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NEW ZEALAND INSTITUTE OF ECONOMIC RESEARCH

The price is right

Land prices can help guide land use regulation

NZIER report to Ministry for the Environment and New Zealand Treasury

September 2015

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Authorship

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Context

House prices continue to reach new heights, pricing many younger families out of home ownership and reducing the capacity for some cities to accommodate productive workers.

Land supply, initially carefully planned to keep up with demographic forecasts, has been crimped by a combination of tight geography and land use regulation that has moved house prices higher.

Auckland is not alone – many other cities and regions are affected by tight land use regulation. But the city's processes and the existing legislative environment have not kept pace with demand, exacerbated by strong immigration and New Zealanders staying closer to home rather than crossing the Tasman.

Within that context, we were asked by the Ministry for the Environment and the New Zealand Treasury to assess whether variation in the price of land across the city – land price differentials – could be used as a signal of 'tight' land use regulation to prioritise development under existing resource management legislation. We were asked to examine:

- Any theoretical strengths or shortcomings of using land price differentials between zones in determining the sufficiency of "development capacity".
- The practicality of using land price differentials with regard to the current resource management framework.
- How to separate the impact of the availability of transport infrastructure on land price differentials from the impact of planning rules.
- Whether price differentials can be used to reveal where planning changes should occur, including relevant international experiences.

Our clients were most interested in how a system might work in major cities and were also mindful of two distinct spatial cases:

- The fringe of the city between residentially-zoned and rurally-zoned land.
- Between suburban residential zones with different planning rules.

This paper reports initial scoping analysis on how land prices can inform development capacity so district and regional planning can evaluate the needs of urban areas and respond appropriately.

Key Points

Surging land prices suggest we need to overhaul how we plan our cities

- House prices across many of our cities, but particularly Auckland, are sharply higher, reducing affordability and limiting economic growth.
- The current episode of price rises has shown the current approach to planning land supply just isn't flexible enough to encourage the supply of developable land in a timely fashion – especially when surges in demand are experienced unequally across our cities.
- One reason could be the limited consideration of economic signals, such as the land prices or the available quantity of developable land, to shape land use regulation and the release of land for residential use.
- When land use plans are set made for many decades and at regular intervals, without a nimble planning process, the economic and demographic landscape can change rapidly between plans. Planning can end up playing catch-up and quickly get behind the curve.

A multi-disciplinary approach that uses price signals could help

- Current land use regulation practices could benefit from a stronger economic focus on the costs of regulation and how both households and developers respond to incentives.
- A multi-disciplinary approach that complements planning with a response to market signals such as land prices, could help by identifying areas where regulations could be eased to improve efficiency of land use.
- Stronger focus on monitoring and understanding incentives to manage the inventory of land *within* the urban growth boundary is likely to also help since this stock indirectly influences land prices and the cost of housing.

Differences in land prices can signal tight land use regulation

- Land use regulation comes with benefits, including environmental amenities to residents such as mitigating industrial pollution and providing open spaces, and costs that manifest elevated land and then house prices.
- Cheshire and Sheppard (2005) argue that *price premiums* show shortages in land supply for particular land uses at particular locations. So allowing land regulation and zoning decisions to respond to these price signals is likely to increase efficiency.
- Our exploratory work shows how three empirical strategies can use differences in land prices to filter out amenities and transport connections to indicate areas where land use regulation is particularly restrictive.
- Relaxing these land use regulations identified by land price differentials, or even how these regulations are interpreted and enforced, would help build a more flexible and responsive housing market at the city level.

A range of factors drive demand for living in specific locations

- Local amenities can drive demand for living at specific locations across the city and connections to transport matter. Different analytical strategies can help identify some of these impacts.
- But isolating the impact of land use regulations is not straightforward: expectations of future price growth, the location of schools, migration shocks, and the history of regulation and transport connections all matter.
- Since changes in demand are likely to be most stark across land uses, such as industrial and residential, inefficient land use regulation is likely to be easier to identify across zones than within zones such as residential areas.

We recommend first establishing a monitoring framework

- The evidence base on the impact of land use regulation at the local level is not as well developed in New Zealand as elsewhere.
- As a first step, we recommend regularly monitoring land price differentials, perhaps on an annual basis, and using econometrics to disentangle the relative effects of amenity value, transport connectivity and regulation.
- Publishing results would help decision-makers understand what land prices tell us, where land use regulation is and is not working and where land use regulation could be relaxed.

How the rural-urban boundary is managed could be developed

- Existing research shows large price differentials at the rural-urban boundary that are a function of the stock of developable land inside the boundary.
- Better management of development-ready land at the urban boundary under what Knaap and Hoskins (2001) describe as *event-driven* rather than *time-driven* land inventory management, is likely to help.
- Rather than extending the rural-urban boundary at set times, an event-driven approach periods triggers an extension of the boundary when development-ready land *inside* the boundary falls below a trigger level.
- 'Development-ready' land would need to include a buffer for landowners that are not willing to develop at market prices.
- Such an approach requires more monitoring of available land, and would require coordination with infrastructure provision, but is less reliant on forecast of future growth and likely to produce better outcomes.

Don't expect large gains from incremental change

- When land prices are high and pushing up house prices, delays in consent and building processes mean it takes at least 5 years to alleviate pressure.
- Although identifying and integrating prices to assess land use regulation across suburbs will improve regulation, nudging the consent process is unlikely to produce material changes to the flexibility of housing markets.

Table 1 Recommendations

	Recommendation	Description
1.	Establish land price monitoring framework	• Set up monitoring of land prices across spatial areas with different land use regulations. • Use hedonic pricing models to allow for amenity and transport connectivity. • Results could be formally published on three-year reporting basis to coincide with three year valuation cycles complemented with regular in-house annual updates.
2.	Use land price differentials to signal where regulation could be relaxed	• Over time, identify local areas – within residential zones – where land use regulation drives land price differentials above a trigger point. • Price differentials could be used a signal that there is a need to look at relaxing controls – including both within the Metropolitan Urban Limit and zoning more land at the city edge.
3.	Consider event-based inventory management to manage the rural-urban boundary	• Consider moving from a time-based inventory control system to an event-based system for managing the urban growth limit. • Conduct further research on the appropriate inventory reorder trigger for land within the rural-urban boundary. That point could be a price-trigger or a quantity trigger based on: (i) lead time inventory, that accommodates growth between deciding to expand the boundary and when additional land is development ready (ii) safety stock inventory, for when growth is faster than expected (iii) market factor inventory, to prevent land owners exercising market power. • Moving to an event-based approach would require assessing how to coordinate with infrastructure provision and the extent to which finance can be raised quickly.

Source: NZIER

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1. Introduction

Only rarely does our current urban planning system take an economic approach and use price information to make decisions on land use regulation. This suggests an opportunity to improve outcomes by taking closer look at relative land prices across the city.

1.1. Our current approach to land regulation

Right now land use zoning that regulates minimum lot sizes, minimum size standards on bedrooms and verandas and limits on maximum building heights are restricting the effective land supply in our cities.

These zoning decisions have their origins in an approach to planning that is characterised by a long history of making zoning and land supply decisions (that have their origins in The Town and Country Act (1977) and earlier legislation) based on demographic forecasts of population growth and sometimes household formation.[1]

The Resource Management Act (1991) (RMA) was to be a key element governing urban planning and intended to recast zoning within an effects-based system that permitted activities that did not materially impact on the environment.

Instead, the focus of the economic elements of the RMA has been with regard to environmental protection beyond the urban system. The RMA was set up to:

- avoid any adverse effect on the environment
- manage development and land use effects
- boost efficiency in the use of natural and physical resources
- improve the environment's quality
- prevent natural hazards
- control the subdivision of land
- control the emission of noise
- maintain amenity values.

In practice the RMA has been characterised by local government decision making premised on zoning decisions that avoid environmental or amenity impacts, and which tend to limit the economic value from development. Clough (1994) characterised the legislation as the following:

> *"Area delimitation or zoning is a common land use tool. The Resource Management Act changes the basis for zoning, from one of prescribing activities to one of proscribing effects, but it does not necessitate the abolition of zoning."*

[1] The New Zealand Productivity Commission (2015a) provides a summary of the history of urban planning in New Zealand.

