include (from left to right in the graph) Whangarei, New Plymouth, Palmerston North, and Dunedin.

To understand the potential for benefit from inclusion under the intensification and responsive planning policies, we look for areas where density is constrained, and land is scarce. There is no simple way to measure this, but there are clues in urban data. Figure 74 shows exponential curves representing land values by distance from the city centre for the six MUCs and the four largest cities approaching the frontier described above.

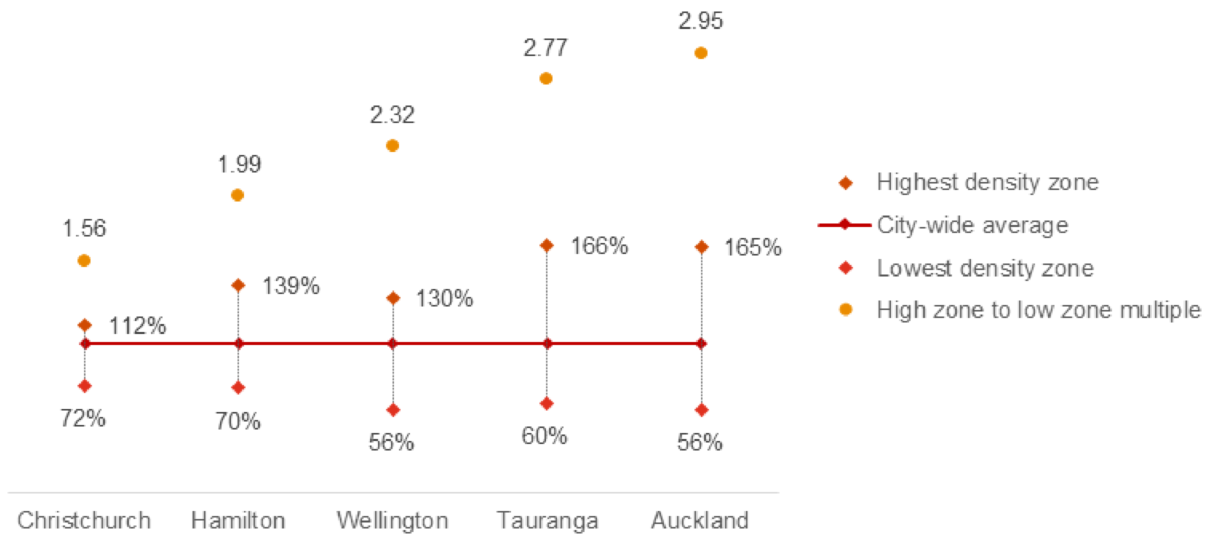
Figure 74: Land values by distance for MUCs +4



Source: HUD and LINZ data, PwC analysis.

If supply constraints emerge when land is scarce and land values provide a window into land scarcity, then a possible measure to understand where significant supply rigidities could pop up is the multiple between land values in the city centre and the urban periphery. If all land was priced similarly within a city, and the multiple was one-to-one, then supply constraints might be less important but in cities that show big differences, the potential for binding supply constraints may be stronger. Figure 75 below summarises the results of an empirical proxy for the degree of regulatory constraint on urban development, as discussed in the section on intensification. There is a necessary association between these estimates and the land value curves above: the greater the value of the land under constraint, the more foregone development the constraint will cause.

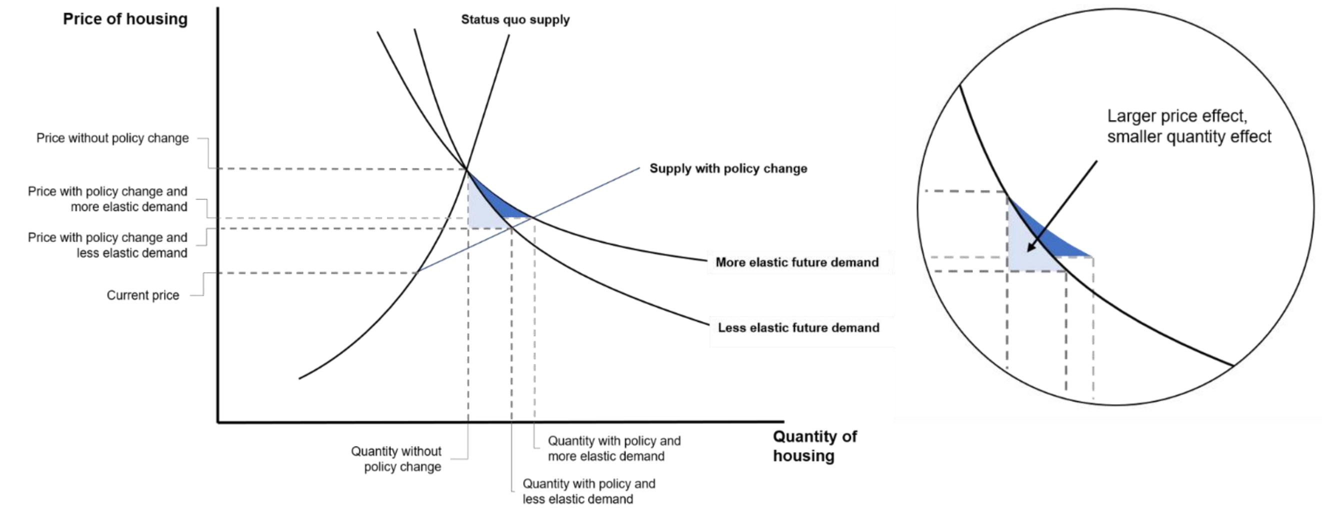
Figure 75: Expected Floor Area Ratio increase for a given increase in land value



Source: PwC analysis.

Policies that relax existing zoning policy will have a weaker economic effect in cities where zoning is not binding. Smaller, lower growth cities may benefit from inclusion in the policy, but whether the benefits outweigh the external costs will depend on the relative magnitudes of the price effect and the quantity effect. If we hold the policy impact on supply constant, this relative magnitude is determined by demand characteristics. In other words, how the costs compare against the benefits depends on how potential new entrants respond to differences in housing prices. Figure 76 illustrates the difference between a more elastic demand scenario—where small changes in housing costs have a big effect on population growth—and a less elastic demand scenario—where population growth is less influenced by housing prices.

Figure 76: Demand-side effects on consumer surplus



Source: PwC analysis

Under the less elastic scenario in Figure 76, the pure economic benefit of the policy represented by the area of the light blue triangle might be similar in value to the more elastic scenario, but the costs of the policy (which are a function of population increase) and the transfers between existing households (which are a function of starting population and price impact) change considerably. With less elastic demand, the same policy impact generates lower external costs and greater transfers between existing households, all else equal.

At one extreme of demand responsiveness, if population does not change, the effects are purely a redistribution, from homeowners to renters for instance. At the other extreme, if population is highly responsive, crowding and congestion costs per added household might exceed the added benefits per household. Councils may also act to minimise per household costs by encouraging modal shift and ensuring quality development outcomes.

Our analysis shows that net benefits for MUCs are likely robust to a range of possible demand conditions, but for smaller cities, these dynamics are worth considering carefully on a case-by-case basis. Demand interactions with supply constraints can change unpredictably over the life of a policy, suggesting that councils should be encouraged to adopt the practises outlined under NPS-UD if they consider the transition worthwhile.