Over time, rule making based on the RMA has become increasingly fraught, complex and limiting towards development. Perkins and Thorns (2001) note:

> *"Far from becoming more certain as was hoped for by the authors of the Resource Management Act, with its intrinsic faith in ecological science's ability to provide guidelines and measurement devices, the strategic planning provisions of the Local Government Act have meant that decision making has, in fact, become more ambiguous and uncertain and more open to differing interpretations and thus possibilities for challenge and objection."*

Our current approach to land regulation inhibits land supply, increases the cost of land and is driving up the cost of housing in many areas of New Zealand but particularly Auckland (see New Zealand Productivity Commission 2012 and 2015).In practice the current legislation has proved fraught and not easily amenable to dealing with urban development. The Ministry for the Environment (2010) describes the situation as follows:

> *"However, the environmental effects-based nature of the RMA, as the primary land-use planning legislation, does not easily allow this. In an urban context, the RMA has limited capacity to adequately consider the value created by urban development and good urban design compared to what already exists, or to support positive impacts of development on the built environment, beyond effects on amenity values."*

Alternative models of planning hold the promise of improved outcomes. Geoff Cooper (2014), then chief Economist at Auckland Council suggests:

> *"Improving housing affordability and creating greater housing choice require radically new models of planning. Reduced regulations could be exchanged for greater local amenity, improved levels of service, financial compensation or some combination."*

So it is worth scoping a possibility for improving land use regulation.[2]

1.2. An opportunity

A different approach to land use regulation is to more explicitly include information on economic efficiency – such as the price of land and housing – to improve the efficiency of land use regulation decisions such as zoning within an urban setting.[3]

Cheshire and Sheppard (2005) and Cheshire (2006) make the case for a particular improvement – using differences in land prices across adjacent land parcels to help

[2] Here we focus on the opportunity from making more of land price differentials. Other opportunities for improving our planning frameworks include for example, collaborating across local councils and looking at international examples of best practice. These other opportunities are out of scope of our brief.

[3] Notwithstanding section 7(c) of the Resource Management Act (1991) refers to "…regard to: the efficient use and development of natural and physical resources..."

set zoning decisions. Cheshire and Sheppard (2005) note a similar absence of economics within the UK planning system:

> *"The system decides the physical quantity of land to be made available for any given use but market forces then allocate such land to competing bidders."*

They note that since demand for urban uses (distinguishing between commercial, residential, industrial and agricultural uses) changes, price discontinuities can arise where zoning is inflexible and doesn't respond to changing demands.

They argue that *price premiums* show shortages in land supply for particular land uses at particular locations. An even stronger case can be made when changes in land price differentials coincide with known changes in land use regulations. Allowing land regulation and zoning decisions to respond to these price signals is likely to increase efficiency.

Their proposal can be viewed as a specific example of how expanding urban planning into a multi-disciplinary approach that more explicitly includes economics.

Writing in 2005, they note that UK house prices have been much higher and more volatile than would be the case under a more transparent planning process based on responding to differences in the price of land.

1.3. International evidence

Cheshire and Sheppard (2005) show pronounced *land price discontinuities* or differences in land prices across adjacent land parcels. They use the particular example of Reading to show effective premiums that arise from inappropriate zoning relative to demand. They don't hold back and conclude:

> *"Over time controlling land supply by fiat has generated price distortions on a par with those observed in Soviet bloc countries during the 1970s and 1980s."*

The US literature also suggests the existence of material land price discontinuities from land use regulation (see for example, Glaeser and Gyourko 2003, Malpezzi 1996, Ihlandfeldt 2004, Quigley and Rosenthal 2005, Turner et al 2014).

The US experience tends to be heterogeneous with land use regulation particularly stringent for some states and city areas and consequently there are large impacts on land and house prices (see Glaeser and Ward 2009 who document impacts of land use regulation for Boston, Quigley and Raphael 2005 for the case of California and Kok et al 2014 for the case of San Francisco). But precise policy prescriptions of what to do are less forthcoming (see Ihlanfeldt 2004 for discussion).

Within New Zealand, Grimes and Liang (2009) show how Auckland's metropolitan urban limit has driven up land and thus house prices within Auckland. Other reports (see for example, Lees 2014 and 2015 and the New Zealand Productivity Commission

2012 and 2015) clearly show how land use regulation is driving up house prices in New Zealand.

Perhaps this is not so surprising, given the absence of economic planning consideration in earlier district plans required under the Resource Management Act. As Perkins and Thorns (2001) note:

> *"Consistent with the Resource Management Act's sustainable management ethos, the local authorities we studied have all emphasised biophysical environmental issues in their district plans… With only one notable exception, Manukau City, social and economic planning considerations have been largely relegated to the margins of these plans, if they have been considered at all. "*

International literature suggests heterogeneous land use regulation can manifest through land price differentials when demand for land changes. The current experience of soaring house prices in Auckland city suggests insufficient flexibility in our planning system to cope with exogenous shocks. Within that context it is worth scoping whether embedding a greater role for land price differentials could improve the efficiency of land use regulation and make land supply more flexible and responsive to changes in demand.

2. How land regulation drives differences in land prices

Differences in land prices can arise from four main sources: (i) productivity of firms in the local area; (ii) amenities that make some locations more attractive than others to live; (iii) transport connectivity that shift the accessibility of particular locations and (iv) land use regulation that restricts activity in particular locations. We show how land price differences develop across different land uses and within a specific land use – residential in particular.

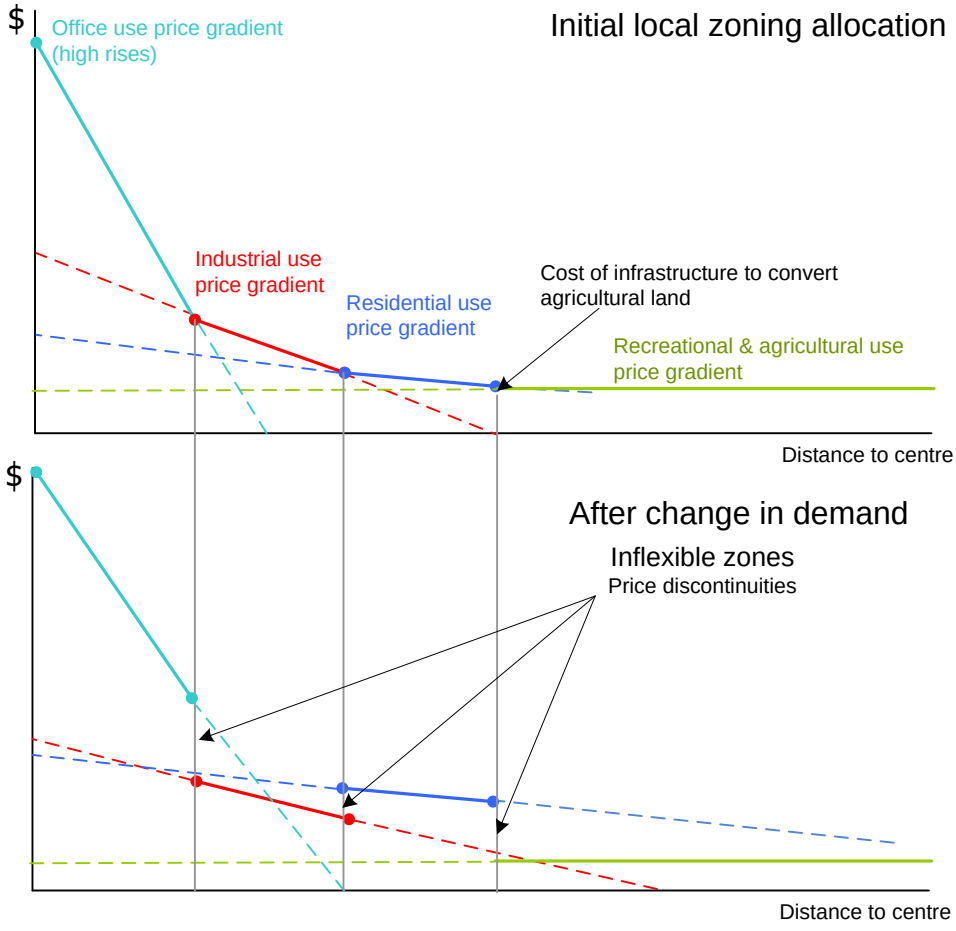
2.1. Land price differences at the city limit

How discontinuities can develop at land use boundaries

Cheshire and Sheppard (2005) note the UK planning process is based on the 1947 Town Planning Act that sets up the planning problem as separating different zones for land use activity. But when demand changes, price discontinuities can occur between zones of economic activities. Figure 1 shows an example.

Figure 1 Changing demand for land generate local price differences

Price gradients of land prices across the city before a shift up in demand for residential land



Source: Adapted from Cheshire and Sheppard (2005)

When demand for residential land changes under a fixed supply of land, potential residents bid up the price of land. This drives a discontinuity or difference in the price of land at the boundaries of residential land and other land uses.

These discontinuities indicate an inefficient allocation of land resources (assuming the initial local zoning allocation was efficient). The marginal benefits of additional residential land will be greater than the marginal costs of providing additional land. That means that the highest and best use of the land, maximising social benefits from open spaces for example, and taking into account externalities such as pollution, will not be met.

An alternative approach to managing growth at the city limit

The example in Figure 1 is based on a simple model with four land use activities – office use, industrial, residential and agricultural. Unless local planners can correctly guess how to bring on sufficient land to meet demand for each land use, discontinuities appear at the boundaries between activities.