Minimum car parking requirements

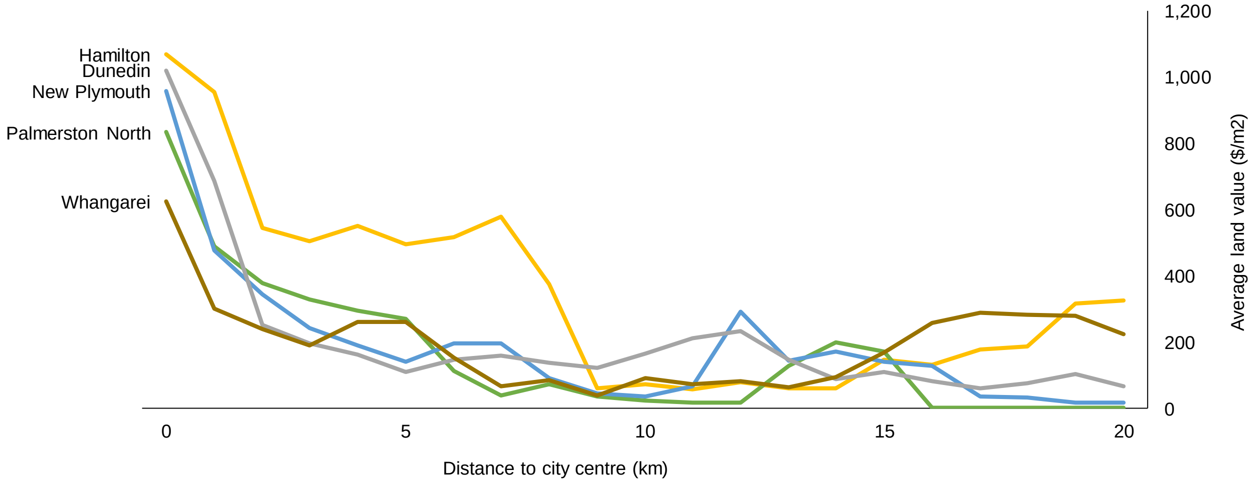
The MPR policy proposes removal of existing distortions in how land and building space is allocated between storing cars and other uses. In smaller cities where other uses of space are less constrained by MPRs, this policy may have no impact. However, since policy generated costs at worst will decline in proportion to lower benefits, there is little risk of a net loss by implementing this policy regardless of city size or growth rate. We recommend that all urban areas remove minimum parking requirements in favour of concentrated, market-provided parking structures.

HBA and FDS requirements

That the costs of HBA and FDS requirements reduce much less than intended benefits as cities become smaller and less constrained implies a threshold at which the benefits of the policy can no longer be expected to outweigh the costs of compliance with confidence.

However, the monitoring and strategic forecasting capacity that councils would develop under these requirements may carry significant option value under uncertain long-term demand conditions. This is especially true for cities whose land value profiles are approaching the levels observed in the smaller MUCs (Figure 77).

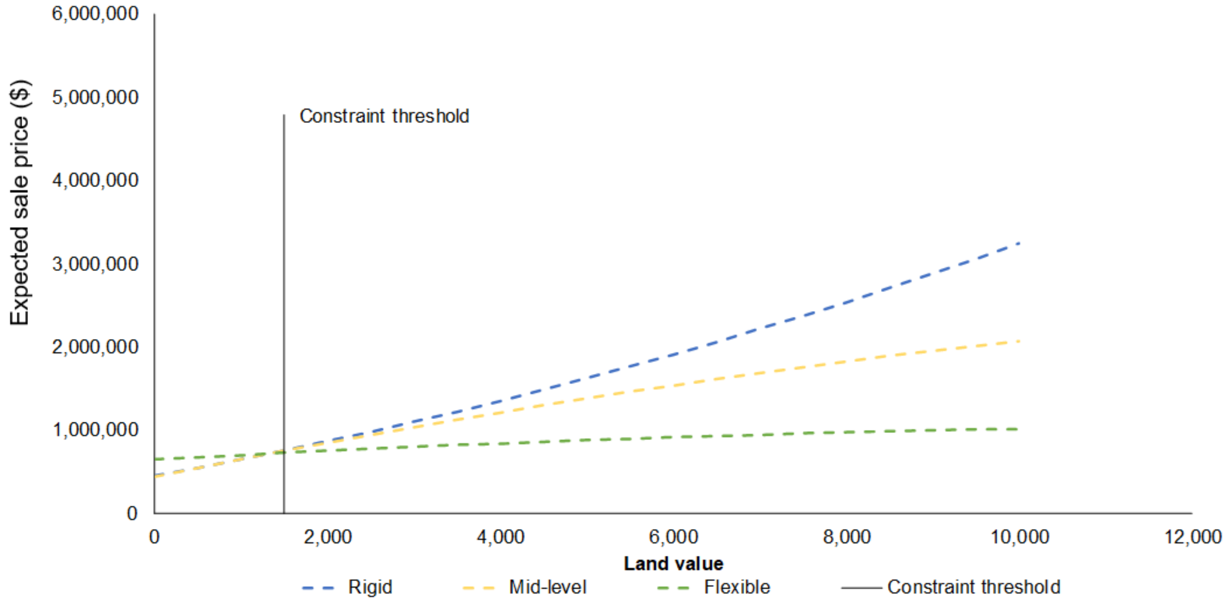
Figure 77: Land value profiles for four 2nd tier cities and Hamilton



Source: HUD data, PwC analysis.

If we use observations of apartment prices in Auckland for comparison, land values in these 2nd tier city centres sit at the threshold where differences in zoned density limits under the Unitary Plan begin to affect affordability (Figure 78).

Figure 78: Expected price for a 100m² apartment in Auckland by land value per m² and zoned density limits



Source: Auckland Council data, PwC analysis.

That we already observe differences in supply response across zones in Hamilton (shown in Figure 75 above) indicates that these cities may soon approach this threshold, which may be lower in some cities than others.

We recommend consultation with local urban planners to determine whether a national mandate to meet the HBA and FDS requirements would be preferable to optional participation.

References

Auckland Council. *Auckland Plan*. Scenario Evaluation Workstream Technical Report, Auckland, 2011.

Adams, Matt, and Ralph Chapman. *Do denser areas save on infrastructure? Evidence from New Zealand territorial authorities*. Policy Quarterly, V12, pp. 63-70. Wellington: Victoria University of Wellington, 2016.

Baumeister, Roy, Catrin Finkenauer, Kathleen D. Vos, and Ellen Bratslavsky, *Bad is Stronger than Good*. Review of General Psychology, Vol. 5 (2001), Issue 4, pp. 323-370.

Blinder, Alan. *Advice and Dissent: Why America Suffers When Economics and Politics Collide*. Basic Books, 2018.

Brueckner, Jan. *The Structure of Urban Equilibria: A Unified Treatment of the Muth-Mills Model*. Chapter 20 of Handbook of Regional and Urban Economics, Volume 2. Netherlands: Elsevier, 1987.

Bureau of Infrastructure, Transport and Regional Economics. *Traffic and congestion cost trends for Australian Capital Cities*. Australia, 2015.

Cooper, Geoff, and Kabira Namit. *City With a Billion Dollar View*. DOI: 10.1080/00779954.2018.1509110. New Zealand Economic Papers, 2018.

Duranton, Giles, and Diego Puga, *Micro-Foundations of Urban Agglomeration Economies*. NBER Working Paper No. 9931, Handbook of Regional and Urban Economics, Edition 1, Volume 4, chapter 48, pp. 2063-2117. National Bureau of Economic Research, 2004.

Glaeser, Edward. *Cities, Agglomeration and Spatial Equilibrium*. United States: Oxford University Press, 2008.

Gollin, Douglas, and Martina Kirchberger, and David Lagakos*. In Search of a Spatial Equilibrium in the Developing World*. CSAE Working Paper Series 2017-09. Centre for the Study of African Economies, University of Oxford, 2017.

Graham, Daniel J., and David C. Mare. *Agglomeration Elasticities in New Zealand*. New Zealand Transport Agency Research Report No. 376. New Zealand: New Zealand Transport Agency, 2009.

Grimes, Arthur, and Andrew Aitken. *Regional Housing Markets in New Zealand: House Price, Sales and Supply Responses*. New Zealand: Motu Economic and Public Policy Research, 2005.

Grimes, Arthur, and Andrew Aitken*. Housing Supply, Land Costs and Price Adjustment*. Real Estate Economics V38 2: pp.325-353. American Real Estate and Urban Economics Association, 2010.

Grimes, Arthur, and Chris Young. *Spatial effects of urban rail upgrades*. Journal of Transport Geography, Vol. 30(C), pp. 1-6. Elsevier, 2013.

Gyourko, Joseph, and Joseph Tracy. *A look at real housing prices and incomes: some implications for housing affordability and quality*. Economic Policy Review, Vol.5, issue Sep, pp. 63-77. Federal Reserve Bank of New York, 1999.

Hufner, Felix, and Jens Lundsgaard. *The Swedish Housing Market: Better Allocation via Less Regulation.* OECD Economics Department Working Papers No. 559. OECD, 2007.

Kahneman, Daniel. *Thinking Fast and Slow*. ISBN 9780141033570. Farrar, Straus and Giroux, 2011.

Kahneman, Daniel, and Amos Tversky. *Advances in prospect theory: Cumulative representation of uncertainty*. Journal of Risk and Uncertainty, Vol. 5 (1992), pp. 297-323.

Kulish, Mariano, Anthony Richards, and Christian Gillitzer. *Urban Structure and Housing Prices: Some Evidence from Australian Cities.* Research Discussion Paper – RDP 2011-03. Australia: Reserve Bank of Australia, 2011.

Kuschel, Gerda, Jayne Metcalfe, Emily Wilton, Jagadish Guria, Simon Hales, Kevin Rolfe, and Alistair Woodward. *Updated Health and Air Pollution in New Zealand Study*. Prepared for Health Research Council of New Zealand, Ministry of Transport, Ministry for the Environment and New Zealand Transport Agency, Volume 1: Summary Report. New Zealand: Emission Impossible Ltd, 2012.

Lewicka, Maria, and Janusz Czapinski, and Guido Peters. “Positive-negative asymmetry or ‘When the heart needs a reason’.” *European Journal of Psychology*, Vol. 22 (1992), pp. 425-434.

Maré, David, and Daniel Graham. *Agglomeration Elasticities in New Zealand*. Motu Working Paper No. 09-06. New Zealand: Motu Economic and Public Policy Research, 2009.

McIntosh, James, and Roman Trubka, and Peter Newman. *Can value capture work in a car dependent city? Willingness to pay for transit access in Perth, Western Australia*. Transportation Research Part A: Policy & Practice. Vol. 67, pp. 320-339. Australia, 2014.

Ministry for the Environment. *National Policy Statement on Urban Development Capacity*, 2016.

Ministry for the Environment. “Ozone” Ministry for the Environment. https://www.mfe.govt.nz/air/specific-air-pollutants/ozone.

Ministry for the Environment. “Sulphur Dioxide” Ministry for the Environment. https://www.mfe.govt.nz/air/specific-air-pollutants/sulphur-dioxide.

MRCagney, BECA & Covec. *Cost benefit analysis of policy options for a National Policy Statement on Urban Development Capacity*. Job Number: NZ2052, Prepared for Ministry for the Environment. Auckland: 2016.

MRCagney. *The costs and benefits of urban development*. MRC Reference: NZ 2427, Prepared for Ministry for the Environment. Auckland: MRCagney, 2019.

MRCagney. *The Economic Impacts of Minimum Parking Requirements: An Analysis of Dominion Rd, Takapuna and Onehunga*. Prepared for Auckland Council, Job Number NZ1736. Auckland: 2012.

Nunns, Peter. *The Causes and Economic Consequences of Rising Regional Housing Prices in New Zealand.* Centre for Applied Research in Economics, Working Paper No. 005. Auckland: University of Auckland Business School, 2019.

Olsen, Mancur. *The Logic of Collective Action: Public Goods and the Theory of Groups*. Harvard University Press, 196

Polkinghorne, John. “What do carparks cost to build?”. Greater Auckland. Updated May 15, 2014. https://www.greaterauckland.org.nz/2014/05/15/what-do-carparks-cost-to-build/.

Rae, David, and Paul van den Noord. *Ireland’s Housing Boom: What has driven it and Have Prices Overshot?*. OECD Economics Department Working Papers No. 492. OECD, 2006.

Rawlinsons. *Rawlinsons New Zealand Construction Handbook.* Chapter 1 - Building Costs per Square Metre, and Chapter 6 – Construction Indices. New Zealand: Rawlinsons Publishing, 1998-2013/14.

Roback, Jennifer. Wages, *Rents and the Quality of Life*. Journal of Political Economy, Vol. 90, Number 6, pp.1257-1278. The University of Chicago Press, 1982.

Rosen, Sherwin. *Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition*. Journal of Political Economy, Vol. 82, Number 1, pp.34-55. The University of Chicago Press, 1974.

Sanchez, Aida Caldera, and Asa Johansson. *The Price Responsiveness of Housing Supply in OECD Countries*. OECD Economics Department Working Papers No. 837. OECD, 2011.

Shoup, Donald. *The High Cost of Free Parking.* ISBN 1884829988. Chicago: Planners Press, American Planning Association, 2005.

Speight, G. *Reaction Mechanisms in Environmental Engineering*. United States: Butterworth-Heinemann, 2018.

Statistics New Zealand, 2013 Census. http://archive.stats.govt.nz/Census/2013-census.aspx.

Statistics New Zealand.

Tabuchi, Takatoshi, and Atsushi Yoshida. *Separating Urban Agglomeration Economies in Consumption and Production*. Journal of Urban Economics Vol. 48, Issue 1, pp. 70-84. Elsevier, 2000.

Trubka, Roman, and James McIntosh. *Auckland Light Rail: Value Creation and Sharing Project Report*. Prepared for New Zealand Transport Agency, LUTI Consulting Project Number: LUTI-18-12. Auckland: LUTI Consulting, 2019.

United States Environmental Protection Agency. “Particulate Matter (PM) Pollution” United States Environmental Protection Agency. Retrieved from https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.

Varghese, Jenson. *Economic Development through Parking Reform*. Auckland: MRCagney, 2011.

Waka Kotahi NZ Transport Agency. *Keeping Cities Moving: Increasing the wellbeing of New Zealand's Cities by growing the share of travel by public transport, walking and cycling*. NZBN 9429041910085. New Zealand: Waka Kotahi NZ Transport Agency, 2019.

Appendix A – Restrictions

This document has been prepared for the Ministry for the Environment and the Ministry of Housing and Urban Development ('the Ministries') as a cost-benefit analysis of the proposed National Policy Statement on Urban Development, to inform decisions by the Ministries about the final specifications of the National Policy Statement. This document has been prepared solely for this purpose and should not be relied upon for any other purpose. While we acknowledge that it will be made public alongside the final National Policy Statement, we accept no liability to any party should it be used for any purpose other than that for which it was prepared.

To the fullest extent permitted by law, PwC accepts no duty of care to any third party in connection with the provision of this report and/or any related information or explanation (together, the "Information"). Accordingly, regardless of the form of action, whether in contract, tort (including without limitation, negligence) or otherwise, and to the extent permitted by applicable law, PwC accepts no liability of any kind to any third party and disclaims all responsibility for the consequences of any third party acting or refraining to act in reliance on the Information.

We have not independently verified the accuracy of information provided to us and have not conducted any form of audit in respect of the Ministries. Accordingly, we express no opinion on the reliability, accuracy, or completeness of the information provided to us and upon which we have relied.

The statements and opinions expressed herein have been made in good faith, and on the basis that all information relied upon is true and accurate in all material respects, and not misleading by reason of omission or otherwise.

The statements and opinions expressed in this document are based on information available as at the date of submission.

This document is issued pursuant to the terms and conditions set out in the All of Government Consulting Services Order dated 29th October 2019.

Appendix B – Calculation details for the intensification policy models

Primary data sources

Data for our analysis is sourced from national ministries, local councils, public databases, and private organisations. Table 20 below details our sources for empirical data. However, this is not an exhaustive list of inputs for the intensification analysis, for which we have relied extensively on secondary research in the existing literature.