Knaap and Hoskins (2001) describe the approach to urban growth boundaries in Oregon, where each city within the state must have an urban limit between urban and non-urban use that contains enough land for 20 years of growth that is reviewed at fixed periods that vary across cities between 4 and 7 years. That is, the system of land inventory control is a *time-driven* system, where the line is redrawn at fixed time periods to maintain 20 years of growth.

As an alternative, Knaap and Hopkins (2001) describe an *event-driven* system, where the urban boundary is expanded not at predefined times, but rather, when the stock of developable land with the urban boundary falls to a certain level.

Both systems come with their own pros and cons. An event-driven system requires carefully monitoring the stock of existing developable land within the urban limit. And under an event-driven system, the timing of future expansions is uncertain. The impact on industrial and agricultural land uses would also need to be mapped out.

But in an event-driven system, the stock of available land for building houses never falls below a set level. Knaap and Hoskins (2001) argue this is more important for house prices and the range of choices potential home buyers are confronted with.

The event-driven system requires setting a trigger level for when the level of land within the urban growth limit triggers a shift in the urban boundary. Even where urban growth boundaries may be an optimal or second-best response to unpriced externalities, their operation may cause negative welfare consequences.

Knaap and Hoskins (2001) contrast an optimal inventory management approach to urban growth boundaries with actual management approaches. Typically, revisions to urban growth boundaries are made at discrete points of time (e.g. every 10 years).

Knaap and Hoskins show that this approach is inflexible in the face of unanticipated economic and demographic developments such as large and rapid changes in net

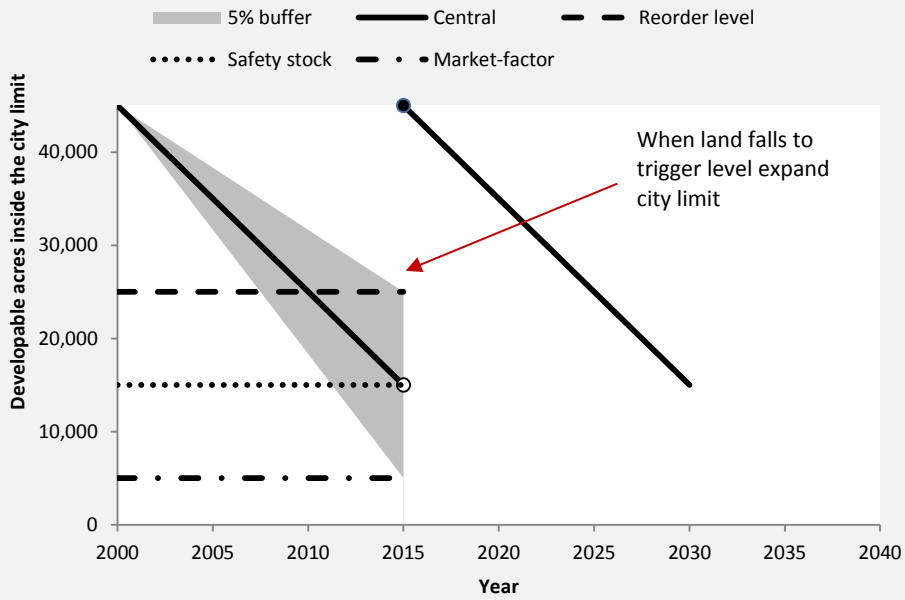
immigration. Instead, boundaries need to be revised on a continuous basis reacting to the available supply and price of vacant land.

In particular, boundaries require expansion once the price of land within the boundary relative to an external benchmark rises past some critical threshold. Their analysis places the issue of discrete boundary effects for land values at centre-stage in analysing the effects and efficiency of a growth limit. Box A explores their event-driven inventory approach in more detail.

Box A: How event-driven urban growth boundaries work

Knaap and Hoskins – two planners – advocate using event-based land control that is triggered when the inventory of development ready land falls below a certain threshold instead of using time-based inventory control with pre-specified timing. Figure 2 shows how event-based control might work in practice.

Figure 2 Event-based land control is triggered on inventory levels



Source: Knaap and Hoskins (2001)

Knaap and Hoskins (2001) suggest thinking about the trigger has three components:

- *Lead-time inventory* – the amount of land required to accommodate expected growth between taking the decision to expand the urban growth boundary and the time it takes to get land development ready.
- *Safety-stock inventory* – a buffer if land grows faster than expected between deciding to expand the urban limit and when additional land is ready.
- *Market-factor inventory* – a stock of land required to prevent landowners holding out and exercising market power when land supply is low.

Setting the inventory level of developable acres that triggers resetting the urban growth boundary then requires assessing each of the three components with regard to trade-offs between the infrastructure costs of making land available and the detrimental impacts of a lack of land development capacity, such as high house prices, higher commuting times and urban structure that restricts productivity (see Desmet and Rossi-Hansberg 2013).

Managing Auckland's urban limit

Auckland Council describes the current approach to the rural urban boundary as a line which defines the proposed extent of urban growth until 2041. The 2010 Metropolitan Urban Limit boundary is described as a reference point for future growth that will fall inside or outside this line.

Right now Auckland Council intends that up to 40 percent of development by 2042 occurs outside the 2010 limit and up to 70 percent of development occurs within the 2010 limit. The Future Urban Zone land lays out which tracts of land will come on stream in five year chunks over the next thirty years – consistent with the time-driven inventory system not the event-driven system.

2.2. Within residential zones

But land price differentials can exist within residential zones too. Land use restrictions limit density, increasing the price of land across the city and can take many forms including restrictions on:

- the maximum height of residential buildings
- the height of residential buildings relative to the boundary of the property
- maximum coverage of the property with residential buildings
- minimum parking spaces to be provided
- heritage protection that limits redevelopment of the existing housing stock
- street frontage rules that limit where a building sits on a property.

And land use regulations are not evenly applied across Auckland. For example, Table 2 shows how variable maximum height restrictions are in Auckland's local centres.

Kulish, Richards and Gillitzer (2012) show how height and density restrictions distort urban structure.[4] Height restrictions limit the number of people that can live on well-located land close to the city centre. Land prices in these central locations are then *lower* than they would be since developers cannot reap the benefit of accommodating more residents close to the city.

But these residents that cannot be accommodated in the centre city are pushed out, demanding more land in the central city suburbs, lifting land and house prices further out from the city. This is one of the central themes of the Alonso-Muth-Mills model Kulish, Richards and Gillitzer (2012) use to describe urban development.

[4] They use the Alonso, Muth, Mills model, a highly stylised model that has been applied in a range of contexts.

Table 2 Height restrictions vary across Auckland centres

Maximum height restrictions for selected local centres

Suburb	Height restriction	Proposed restriction under PAUP	Other restrictions
Albany	Unlimited (in parts)	72.5m (18 storeys)	None.
Devonport	9m	12.5m (3 storeys)	Subject to special rules including the blanket height sensitive overlay (8m).
Manukau	Unlimited (in parts)	72.5m (18 storeys)	None.
Newmarket	33m (9 storeys)	32.5m (8 storeys)	Subject to special rules including volcanic viewshaft height sensitive areas and special character overlays.
Parnell	12.5m	12.5m (3 storeys)	Subject to special rules including special character overlay.
Remuera	12.5m	16.5m (4 storeys)	None.
Royal Oak	12.5m	24.5m (6 storeys)	Subject to special rules including volcanic viewshaft height sensitive areas overlay.

Source: Auckland Council (2013)

Kulish, Richards and Gillitzer (2012) also show that when a single block of land is exempted from existing land use regulations, the value to the developer of that exemption, capitalised into the value of land, can be large. They note that developers are incentivised to lobby hard for rezoning of specific blocks of land to reap higher returns.

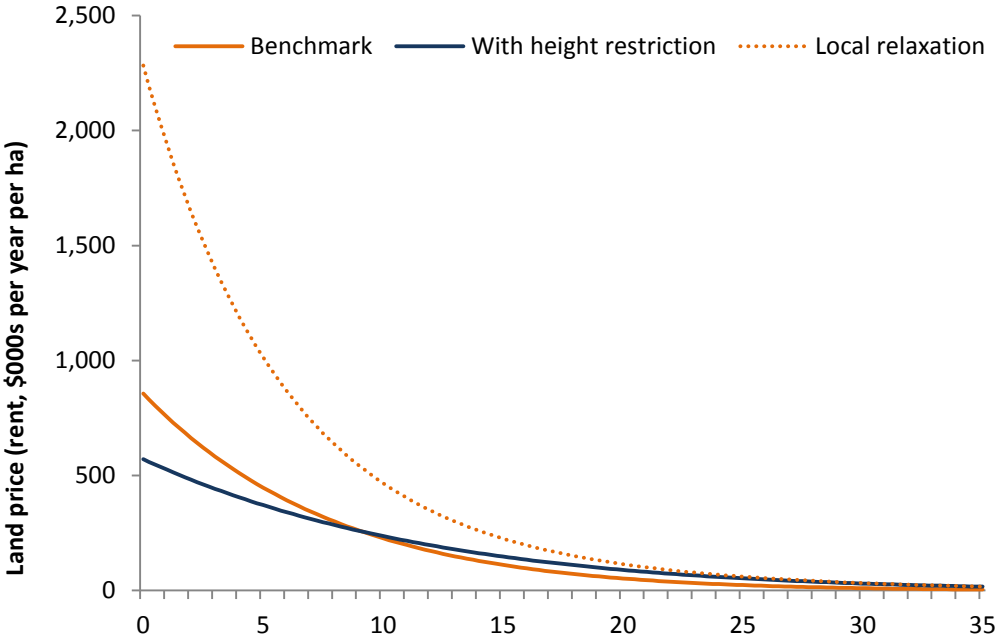
Figure 3 shows three cases: (i) the benchmark price of land under no land use restrictions; (ii) the price of land under a city-wide building height restriction; and (iii) the price of land when the height restriction is lifted for a single location only.

Since residents prefer to live close to their workplace in the city centre, under the benchmark case with no restrictions, the price of land falls at housing locations progressively further away from the city centre. When regulation such as a height restriction applies, land prices close to the city centre are *lower* than the benchmark case since developers are restricted from making the most of the available land to house more residents by building up. These residents must be accommodated further out from the city centre, driving up land prices in the outer suburbs.

Crucially, when developers are able to obtain a local relaxing of the land use regulation, land prices are significantly higher since developers benefit from facing higher demand that cannot be accommodated at neighbouring locations. Moreover, differences in land prices between the restricted and unrestricted case vary and are dependent on distance to the city centre. That makes identifying local impacts challenging.

Figure 3 Height and density restrictions can produce discontinuities

Land prices using the Alonso, Muth, Mills model



Source: NZIER (2014)

2.3. What about amenities and transport?

The Alonso-Muth-Mills model (AMM) is stark – no room for parks, no room for traffic congestion. But Homans and Marshall (2008) introduce a greenbelt into the AMM model and show the location of amenity, such as a park, generates changes in the land price gradient. Moreover, the relative change in land prices depends on whether the park is located with the city limits or on the boundary of the city.

But several researchers find that both amenities and transport connectivity matter for land prices, confirming the insight from simple theoretical models like Homans and Marshall (2008).

Much of this literature relies on hedonic models of housing prices (see for example, Griliches 1971 and Rosen 1974) that seek to disentangle the key drivers using large datasets on house sales.[5]

This literature tends to find moderate impacts of transport infrastructure on house prices. For example, Boucq and Papon (2008) use house sales data (1993-2004) from the Hauts-de-Seine department, that spans most of the western inner suburbs of Paris. They use accessibility improvements to a specific T2 tramway to find home values capture these benefits at about 3 percent of the capitalisation of the house.

[5] Other researchers take an approach that relies on aggregate data to define amenity values across rather than within cities. Albouy (2015) notes distinct differences in US cities with the most valuable cities typically being coastal, sunny, mild, educated, and large. San Francisco tops the list.

Other examples include Chernobai, Reibel and Carney (2011) who use 11 years of house sales data near a new motorway extension in Los Angeles and find non-linear spatial impacts from transport infrastructure. Land prices fall near the motorway, rise a moderate distance from the motorway and then decline. Over time, these land price differentials appear to decline.

Coleman (2010) and Frost and Dingle (1995) show how transport can have long-lived impacts. Path dependencies develop such that the urban structure of a city today is largely dependent on the transport infrastructure of the past. Grimes and Young (2013) show that these issues matter for Auckland. They use the example of upgrades to Auckland's Western Line rail service to show improvements in rail services are capitalised into housing values.

So although land use regulation can generate land price differentials, so can amenities and transport connectivity. We need a strategy to disentangle the impacts.

3. Empirical strategies

To distinguish between the key drivers of differentials in land prices we show how three different strategies (i) a naïve strategy; (ii) a sophisticated strategy; and (iii) a focussed strategy can be used to establish the contribution of amenities, access to transport and land use regulation to relative land prices.

3.1. A naïve strategy

Testing at the city limit

As a first step, it makes sense to examine relative land prices without adjusting for amenity values or other factors as a first step.

Grimes and Liang (2009) provide an extensive test of land price differentials at the city limit for Auckland. They show large differences in land prices close to the urban-rural boundary. Table 3 summarises the raw land price differentials they find using land values from Quotable Value at the meshblock level.

Table 3 There are large land price differentials at the city limit

Real per hectare land values relative to same year real per hectare land values in Hamilton and Wellington

Location of land parcels	1992	2003	Number of observations	% Change 1992-2003
Land in core city	3.933	6.268	6524	59
Land in core, close to limit	1.782	**2.520**	281	41
Land on the boundary	0.923	1.413	183	53
Land immediately outside limit	0.125	**0.216**	92	73
Land close to outside limit	0.132	0.183	77	39
All other land outside limit	0.434	0.595	883	37
Total	3.325	5.276	8,040	59

Source: Grimes and Liang (2009)

If we ignore land parcels where the city limit runs through the meshblock, then we find clear land price differentials at the rural-urban boundary of about 11.7=2.520/0.216 in 2003.[6] At least at first glance, there is a strong case to further

[6] This finding is perhaps not unexpected. Unless changes in land supply precisely match the growth in the relative demand for urban land then we expect a land price differential to exist between zones.

evaluate land price differentials at the city limit – the border between residential and agricultural activity.

Testing for discontinuities within city limits

That simple test – mapping land value across areas where land use regulation differs can be extended to look at land within city limits. That could include for example:

i. areas subject to volcanic viewshaft overlays, that protect the view of Auckland's volcanic cones by establishing maximum building heights and preventing buildings rising in a volcanic viewshaft
ii. areas subject to a variety of height restrictions across the city
iii. areas subject to heritage building protection that limits changes to the existing building stock.

But land use regulations are wide ranging and can also include minimum lot sizes within local suburbs, maximum building coverage of existing sites, minimum balcony and yard sizes and restrictions on the height of a dwelling in relation to the property boundary, that all act to restrict density within suburbs.

Moreover, the boundaries for each regulation often overlap. For example, Parnell, which is subject to maximum height restrictions of 12.5 metres is also subject to a special character overlay that restricts development. Maximum heights in Ponsonby range from 8 to 12.5m where a special character overlay is also in place. In Mt Albert height restrictions vary from 10 to 12.5 to 15 metres but some locations are subject to volcanic viewshafts that also restrict development.

In principle, we could test for the impact of each individual piece of land use regulation. For example, we could isolate the land areas subject to volcanic viewshaft overlays. Rather than take this detailed approach (that is time prohibitive within this scoping exercise but not for a systematic review) here we instead take areas defined by local area boards.[7]

Local area boards are elected to undertake a range of responsibilities at the local level that include developing bylaws and developing local board plans that provide input into the regional strategies and plans of Auckland Council.

These boards form the most granular political organisation responsible for local land use regulations. If local residents are motivated to organise local land use regulation to protect home values (see Fischel 1985, 2005) then we expect to see differences in land use regulation and land value across local boards that arise from local board influence on the land use regulation process.

[7] Understanding the impact of a substantive piece of land use regulation is likely to be feasible within existing Auckland Council resources. A solid understanding of impacts across the full suite of regulations could be developed through a sequence of projects that could be conducted either internally, with external resources, or some combination of the two.

Local area boards can also be large and powerful – the Albert-Eden local board alone contains 94,695 residents. Local boards also monitor a local board agreement for the delivery and funding of services in the local area.

Data

To test that hypothesis, we use a detailed set of sales data from Auckland Council's District Valuation Roll from 2011 to 2014.[8] The data is maintained by Auckland Council to help improve ratings valuations that take place every three years according to the rules and regulations provided by Land Information New Zealand.

The data contains coordinate information provided by Nunns, Hitchins and Balderston (2015) and we can label each house sale location according to the local area board and area unit (suburb) (Nunns, Hitchins and Balderston 2015).

As a first step, we use the land area information and land value associated with each property to calculate land value per square metre and check for any land price discontinuities across the city.