Table 20: Empirical data sources

Source	Data derived
Ministry of Housing and Urban Development (HUD)	• Property ratings data at rateable unit level for 14 territorial authorities, latest as of June 2019. • Code match data showing the many-to-many relationship between property valuations and LINZ land parcels.
Land Information New Zealand (LINZ) Spatial Data	• Primary parcel shape files for 14 territorial authorities • Territorial authority boundaries
City and District Council	• Operative land use zone shapefiles • Survey of NPS-UDC reporting costs
Stats NZ	• Historical and projected population at territorial authority level • Historical building consents at territorial authority and regional levels • Historical demographic data at territorial authority level • Historical gross regional domestic product by region and industry • Historical Consumer Price Index and interest rates at National level • Historical income at regional level
Rawlinsons New Zealand Construction Handbook	Historical construction cost and construction cost indices at territorial authority level
Ministry of Business Innovation and Employment	Historical gross regional domestic product at TA level
Real Estate Institute of New Zealand	Historical nominal median house price at territorial authority level

Source: PwC analysis.

Assumptions related to the AMM model

The AMM model assumes a city with fixed population living around a single central business district (CBD), where each individual has identical income levels and preferences.[47] All individuals commute to the CBD for work and face travel costs that increase with distance from the CBD. This latter assumption reflects relatively higher petrol costs, time costs, general vehicle upkeep costs, public transport fares, etc.

The following limitations arise from the model's simplifying assumptions:

- Individuals have identical income and preferences in the model, but in reality they differ. However, factoring differences in income and preferences into the model provides the same basic insights as without accounting for them (e.g. Anas (1990)). It is therefore justifiable to employ the basic model as the qualitative conclusions of the simple model would be similar to those conclusions with extensions (see Arnott and MacKinnon (1977) and Brueckner (1983)).[48]
- The city is monocentric (one centre). This means that individuals only work in one city centre and excludes the possibility of other business districts within the city. It does not however exclude the possibility of jobs outside the CBD, only that there is a concentration of jobs in the core. In addition, the monocentric assumption does not allow for other locations to be considered desirable based on attributes such as, proximity to places like schools, pubs or beaches (these need to be controlled for separately). The only location that is taken into account when valuing the housing cost or travel cost gradient is the CBD. While this is clearly not an accurate description of cities around us (for example, waterfront property often has higher land value than its proximity to a city centre alone would predict), conclusions from the basic model are qualitatively robust to such extensions and these individual city characteristics are easily controlled for. An example of this is Henderson and Mitra (1996), who analyse a version of the model with multiple employment centres.
- The equilibrium is partial as it is based on a restricted range of data. The economic system in this model (wage and rental rate) are assumed to be exogenous, meaning that the value is determined outside of the model (labour or capital markets) and is imposed on the model.
- The model does not consider housing stock, availability of finance, the process of urban change and phenomena such as gentrification. Instead, the static model provides insights into longer-run determinants of urban equilibrium.

[47] To illustrate some of the key economic concepts we first present the "closed city model", meaning that population is fixed and exogenously given. Elsewhere in this report we present models that assume, more accurately, that the city's population is formed through spatial equilibrium with the outside world (accounting for migration flows). This 'open city model" is endogenously determined through a national labour market. See Bruckner (1987) for details on this extension to the AMM model.

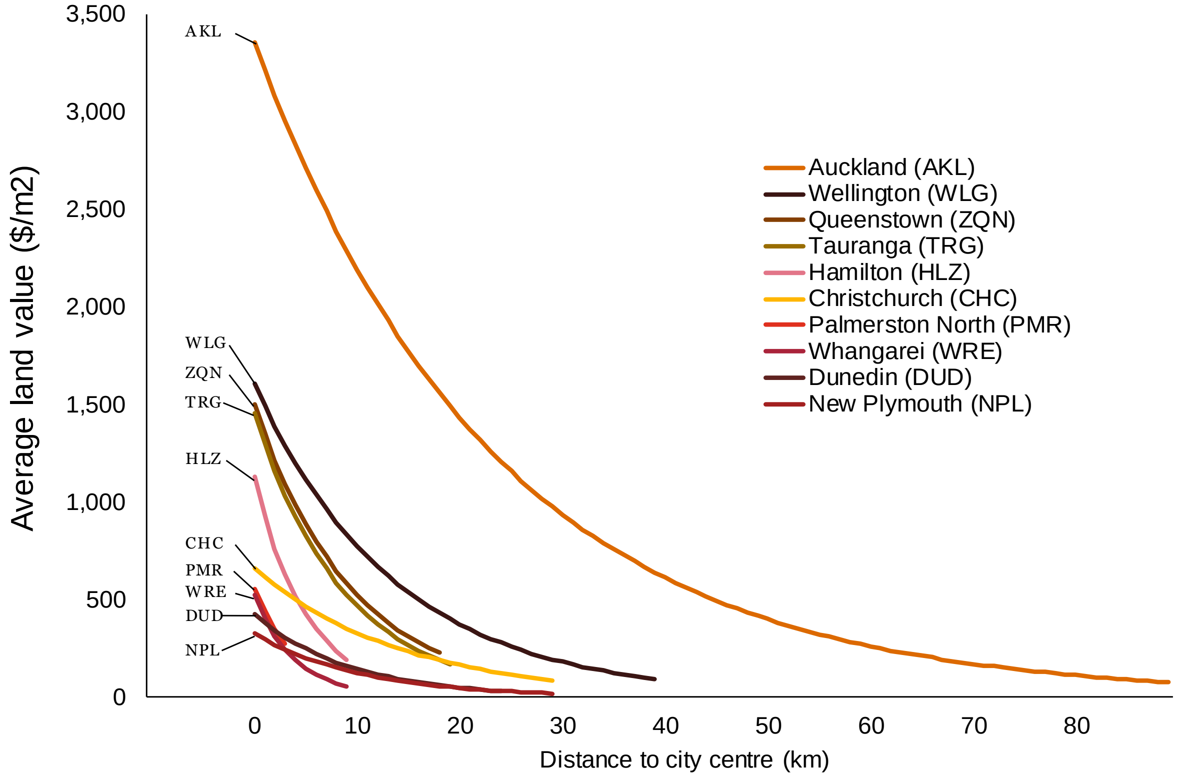
[48] Kulish, M. Richards, A. Gillitzer, C. (2013)

Land value difference between and within cities

High land values reflect a fierce competition for access to amenity and productivity and explain some of the differences in price both between and within cities. City centres are more productive and provide more amenity than urban fringes, and some cities are more productive than others. However, we observe that there is far more variation in demand for intensification within New Zealand cities than between them, an important point for regulatory change.

Figure 79 shows a smoothed exponential trend of land values in relation to distance from the city centre in ten cities. All cities depict the same relationship, land values decrease as distance to the city centre increases. Auckland is found to have the highest land values by a significant margin, reflecting its position as the largest and most productive city in New Zealand. Other MUCs are grouped closer together under Auckland's curve.

Figure 79: Land values by distance to city centre (fitted exponential trend)



Source: Auckland Council, Ministry of Housing and Urban Development, PwC Analysis

Table 21 and Figure 80 highlight the differences within cities. Table 21 shows that the land value multiple for Auckland is 1,770, meaning inner city land is 1,770 times more expensive than land on the periphery. Other cities with large multipliers include Wellington (600x), Tauranga (380x) and Queenstown (370x).

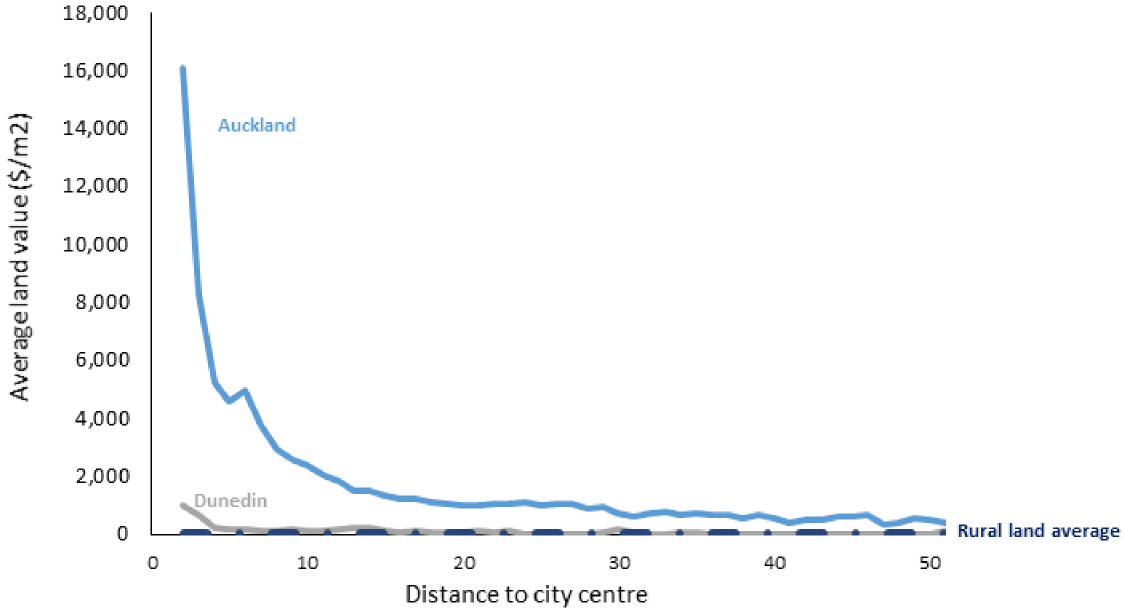
Table 21: Summary of land value gradients by city

City	Land value multiple (inner city compared to rural land):	For every km closer to city centre, land values per square metre increase by:
Auckland	1,770x	$190
Wellington	600x	$65
Tauranga	380x	$36
Queenstown	370x	$12
Christchurch	200x	$23
Hamilton	110x	$12
Dunedin	110x	$12
New Plymouth	100x	$12
Palmerston North	80x	$11
Whangarei	70x	$8

Source: Auckland Council, Ministry of Housing and Urban Development, PwC Analysis

At just over $1000/m^2, median Auckland land values are around six times higher than those in Dunedin, but this obscures broad variation. Land in Auckland ranges from $20/m^2 to $30,000/m^2; the most valuable land is some 16 times higher than Dunedin's most valuable land.[49]

Figure 80: Differences in land values within Auckland and Dunedin



Source: PwC analysis.

[49] Ministry of Housing and Urban Development.

Comparative statics calculations

Our calculations of consumer surplus and transfers between stakeholders arising from an increase in the responsiveness of housing supply are based on the method used by MRCagney, BECA & Covec in the 2016 cost benefit analysis of the NPS-UDC. Demand and supply equations are shown below.

Equation	Functional Form
Demand at t=0	$Q_D = \frac{P_{max} * Q_0}{P_{max} - P_0} - \frac{Q_0}{P_{max} - P_0} * P$
Demand at t=1	$Q_D = \frac{P_{max} * Q_0}{P_{max} - P_0} * g - \frac{Q_0}{P_{max} - P_0} * P$
Supply under status quo regulation	$Q_{sqo} = \left(E_{sqo} * \frac{Q_0}{P_0}\right) * P + (Q_0 - E_{sqo} * Q_0)$
Supply with policy option	$Q_{opt} = \left(E_{opt} * \frac{Q_0}{P_0}\right) * P + (Q_0 - E_{opt} * Q_0)$

Where:

Table 7: Intensification model variables

Variable	Description
Q_D	Modelled housing quantity given any set of inputs
Q_0	Quantity of dwellings at the time of policy implementation
P_{max}	Demand curve intercept
P_0	Median price at time of policy implementation
g	Demand growth over the study period
Q_{sqo}	Expected quantity of dwellings under the status quo scenario
E_{sqo}	Expected supply elasticity under the status quo scenario
Q_{opt}	Expected quantity under the with-policy scenario
E_{opt}	Expected elasticity under the with-policy scenario

Source: MRCagney, BECA & Covec (2016).

We apply current occupied dwelling numbers and median home prices as our starting price and quantities, and project demand growth according to Stats NZ projections to 2043.

We establish the slope of demand based on the New Zealand-wide estimates of Hyslop et al (2019), who observe a demand elasticity of -0.516 with a standard error of 0.717 using data from 308 Territorial Authorities and Auckland Wards from 1991 to 2013.[50] We use this estimate to inform two scenarios for demand elasticity:

- A low-response scenario equal to the New Zealand-wide estimate of -0.516. This reflects our assumption that the MUCs targeted by the NPS-UD are likely to have above-average demand responses to a given change in housing price, particularly a decrease.
- A high-response scenario equal to -1.233; that is, the same estimate plus one standard error. This higher demand scenario remains well within the bounds of historically observed variation.

To estimate policy impact on elasticity, we use a high and a low estimate derived from the maximum and minimum observed standard errors in our empirical models described above. This ensures that our assumed policy impacts are well within the scope of historical variation in elasticity for New Zealand cities as a starting point.

We then apply an adjustment to reflect the observed level of regulatory restraint in each city. For this we make use of our estimate of the impact of zoning on floor area ratio:

$$FAR = \beta_1 + \beta_2 Land\ Value + \beta_3(Land\ Value * LowestDensity) + \beta_4(Land\ Value\ * HighestDensity)$$

[50] That this estimate is not statistically different from zero is irrelevant as we are not testing a hypothesis about whether the relationship between price and quantity demanded of housing exists. The high standard error tells us instead that the strength of the relationship (the existence of which we assume) varies widely by time and location. The estimated elasticities are in log-log form.

Where β_2 is the citywide expected increase in floor area for a unit increase in land value, and β_3 and β_4 are the marginal changes in that estimate expected where a property belongs to the areas zoned for lowest and highest density respectively. Our constraint factor C is thus:

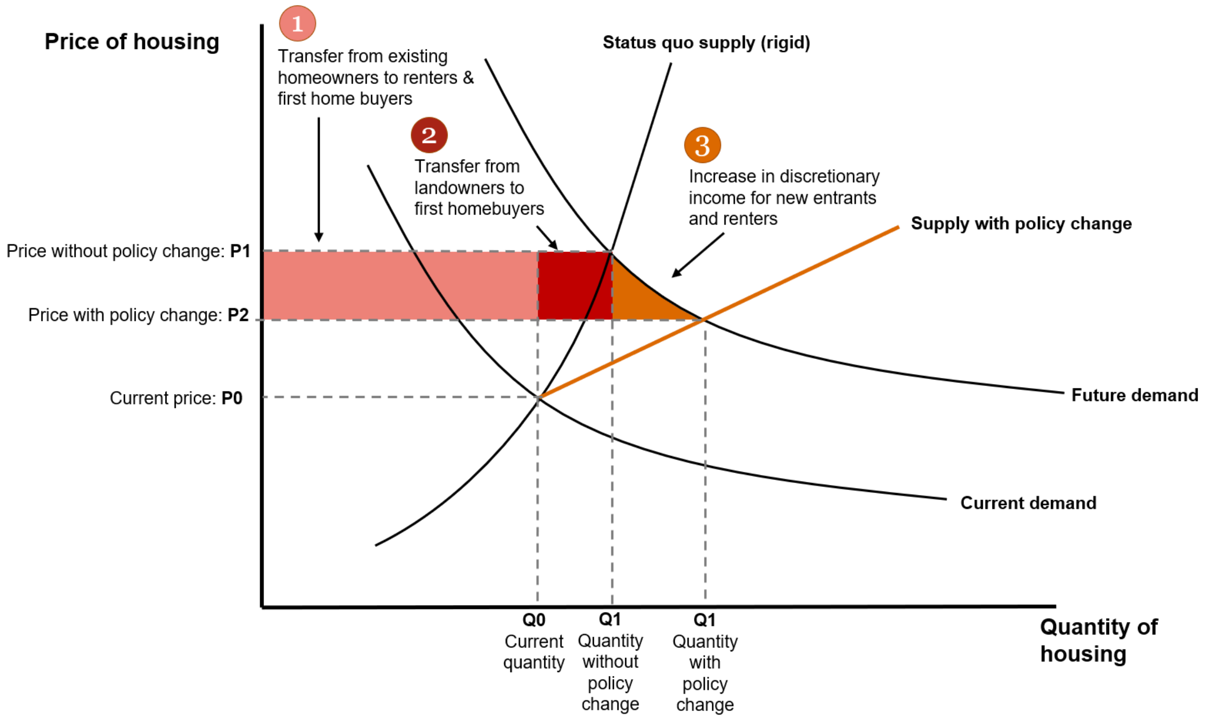
$$C = \frac{\beta_2 + \beta_4}{\beta_2}$$

That is, the mean factor by which floor area provision in the most permissive zone deviates from the city-wide average, holding land values constant.