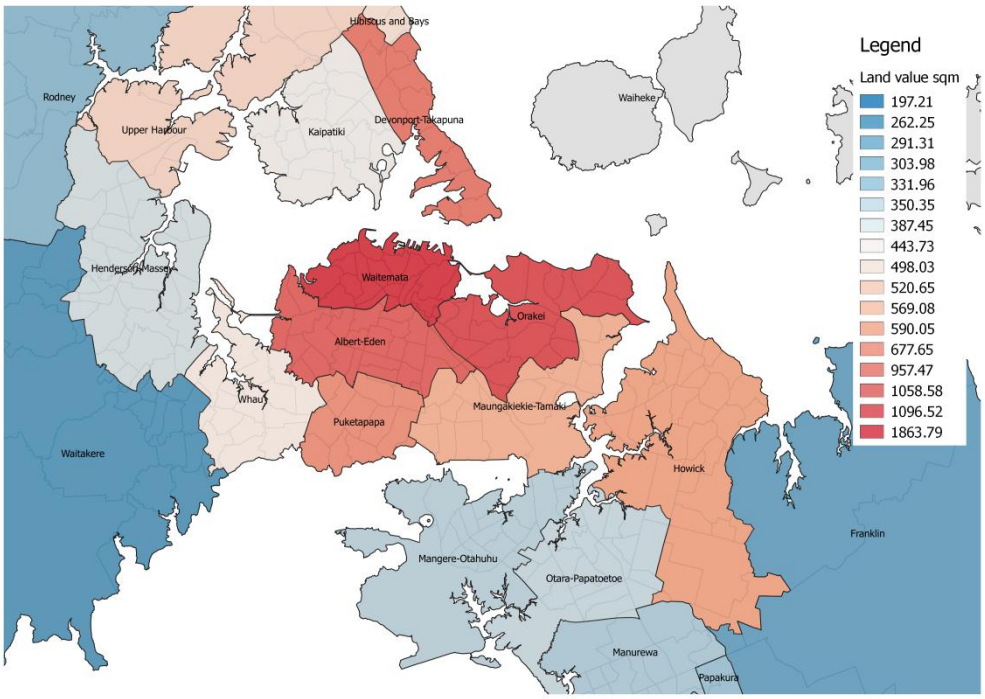
To maintain like-for-like comparisons across the city we restrict our estimates to land values for houses with positive land values up to $10,000 per square metre. That leaves 69,402 observations and we choose to map the 15,128 house sales from 2014.

Our data spans the population of house sales. Since our focus is on land values it would be possible to conduct a similar exercise that includes the stock based on valuation data. Figure 3 shows that there are large variations in land prices by local area boards.

[8] Nunns, Hitchins and Balderston (2015) notes the dataset was obtained in December 2014 and excludes some sales data from December 2014.

Figure 4 Large land price discontinuities appear by local area board

Land price discontinuities by local board (land value per square metre, 2014)



Source: NZIER

Testing for the significance of discontinuities

We would like to know whether the variation is significant or just random. We can use a simple *t*-test for the difference in the mean of land prices across local board areas to test for the significance of any difference in land prices.

Table 4 shows the results of testing for differences in land prices between three local area boards and the rest of Auckland. The table shows that even for the case of Howick, where land values are only a little over 4 percent higher than the rest of Auckland, our test suggests a significant difference in land prices.

Table 4 Land price differentials across area boards are significant

t-tests of per sq. metre land prices at the local area board level compared with the rest of Auckland

Local Area Board	Number of sales	Mean Local area board	Mean Rest of Auckland	*t*-stat	Critical value	Conclusion
Albert-Eden	845	1058.58	540.09	34.583†	1.962	Different
Devonport-Takapuna	472	957.47	556.55	14.996†	1.965	Different
Howick	1,630	590.05	566.42	3.3373†	1.961	Different

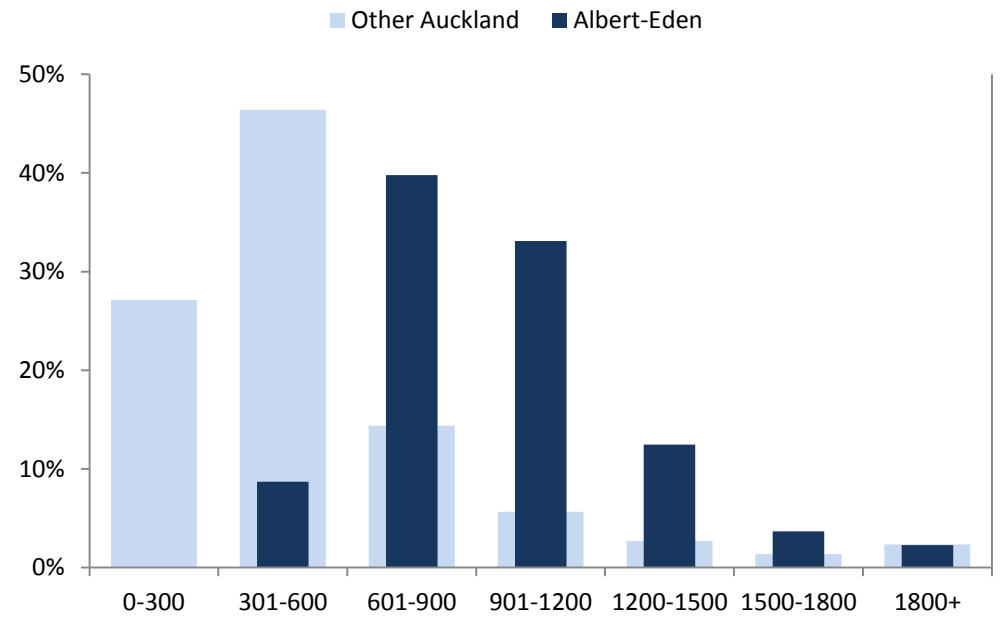
NB. † denotes significance at the 1% level, 'rest of Auckland' is defined by dropping house sales from within each Local Area Board in the left-most column of the table from the dataset.

Source: NZIER

One question is whether the quality of the dataset is sufficiently robust to conduct out analysis. Land price differences could be driven by a handful of high value house sales. Figure 5 shows that this is not the case and that the entire distribution of land prices within our house sales dataset in Albert-Eden is materially different to the rest of Auckland.

Figure 5 Albert-Eden land is mostly higher than the rest of Auckland

Distribution of land prices per square metre by property based on 2014 house sales

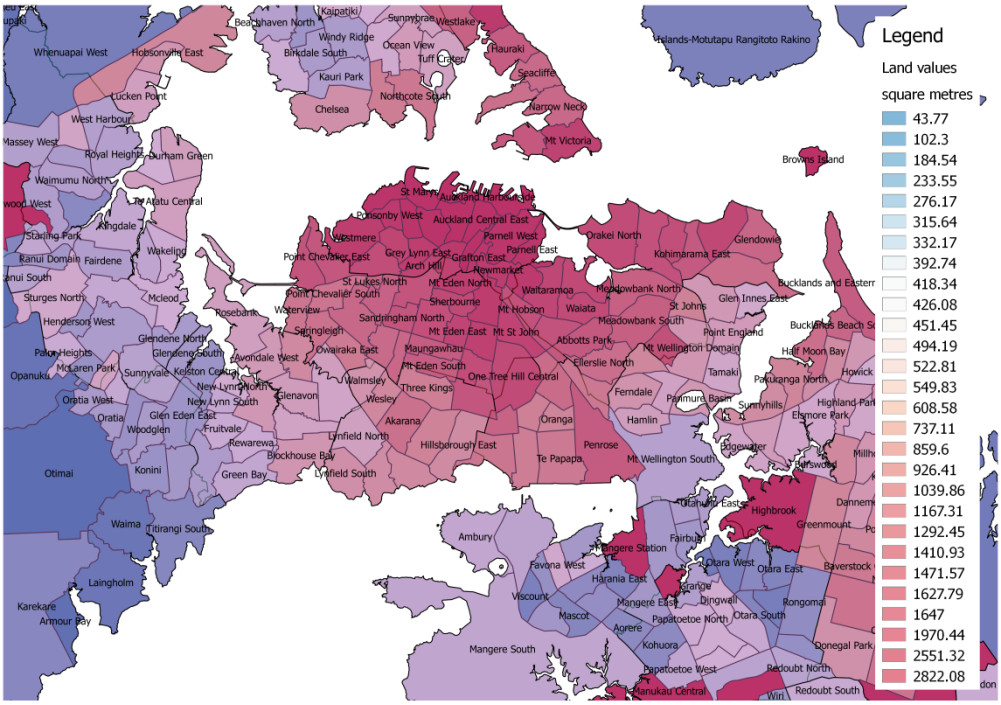


Source: NZIER

Of course, a method for evaluating land price differentials is not restricted to looking at local area boards. We can use the method to look at a range of land use regulations, for example, where height restrictions are material or land is subject to volcanic viewshafts. Figure 6 shows an alternative take on our data, this time showing that land price differentials persist at the suburb level.

Figure 6 Large land price discontinuities apparent by suburb

Land price discontinuities by local board (land value per square metre, 2014)



Source: NZIER

3.2. A sophisticated approach

Testing at the city limit

Grimes and Liang (2009) use detailed spatial hedonic methods that filter out a range of demand factors including views, and amenities and infrastructure. Their key finding is that once these factors are accounted for the price of land just inside the rural-urban boundary is 10 times higher than land just outside the rural-urban boundary.

We interpret this as clear evidence of a substantial land price differential *between* land use zones that arises from a shift in the demand for residential land not met by a land supply system sufficiently flexible to meet these changes in demand. One question that arises is what the trigger point should be reaching the conclusion that there is a substantial land price differential. We think a magnitude of ten clearly passes the threshold.

But perhaps a better way of couching that analysis is in terms of the Knaap and Hoskins (2001) analysis – what should be the inventory level of land within inside the urban boundary that triggers an extension to the rural-urban boundary?