We multiply our high and low standard errors by this factor to arrive at our base case estimates of policy impact on supply elasticity. While this is a novel approach, it serves the purpose of establishing a credible range of magnitude for the potential policy impact on supply elasticity that is informed both by historically observed changes in supply responsiveness across New Zealand cities and by an empirically derived proxy for the degree to which development is constrained in each city. This is not a prediction, but a starting point from which to test sensitivities in our model.

The benefits of the policy are then quantified by calculating the area of rectangles (1) and (2) and triangle (3) in Figure 81 above, with the elasticity impact estimates informing the shift in slope of the supply curve.

Figure 81: Consumer surplus effects of more responsive housing supply



Source: PwC analysis.

Consumer surplus effects are calculated as follows:

$$CS = \frac{(Q_{opt} - Q_{sqo}) * (P_{sqo} - P_{opt})}{2}$$

Transfers between households:

$$T_H = Q_0 * (P_{sqo} - P_{opt})$$

Transfers from landowners and developers to households:

$$T_{LD} = (Q_{sqo} - Q_0) * (P_{sqo} - P_{opt})$$

Estimating the price elasticity of housing supply

The price elasticity of housing supply quantifies the relationship between changes in housing prices and changes in new housing supply; that is, how responsive housing supply is to a change in price. By observing differences in historical variation in this relationship between cities, we can estimate the potential for NPS-UD policies, which aim to relieve regulatory constraints to development, to influence future responsiveness of housing supply to price in each city.

Few studies in the literature have attempted to estimate housing supply elasticity on a subnational level in New Zealand. The most recent estimates at the city level were by Grimes and Aitken (2011) using data from 1992 to 2004,[51] before both the Global Financial Crisis of 2008 to 2012 and the steep rises in housing prices in New Zealand cities that contributed to what has come to be called the housing crisis.

Because the NPS-UD intends to address housing affordability through the mechanism of improving supply elasticities, our model requires both status quo and with-policy estimates of what those elasticities might be in the future. In this section, we describe our attempts to establish reasonable assumptions for those elasticities as inputs into our comparative statics and greenfield expansion models described in our chapters on intensification and responsive planning. Building on recent OECD working papers (Hufner and Lundsgaard, 2007, Rae and van den Noord, 2006, and principally Caldera-Sanchez and Johanssen 2011), we aim to estimate the historical price elasticities of new housing supply for New Zealand's MUCs, as well as the degree to which they have varied over time, using a time-series regression model.

The model is estimated separately for each MUC to maximise the internal validity of the results, as we are interested in applying these estimates to the same cities in each sampled observation rather than generalising them to a larger population of cities. The model uses monthly data on housing prices, building consent values, annual construction cost indices, and demographic statistics from 1998-2019.

Base model

Our model is based on the approach used by Caldera-Sanchez and Johansson, a stock-flow model incorporating one estimate for long run trends, and a second for short run dynamics that estimates the patterns of reversion to the long-run trend. While our assessment of NPS-UD benefits concerns us primarily with the long-run equation, we test our data with the full model as a robustness check. The long-run model is as follows:

$i_t = \beta_0 + \beta_1 \, p_{t-1} + \beta_2 \, cc_{t-1} + \beta_3 \, tp_t + \gamma \, GFC_t + u_t$ (long-run)

Where:

- i_t = *Real investment in new housing stock*
- p_{t-1} = *Real median house price*
- cc_{t-1} = *Real construction costs*
- tp_t = *Total population*
- GFC_t = *GFC dummy*

Description of variables

The dependent variable and the independent variables are logarithmically transformed for ease of interpretation and application as inputs to our comparative statics model. In this estimate, we are interested in how a percentage change in real median house price affects a percentage change in real investment in new housing stock. Price variables (building consent value, median house price, construction costs), are modelled in real terms.

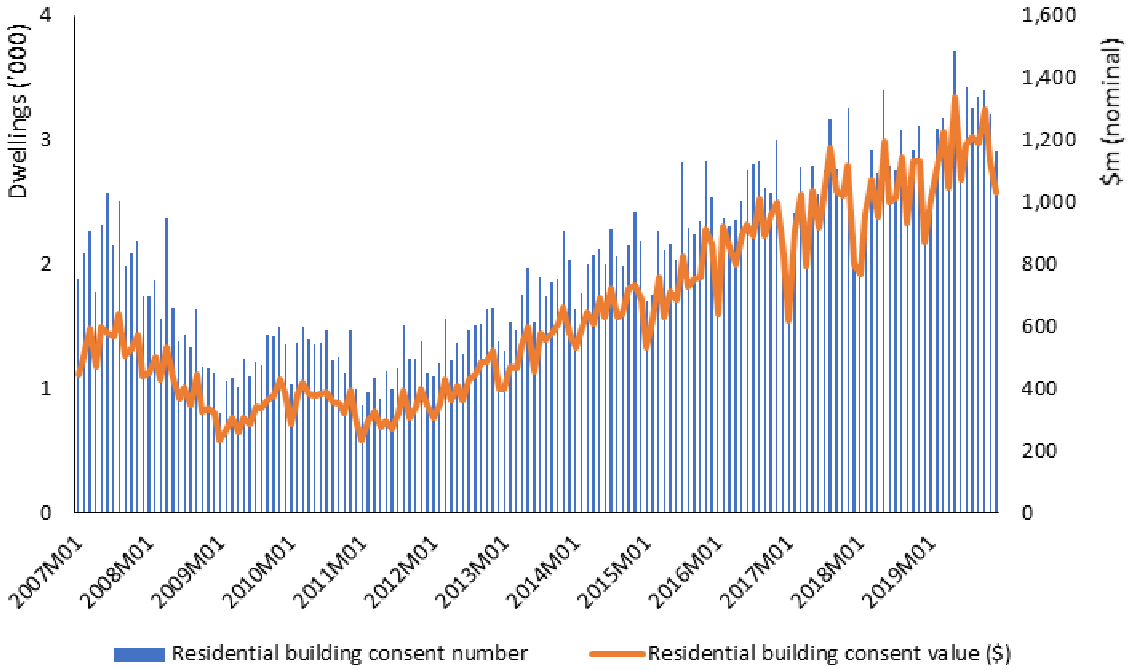
The coefficient of interest in the model is β_1 , which measures the long-run elasticity of housing investment, or new housing supply, with respect to prices. If $0 < \beta_1 < 1$ then housing supply is relatively inelastic, meaning it is not very responsive to an increase in price. In this case house prices are estimated to increase faster than supply, which can be an indicator of shortages and unaffordable housing. The closer β_1 is to 0 the less elastic

[51] We compare our results with those of Grimes and Aitken below.

housing supply is. Conversely, if β_1 > 1 then housing supply is relatively elastic meaning that supply is responsive to an increase in price.