Although a sophisticated approach strips out amenity values and other factors, financing the infrastructure that comes with any extension to the rural-urban boundary would require a cost-benefit analysis. Our prior is that at a magnitude of 10

the benefits of relaxing land use restrictions outweigh the costs. Others (see the New Zealand Productivity Commission 2012, 2015 for example) have reached a similar conclusion.

Testing for discontinuities within city limits

To take account of location and amenities we use a dataset that allows for amenity values and transport. To capture a wider array of potential amenities and better proxies for transport connectivity (for example, distance to rail stations and distance to bus stops) other richer datasets would be required.[9]

Instead our analysis is indicative and designed to show the substantive econometric issues required to take account of amenity value and connectedness.

The data also contains a rich set of information on aspects of the house used for mass property appraisal techniques that includes:

- the date when the property was sold
- the gross sale price including chattels
- land use information, including whether the property is zoned residential, industrial or commercial
- information on the actual land use of the property
- number of units on the property
- number of off-street carparks
- data on the estimated decade of construction
- condition of the primary buildings on the property
- land area of the property
- building size (gross floor area) and site coverage, including the total living area, number of decks, workshops and garages
- the view from the dwelling including information on the scope of the view and the nature of the view (water, other or no view)
- the property contour and whether the land has an easy or steep rise or fall.

Several points are worth noting with regard to the data. First, we work with land values rather than house prices. Since we observe a sale of house-land package, land value is already subject through mass appraisal techniques that will attribute some features of location and amenity value to different land values.

[9] Mikelbank (2004) shows how to evaluate the impact of transport improvements and Grimes and Liang (2010) show a New Zealand specific example.

We started with a range of variables and settled on the regression model summarised in Table 5 that uses a spatial regression technique outlined in Box B.[10]

The regression explains over 50 percent of the variation in land value. Distance to the CBD is a significant explanatory factor in land values, indicating that connectivity matters. Moreover, several factors that relate to the amenity value of the location of the property were apparent. The gradient of the ground matters, the number of heritage properties nearby has a positive impact on value and whether the property has a view are significant drivers of land value. At least in our model, distance to the coast was negatively associated with land value. Alternatives might be expected to produce different results. For example Grimes and Yiang (2009) use a logarithmic distribution for distance to the coast and a minimum distance threshold of 0.25 km.

Table 5 Our estimates show amenities help determine land value

Spatial regression results for 15,129 observations from 2014

Variable	Parameter	t-stat	
Constant	6.413	277.382†	Other
Distance to CBD	-0.0140	4.778	Connectivity
Distance to coast	-0.0300	-18.393†	Amenity
Number of pre 1940 heritage buildings in area	0.0146	33.707*	Amenity
Contour (steep =-2, easy gradient =-1,level=0)	0.1250	17.905†	Other
View (water=2, other=1, no view=0)	0.0646	24.772†	Amenity
Rho – spatial dispersion measure	0.1040	61.110*	Other
Adjusted r^2	0.573		

Source: NZIER

With our estimated model that includes amenity and transport in hand we can in principle test for the impact of any particular land use regulation. For example, we can introduce a dummy variable takes a value one for house sales within volcanic viewshafts. The significance of that dummy variable would provide some evidence of land use regulation impacts on land prices.

Within the timeframes available, our work is exploratory rather than definitive. A richer set of variables to capture amenity value, including for example:

- school zones

[10] Sheppard (1999) provides discussion of applying hedonic methods to housing and Irwin and Carrion-Flores (2005) detail how a regression discontinuity approach can be used to identify zoning impacts.

- number of off-street carparks
- quality and location of local shops.

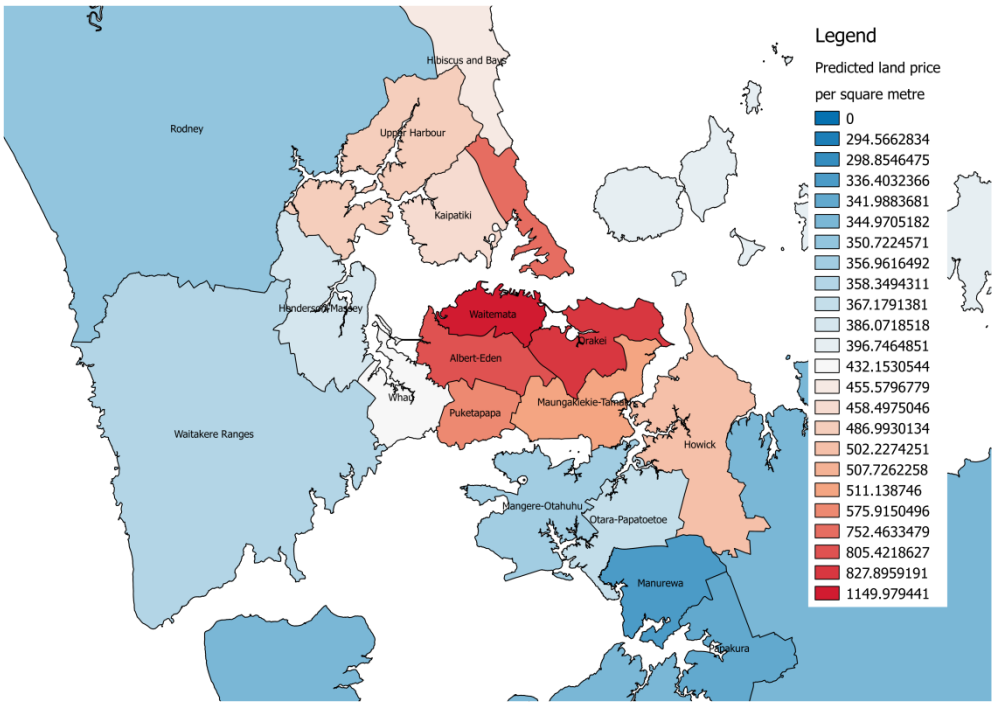
For transport connectivity a second set of variables would also be worth including in a comprehensive study. These variables would include:

- distance to train stations (see Ossokina 2010 for example)
- distance to bus routes (Des Rosiers et al. 2006 provide an example)
- the impact of connectivity to local roads and motorways (see Boarnet and Chalermpong 2003 for a US example)
- walkability of the local region (see Boyle et al. 2014, Torshizian and Grimes 2014 and others who use GPS data to make this assessment and define the local neighbourhood unit).

Figure 7 shows that our regressions that adjust for some amenities and distance to the CBD, narrow the range of land prices across the city. That is, our sophisticated approach filters out many of the amenities and the connectivity to leave relative land price differentials across the city stripped of these effects. Although there are substantial differences across the most extreme local area boards (between Waitemata and Mangere-Otahuhu for example) the land price differentials between local area boards are much smaller than at the rural-urban border.

Figure 7 Our econometric model produces a narrow range

Predicted land values using 2014 house sales according to our econometric model



Source: NZIER

Box B: The spatial estimation technique we use

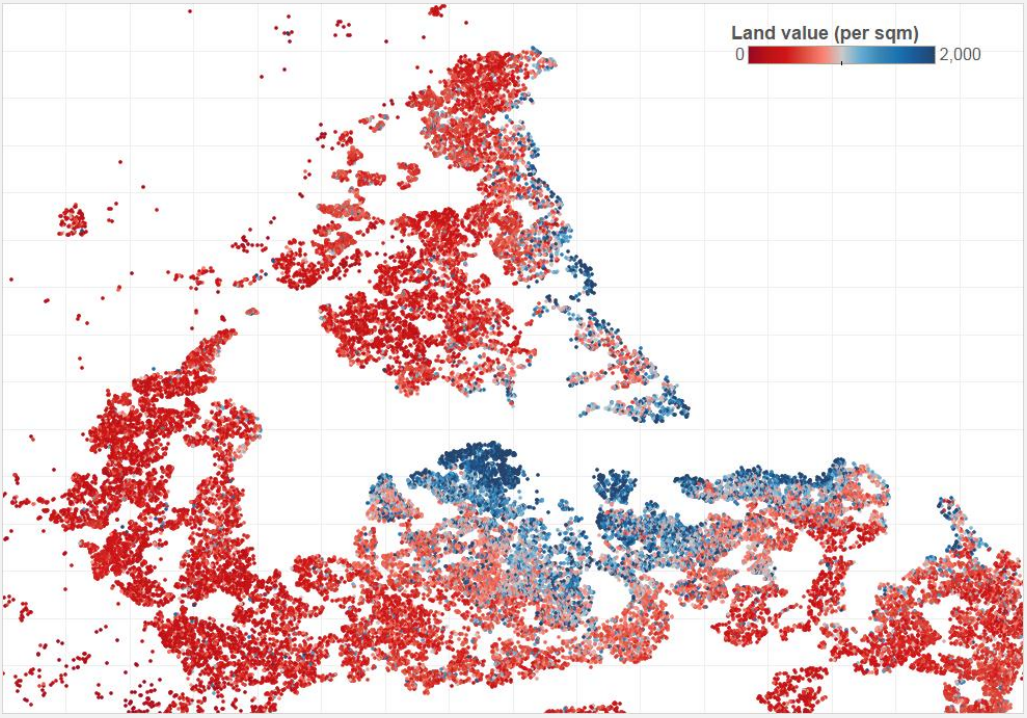
Spatial correlation and spatial dependence

One key feature of our data is the influence of spatial location on land values. In particular our data may be spatially correlated, that is, the land value associated with one house sale may depend on land values associated with nearby house sales.