The dependent variable, $i_{t,}$ represents real gross investment in residential property. In New Zealand, the closest estimate of this variable is Residential Gross Fixed Capital Formation (GFCF). However, GFCF is measured at the national level. In order to obtain granularity at the TA level, i_t is proxied by the real value of building consents for new dwelling units. Real building consent value is an appropriate proxy as it represents dwellings to be built within subsequent months. Empirically, the higher the consent value the more dwellings are built. This idea is represented in Figure 82, which shows that there is a strong relationship between building consent number and building consent value (*correlation 0.75*) in New Zealand from 2007-2019. Employing consent value as opposed to the raw number of dwellings allows the estimate to incorporate location effects—desirable areas will have higher consent values and will be weighted more than less desirable areas. However, it will also incorporate the effects of greater consumption of space per dwelling further from the city centre. The two effects of more valuable locations and larger dwellings are countervailing, though we expect the land value effect to dominate to the extent that households must accept higher transport costs in exchange for consuming more space.[52] The data was sourced from NZ Stats InfoShare.

Figure 82: Relationship between building consent number and building consent value in New Zealand 2007-2019



Source: Stats NZ, PwC analysis.

The first independent variable, p_{t-1}, represents real house prices. We use real median house price data compiled by the PwC Real Estate team and sourced from REINZ. The second independent variable, c_{t-1} , represents real construction costs. The model uses real residential construction costs for years 1998-2014 and 2018-2019 from Rawlinsons Handbook and QV Costbuilder respectively. Construction cost index values for the years 2015 – 2017 were estimated using simple linear interpolation. Both the construction cost and house price variables are lagged one period (t-1) in the equation. This is to reflect the lag between price signals and investment in new housing and is also to avoid potential endogeneity. The third independent variable, tp_t , represents the total population. Population estimate data was sourced from Statistics New Zealand. The price and population coefficients are expected to be positive and the construction costs coefficient is expected to be negative.

[52] See our description of the AMM model for the theory behind this expectation.

The dummy variable,[53] GFC_t, controls for the influence of the Global Financial Crisis. We found that marking the Global Financial Crisis variable as true for the years 2008 to 2012 resulted in a statistically significant coefficient at the 5 percent level for all 6 MUCs.

Detailed time-series methodology

The explanation below is intended for individuals, mainly econometricians, who are interested in the step by step methodology of how we estimate and check the validity of our housing supply elasticities.

Each model was estimated using an error correction framework employing the Engle-Granger two-step estimation procedure (1987). We used this method as it was likely that we would have non-stationary data, meaning that the OLS assumptions of a stationary mean, unchanging variance across independent variables, and absence of autocorrelation are or may be violated. As a rule, non-stationary data cannot be relied on in regression models due to the risk of generating spurious results, ie, the apparent indication of a relationship between two variables that does not exist.

There are some established methods of correcting for this weakness of non-stationary data. One of these involves cointegration of the estimated variables. If two or more variables are non-stationary but some linear combination of them is stationary, they are cointegrated, meaning the OLS assumptions are not violated for that linear combination of time series variables.

However, in the case of our estimations, the existence of a relationship between housing investment, price of housing and construction costs is already well documented in the literature. Our aim is to obtain sensible assumptions for the magnitude of these relationships as inputs into a cost-benefit model rather than to prove their existence. As such, the chance of a theoretically spurious regression is not a concern. Even so, the cointegration method is used on models employing non-stationary variables as a robustness check.

The long-run equation highlights the relationship between the variables in percentage form. For example, if β_1 = 0.9 then the value of building consents rises by approximately 0.9% in response to a 1.0% increase in real median house price.

The first step of the procedure requires estimating the cointegrating regression (long-run model) by OLS. The second step is to test for a unit root in the residuals from the cointegrating regression (long-run model). If the null-hypothesis of a unit root is rejected, then there is evidence of cointegration and the residual from the first step regression can be added as an error correction term to a dynamic regression (short-run model). As a robustness check, the p-value of the error correction term in the short-run model was checked for statistical significance.

Steps used for model estimation – Auckland example

Step 1 – estimate the long-run model

1.1 Run an OLS regression using the base model for Auckland.
1.2 β_1 (0.876) had a significant p-value (0.000) and a high R2 value (0.7627).
1.3 Estimate the values of the long-run model residuals.
1.4 Run an Augmented Dicky-Fuller (ADF) test on the estimated residuals to test for a unit root.

For cointegration testing, the critical values are not the ADF critical values generated in STATA. The Engle-Granger critical value (at the 10% level) for a model with four variables and a sample size of 200 is -3.83 (Engle and Yoo, 1987). In order to reject the null hypothesis and accept the cointegrating regression, the t-statistic of the ADF must be smaller than -3.83.

1.5 The Auckland estimate showed a t-stat of -9.078

Step 2 – estimate the error correction model

Although we are interested in the long-run relationship, this step needs to be completed to meet the requirements of the Engle-Granger 2-step procedure (1987). The error correction model (ECM) describes how the dependant and independent variables behave in the short run consistent with the long run cointegrating relationship.

[53] A dummy variable takes the value 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome (y variable).

2.1 Test whether the Error Correction Term is statistically significant and estimate the short-run relationship using the following model (OLS):

$$\Delta i_t = \boldsymbol{\alpha}_0 + \boldsymbol{\alpha}_1 \Delta p_{t-1} + \boldsymbol{\alpha}_2 \Delta cc_{t-1} + \boldsymbol{\alpha}_3 \Delta tp_t + \boldsymbol{\alpha}_4 ECT^i_{t-1} + \gamma GFC_t + u_t \quad \text{(short-run)}$$

The coefficient $\boldsymbol{\alpha}_4$ measures the speed at which a dependent variable returns to equilibrium after a change in other variables. The coefficient $\boldsymbol{\alpha}_4$ is expected to be negative as lower-than-expected investment due to short-term volatility in the previous period should have a positive effect on investment in the next period. That is, if the actual flow of housing investment is lower than the long-term trend predicts, investment is expected to rise in the following period.

2.2 Auckland has a p-value of 0.000 for the ECT coefficient, meaning that the ECT is statistically significant.
2.3 The coefficient of interest for the short-term equation, $\boldsymbol{\alpha}_1$, is 1.444. This highlights the magnitude of short-run volatility and implies that a 1% level shock in house prices leads to a 1.4% change in building consent value in the short-run.
2.4 The long-run equation coefficient β_1 = 0.8767, implying that as median Auckland house prices increase by 1%, investment in new housing stock has increased by approximately 0.87% over the sampled period. This is the estimate to be used as a baseline elasticity assumption in our cost-benefit model.

Model estimation results for each MUC

Each model was estimated using the methodology above. In some cases the base model did not have a significant p-value (Hamilton), or the R^2 value was low (Wellington). Because we are more interested in long-term relationships between price and housing investment than in short-term market dynamics, models which failed tests or had the potential to improve were adjusted by smoothing the dependent variable, i_t, using a 12-month rolling average of median prices instead of a monthly median. If the 12-month rolling average did not generate significant results, a 24-month rolling average was tested. For example, the Hamilton model had an insignificant p-value for both the base model and the 12-month smoothed model but had a significant p-value for the 24-month smoothed model. Results are summarised in Table 22.

Table 22: Housing supply elasticity model regression results

	Auckland	*Hamilton*	*Tauranga*	*Wellington*	*Christchurch*	*Queenstown*
What model can be tested according to ADF results for order of integration	**Base model**	**Base model**	**Smoothed model**	**Base or Smoothed**	**Base model**	**Base or Smoothed**
Base model β_1	0.876	-0.904	0.517	2.250	0.778	0.654
Base model p-value	0.000	0.722	0.021	0.001	0.000	0.001
Base model R^2	0.869	N/A	0.5199	0.110	0.631	0.6701
Smoothed model (12 month) β_1		0.221	1.207	1.3533	0.8869	0.875
Smoothed model (12 month) p-value		0.162	0.000	0.000	0.000	0.000
Smoothed model (12 month) R^2		N/A	0.733	0.250 (improved)	0.775	0.856
Smoothed model (24 month) β_1		0.840				
Smoothed model (24 month) p-value		0.000				
Smoothed model (24 month) R^2		0.677				
Base model ADF t-stat	-9.078		-11.480	-14.468	-7.571	-13.062
Smoothed model (12 month) ADF t-stat			-4.059	-3.884	-2.484	-4.986
Smoothed model (24 month) ADF t-stat		-2.630				
Base model ECT p-value (from short-run model)	0.000		0.000	0.000	0.000	0.000
Smoothed model (12 month) ECT p-value (from short-run model)			0.024	0.011		0.000
Base model ECT coefficient (from short-run model)	negative		negative	negative	negative	negative
Smoothed model (12 month) ECT coefficient (from short-run model)			negative	negative		negative
Base model α_1 (from short-run model)	1.444		0.1856	3.274	1.221	0.223
Smoothed model (12 month) α_1 (from short-run model)			0.00814	0.198		-0.0053

Source: PwC analysis.
Key: Green cells indicate a passed test, red a failed test. Yellow cells denote potential to improve the model; grey cells indicate a test is not required or cannot be conducted due to pre-test failures.

Notes on Hamilton

For Hamilton, the only model that passed ADF pre-tests for all variables (described further below) was the base model, which generated an insignificant p-value. The 24-month smoothed model had a significant p-value but showed no evidence of cointegration. Therefore, Hamilton was not estimated using an error correction framework. The long-term model for Hamilton is still accepted as the residuals for the smoothed (24 month) model were stationary (ADF t-stat < ADF critical value (-1.620)). This could mean that the smoothing eliminated any stochastic trend leaving only a cointegrated deterministic trend. This would be a problem if our goal was to assert the existence of a relationship between our dependent and independent variables. However, as previously discussed, we are not concerned with spurious regression as these variables have a well-established relationship. For the purposes of using the elasticities to estimate the intended impact of the NPS-UD, this value is appropriate.

ADF tests for individual variables

Prior to estimating the error correction framework, we establish which equation/s could be tested for cointegration by checking the order of integration for each variable. This step is required to conduct the Engle-Granger 2-step procedure.

Conventionally, the dependent (left) side of the regression equation must be integrated to the same order as the independent (right) side, as seen in Tauranga for the smoothed (12 month) model. However, the placement of variables on either side of the equals sign is arbitrary so long as transformations follow the rules of algebra. If there are two I (1) variables on the independent side (as for Auckland, Christchurch, and Hamilton), and if the variables themselves are cointegrated, then the regression can be tested for cointegration. Testing for cointegration between two variables has an Engle-Granger critical value (at the 10% level) of -2.98. Similarly, if all the variables in the equation are I (0) then all linear combinations would be I (0) and therefore can be tested. However, a model with all I (0) variables does not need to be tested for cointegration as it already satisfies the OLS assumptions. We have nevertheless tested for cointegration in this case to determine the short-run relationships.

Table 23: Augmented Dicky-Fuller Tests for Order of Integration/ Stationarity

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Base model i_t	I (0)	I (0)	I (0)	I (0)	I (0)	I (0)
Base model p_{t-1}	I (1)	I (1)	I (0)	I (0)	I (1)	I (0)
Base model cc_{t-1}	I (0)	I (0)	I (0)	I (0)	I (0)	I (0)
Base model tp_t	I (1)	I (1)	I (0)	I (0)	I (1)	I (0)
Base model residuals	I (0)	I (0)	I (0)	I (0)	I (0)	I (0)
Smoothed model (12 month) i_t	I (1)	I (1)	I (1)	I (0)	I (0)	I (0)
Smoothed model (12 month) residuals	I (0)	I (1)	I (0)	I (0)	I (0)	I (0)
Smoothed model (24 month) i_t		I (1)				
Smoothed model (24 month) residuals		I (0)				
Base model p_{t-1} and Base model tp_t	-3.633 Cointegrated	-3.206 Cointegrated			-2.090 Cointegrated at 20% level of significance	
	Base model can be tested for cointegration	Base model can be tested for cointegration	Base model can be tested for cointegration	Base model or Smoothed (12 month) model can be tested for cointegration	Base model can be tested for cointegration	Base model or Smoothed (12 month) model can be tested for cointegration

Source: PwC analysis

Long-run equation results

Considering both the ADF tests for order of integration and the Engle-Granger tests for cointegration, our results for long-run housing supply elasticities are summarised in Table 24. As an example of interpretation, the value of building consents in Auckland increases by approximately 0.876% in response to a 1.0% increase in real house prices.

Table 24: PwC Housing Supply Elasticity Results

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
PwC Housing supply elasticities	0.876	0.840	0.517	1.353	0.778	0.875
P-value	0.000	0.000	0.021	0.000	0.000	0.000
R^2 value	0.869	0.667	0.5199	0.250	0.631	0.856
95% confidence interval	0.441-1.312	0.606-1.074	0.080-0.954	0.923-1.783	0.356- 1.200	0.279- 1.029
Standard error	0.221	0.118	0.221	0.218	0.214	0.115

Source: PwC analysis

The estimate for Wellington is significantly higher than the other cities. We observe that the month-to-month volatility of building consent data for Wellington is an order of magnitude higher than the other cities, which all had similar consent volatility. This may be an idiosyncrasy associated with Wellington's role as the national capital, or Wellington may be an outlier in other ways. It is difficult to determine whether the anomaly is relevant to our expectations of housing supply response to prices in the long term, as long-term trends in the data show little deviation from patterns in other cities. For the purpose of interpreting cost and benefit estimates generated by the model described below, note that the unusually high baseline elasticity for Wellington will dampen the magnitude of both costs and benefits, in near-equal proportion, but will not affect their direction or the general conclusions. Nevertheless, care should be exercised in comparing the magnitude of effects between Wellington and the other cities.

Other estimated housing supply elasticities for New Zealand

Previous papers which focused on housing supply elasticities estimated elasticities between 0.2 - 3.6. This broad range highlights the differences that exist between cities as well as between periods of observation.

Sanchez and Johansson (2011) estimated nationwide housing supply elasticities for all OECD countries. For New Zealand the estimation period was from 1994 to 2007, using quarterly observations. Grimes and Aitken (2011) estimated sub-national housing supply elasticity for 73 regions over 53 quarters (1991-2004). Our model estimates housing supply elasticities for TAs defined in the NPS-UD as MUCs. The estimation period is from 1998 to 2019, using monthly data for a total of 261 observations per MUC. Below are the results from three previous papers which aided us in building our model.

Table 6: Housing supply models from alternative papers

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Sanchez and Johansson (2011) Nation-wide model (1994-2007)	0.705	0.705	0.705	0.705	0.705	0.705
Grimes and Aitken (2011) TLA level (1992-2004)	1.0	2.9	1.2	0.2	1.1	3.6
Grimes and Aitken (2005) National average (1981-2004)	1.0	1.0	1.0	1.0	1.0	1.0
PwC Modelled estimates	0.876	0.840	0.517	1.353	0.778	0.875

Source: Sanchez and Johansson (2011); Grimes and Aitken (2011); Grimes and Aitken (2005); PwC analysis.
Note: Years shown in parentheses indicate the period of observation for data used in each paper.

Interpretation of alternative models

Table 25 shows the range of historical elasticities implied by the Grimes and Aitken estimates and our own. Examples of interpretation from the three papers mentioned above are as follows:

- **Sanchez and Johansson interpretation example:** "Gross fixed capital formation in the housing sector rises by approximately 0.705% in response to a 1.0% increase in real house prices", (Sanchez and Johansson, 2011).
- **Grimes and Aitken (2011) interpretation example:** "Building consents rise by approximately 1.0% in response to a 1.0% increase in real house prices relative to costs," (Grimes and Aitken, 2011).
- **Grimes and Aitken (2005) interpretation example:** "A 1.0% increase in real house prices within a TLA raises housing consents by approximately 1.0% in the first quarter", (Grimes and Aitken, 2005).

Table 25: Range of historical housing supply elasticities using the PwC model and Grimes and Aitken (2011)

	Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown
Range of historical housing supply elasticity estimates	0.876 - 1.0	0.840 - 2.9	0.517 – 1.2	0.2 - 1.353	0.778 - 1.1	0.875 – 3.6

Source: PwC analysis; Grimes and Aitken (2011)
Note: Ranges do not include nationally modelled estimates.