Our data look like likely candidates for spatial heterogeneity: land values within particular areas such as suburbs or school areas might have different relationships compared to houses outside these areas. Figure 8 illustrates that our sales data show more expensive houses tend to locate on the North Shore or inner suburbs.

Figure 8 Our data shows clear evidence of spatial correlation

Land value per square metre of House sales 2011-2014



Source: Auckland Council

Our approach

To deal with the spatial correlation we set up a *nearest neighbour weight matrix* such that for every house, the nearest twenty house sales are used to summarise any spatial dependence across our data. Our estimation equation then takes the form:

$$y = p'Wy + \beta x + \varepsilon$$

where y is a vector of house sales, p is a selection matrix of ones and zeroes used to select the twenty nearest house sales for each observation, W is a weighting matrix that normalises each row to sum to 1, β is a matrix of coefficients on our explanatory variables x and the error associated with each land value is ε.

Other options for the selection matrix include alternative values (5, 10 or 50, for example) for the number of houses to adjust for spatial correlation or using a distance, such as all house sales within one kilometre to inform the correlation.

3.3. A focussed approach

One problem with our spatial regression is that it does not take precise account of the location and intensity of land use regulation.

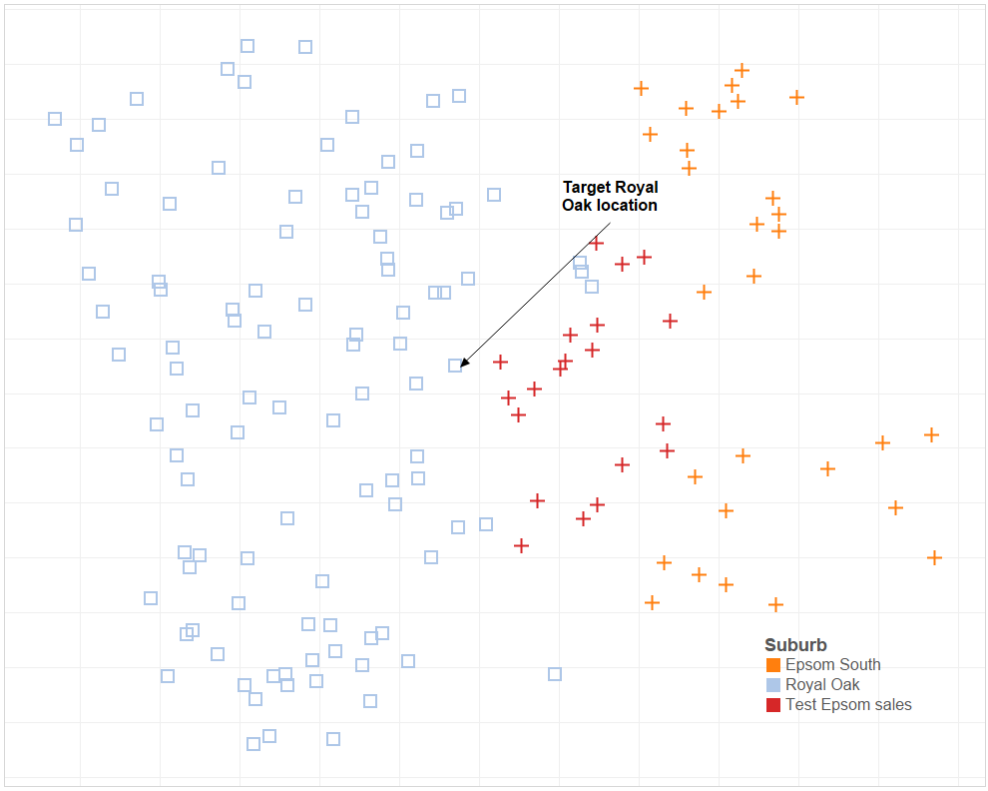
Cheshire and Sheppard (2005) explore a simple alternative – identifying a small number of properties close to the land use regulation border and checking for price differences across different zones. They focus on the case of Reading and examine land prices and distance to the city centre among other variables.

For our illustrative case we look at a handful of 20 house sales within Epsom South that are subject to slightly different land use regulations than the neighbouring suburb of Royal Oak. For example, the local centre in Royal Oak has less stringent height restrictions than other nearby local centres and the mix of local land use regulation is slightly more restrictive.

To test whether we can distinguish differences in regulation we first check whether we can distinguish differences in land prices. As an illustration, Figure 9 shows the location of the 20 house sales in Epsom South closest to Royal Oak, relative to house sales in the neighbouring suburb of Royal Oak and other sales in Epsom South. We select a house sale right on the boundary of Royal Oak and Epsom South and denote the twenty house sales closest to this point with red crosses in Figure 9.

Figure 9 We can test for land price differentials at local boundaries

Scatter plot of house sales between Royal Oak and Epsom South



Source: NZIER

Table 6 shows some of the differences in the characteristics of the three groups of properties. All three sets of house sales show differences in characteristics. For example, the test cases within Epsom South have slightly more heritage properties at the mesh block level and the scope of view is different across the groups. And almost all properties in Epsom South are within the Auckland Grammar Zone but this is not true for properties in Royal Oak. These factors are expected to impact on land values.

For a systematic review, more sophisticated analysis would be required. But in terms of house sales, the average value of each house sale sits between the other Epsom South properties and the Royal Oak properties in terms of value.

Even for this relatively small set of observations, a *t*-test on either the average land value or the average land value adjusted for amenity and distance to the city centre as in Table 5, we would reject the hypothesis that these house sales are from the same distribution – the difference in land values is significant.

How should we interpret this result? It seems a little quick to attribute the difference in land values solely to land use regulation. These differences may be due to a myriad of factors including school zones, the impact of earlier land use restrictions and changes in transport connectivity.

Table 6 Our test cases share some characteristics with neighbours

Characteristics of houses sold in Epsom South, Royal Oak and our test sample

Characteristics	Epsom South	Test cases	Royal Oak
Number of sales	186	20	366
Average number of heritage buildings	14.9	17.9	12.6
Average distance to CBD	4930	5247	5936
Average distance to coast	3149	2818	2161
Average number of off-street parks	2	2.2	1.6
Average view type	1	1	1
Average scope of view	0.5	0.25	0.11
Average garage under main roof	0.62	0.75	0.65
Average of other improvements	0.35	0.2	0.1
Average house sale price	$1,813,400	$1,420,203	$987,543
Average capital price	$1,291,250	$1,160,726	$813,538
Average land price	$868,000	$719,435	$499,331
Average land area	742.35	680.19	531.03
Average land value per square metre	$1169.26	$1057.70	$940.30
Houses in Auckland Grammar Zone	167 (89.8%)	15 (75%)	139 (38%)

Source: NZIER

Of course, this technique of testing land values close to spatial differences in land use regulation can be improved. Using information on the stock of house values would deepen the dataset. Exploring a range of land use restrictions would enhance our stock of knowledge about when and where land use restrictions bind.

Another approach would be to use data on repeat house sales, that is, observations on the sales of the same property at different points in time. Such an approach can be very useful because it adjusts for amenity effects (such as distance to the coast, CBD and other local amenities such as cafes, shops and parks) that are fixed and unlikely to change over time for the same property location (see Grimes and Young 2013, for a New Zealand application).

Relative to the large land price differentials Grimes and Yiang (2009) find across land use zones, the land price differential within zones are much smaller. That means building up a case history of analysis of within zones is likely to be required before moving to implement large policy changes.

Rather than focus on small *relative* price differences between suburbs, monitoring land prices both within and across land use zones is likely to be worthwhile in terms of increasing the efficiency of the land planning system. It may be that some regulations, for example, minimum lot sizes, parking restrictions and height restrictions need to change right across the city. Focussing on local differences in land prices may be useful for identifying specific areas to target, but city-wide interventions are probably required to materially improve flexibility.[11]

[11] Land price differential may vary over the business cycle and with changes in demographics although these effects are likely to be not so problematic for relative price variations across or within land use types.

4. Recommendations

We make three clear recommendations from our exploratory work: (i) establish a framework for ongoing monitoring of land price differentials at the border of land use regulations; (ii) move from a time-based approach to an event-led inventory control of the urban limit; (iii) utilise land price differentials to trigger the stringency criteria that exist in the consent processing framework of some councils.

4.1. Establish ongoing monitoring

Local New Zealand specific knowledge of the impact of land use regulation at the local level is relatively underdeveloped compared to other jurisdictions such as the United States.

Even for the United States, we think Quigley and Rosenthal (2005) have it right:

> "Early efforts to improve and expand research should focus primarily on the deliberate, painstaking development of better, more current data. When better data are available, the existing community of scholars will develop methods providing more reliable tests of hypotheses about the link between regulation and the well-being of housing consumers."

Our first recommendation is to set up a regular reporting framework (perhaps based on detailed formal assessment every three years with annual updates) that evaluates land price differentials across spatial location with different land use regulations. Comparisons across different land uses such as industrial, commercial, residential, agricultural should be prioritised before digging deeper into local suburb level variations unless there have been material changes to land use regulation within the city in which local variation could be very useful.

One direction that is likely to reap reward relative to the exploratory work in this report is testing the impact of transport connectivity via information on access to bus routes, train stations and key roading infrastructure.

4.2. Move to event-led urban growth control

Rather than focussing initially on local land use regulation within suburbs we think more focus on managing urban growth boundaries is likely to be productive.

This is motivated by at least two observations. First, when house prices are deemed to have moved too much because of a lack of development capacity, the time it takes to make sufficient land development ready suggests a solution is somewhere at least 3 to 5 years away. At least based on our preliminary analysis, land price differentials appear larger at the urban boundary rather than within the city limit. So any improvement in managing the inventory of land at the urban boundary is likely to have a large impact on the flexibility of land supply across the city.

We think the Knaap and Hoskins (2001) event-driven proposal for managing urban growth of is the right one. We agree with their suggestion:

> "where urban growth boundaries are employed, too much emphasis is placed on whether urban growth boundaries contain sufficient land to accommodate 20 years of growth and too little is placed on how frequently, how much or under what circumstances urban growth boundaries should be expanded."

Increasing focus on the right inventory level or buffer of available land *within* the urban growth limit is likely to be more productive than trying to second guess the rate of population and urban growth required over a period as long as twenty or thirty years. Land price differentials could be used to help decide what the most efficient inventory level could be.

5. Conclusion

Land and thus house prices across Auckland city are rising faster than they should. Land use regulation is limiting the flexibility of the planning system to provide sufficient "development capacity" to promote home building and attract productive workers into the city.

Land prices can play a role in aiding planning. Land prices can show where regulation is likely to be inefficient and where land supply can be made more flexible. But demand for land is a function of not just regulation, but also amenity value and transport connectivity. That means we need strategies to disentangle the relative effects.

We show how three different evaluation strategies (i) naïve; (ii) sophisticated; and (iii) focussed, can be used to evaluate land price differentials within residential zones.

Based on our exploratory analysis we think that it is likely that it is easier to distinguish when the level of land use regulation is overly restrictive across broad urban zones – such as at the rural-urban boundary than within urban zones – residential in particular. Evaluating changes within zones is more likely to be possible when specific land use regulations change.

We think there is a clear case that regulation at the city border is too tight relative to the price of agricultural land at the urban boundary. The case for inefficiencies caused by regulation within the city limits and across suburbs is less clear, but needs to be further investigated.

That favours an approach that for policy makers first builds credibility and familiarity with the information content of land prices from spatial hedonic models. We recommend setting up an annual monitoring programme, with formal published reviews every three years, to help facilitate this process. Our exploratory work suggests that from a practical point of view, hedonic price models that use spatial techniques can help show where land price differentials exist.

These land price differentials could be used to examine whether land use regulation is too restrictive within zones – such as residential – and right across the city. Regulation may need to change right across the city to have material impacts.

Moving to an event-based inventory management system could improve management of the urban-rural boundary. Such a system triggers land release when the stock of land within the urban boundary falls beneath an inventory trigger level rather than based on pre-specified timing, such as bringing on new land for development every five years for the next three decades. Land price differentials could be used to set the trigger inventory level.

References

Albouy, David and Gabriel Ehrlich, (2012), "Metropolitan Land Values and Housing Productivity", NBER Working Papers 18110, National Bureau of Economic Research, Inc.

Albouy, David (2015), "What are Cities Worth? Land Rents, Local Productivity, and the Total Value of Amenities", *Review of Economics and Statistics*, Forthcoming.

Boarnet, Marlon G and Saksith Chalermpong, (2003), "New Highways, House Prices, and Urban Development: A Case Study of Toll Roads in Orange County, CA", University of California Transportation Center, Working Papers qt2zd554cs, University of California Transportation Center.

Boucq, Elise and Francis Papon (2008), "Assessment of the real estate benefits due to accessibility gains brought by a transport project: the impacts of a light rail infrastructure improvement in the Hauts-de-Seine department", Institute for the Study of Transport within the European Economic Integration, issue 40, pages 51-68.

Boyle, Austin Charles Barrilleaux and Daniel Scheller, (2014), "Does Walkability Influence Housing Prices?," *Social Science Quarterly*, Southwestern Social Science Association, vol. 95(3), pages 852-867, 09.

Chernobai, Ekaterina, Michael Reibel and Michael Carney,(2011) "Nonlinear Spatial and Temporal Effects of Highway Construction on House Prices", *The Journal of Real Estate Finance and Economics* 01/2011; 42(3) pp 348-370.

Cheshire, Paul (2006), "Introduction of Price Signals into Land Use Planning: how applicable in China?", Research Papers in Environmental and Spatial Analysis No. 118.

Cheshire, Paul and Stephen Sheppard, (2005), "The Introduction of price signals into land use planning decision-making: a proposal", *Urban Studies* 42, pages 647–663

Clough, Peter (1994), "The Containment of Urban Sprawl, NZIER report to Auckland Regional Council, July 1994.

Coleman, Andrew, (2010), "Transport infrastructure, lock-out and urban form: Highway development in Auckland and the United States", *Policy Quarterly*, vol. 6(4).

Cooper, Geoff (2014) "Radical planning shift needed for Auckland to prosper", op-ed, New Zealand Herald, Thursday July 10, 2014, accessed 16 July 2015.

Desmet, Klaus, and Esteban Rossi-Hansberg, (2013), "Urban Accounting and Welfare", *American Economic Review*, 103(6): 2296-2327.

Des Rosiers, Francois, Jean Dubé, Marius Thériault, and Marion Voisin, (2006) "Does The Overall Quality In The Supply Of An Urban Bus Service Affect House Prices? - A North-American Case Study",ERES eres2006_171, European Real Estate Society (ERES).

Fischel, William A. (2005), "The homevoter hypothesis: how home values influence local government taxation, school finance, and land-use policies, Harvard University Press.

Fischel, W. A. (1985), *The Economics of Zoning Laws: A Property Rights Approach to American Land Use Controls*. Baltimore, MD: Johns Hopkins University Press.

Frost, Lionel and Tony Dingle (1995), Patrick Tory (ed.), Australian cities: issues, strategies, and policies for urban Australia in the 1990s, Melbourne, Cambridge University Press.

Glaeser, EL, and J. Gyourko (2003) "The impact of zoning on housing affordability." Economic Policy Review 9 (2): 21-39.

Glaeser, Edward L. & Ward, Bryce A., (2009), "The causes and consequences of land use regulation: Evidence from Greater Boston", *Journal of Urban Economics*, Elsevier, vol. 65(3), pages 265-278, May.

Green, R, S Malpezzi and S Mayo (2005), Metropolitan-specific estimates of the price elasticity of supply of housing and their sources, *American Economic Review*, 95(2), pages 334 – 339.

Griliches, Z. (1971), Price indexes and quality change, Cambridge: Harvard University Press.

Grimes, Arthur and Ian Mitchell, (2015), "Impacts of Planning Rules, Regulations, Uncertainty and Delay on Residential Property Development," Working Papers 15_02, Motu Economic and Public Policy Research.

Grimes, Arthur and Chris Young, (2013), "Spatial effects of urban rail upgrades", *Journal of Transport Geography*, Volume 30, June 2013, Pages 1-6

Grimes, A and A Aitken (2010), "Housing Supply, Land Costs and Price Adjustment", *Real Estate Economics*, 38, pages 325 – 353.

Grimes, Arthur and Yun Liang (2009), "Spatial Determinants of Land Prices: Does Auckland's Metropolitan Urban Limit Have an Effect?", *Applied Spatial Analysis and Policy*, Volume 2, Issue 1, pages 23 – 45.

Grimes, Arthur and Yun Liang, (2010), "Bridge to Somewhere: Valuing Auckland's Northern Motorway Extensions", *Journal of Transport Economics and Policy*, vol. 44(3), pages 287 – 315.

Homans, Frances R. and Elizabeth P. Marshall (2008), "Modeling Recreational Amenities in an Urban Setting: Location, Congestion, and Substitution Effects", Agricultural and Resource Economics Review 37/2, October, pages 257 – 272.

Ihlanfeldt, Keith R. (2004). "Exclusionary Land-use Regulations within Suburban Communities: A Review of the Evidence and Policy Prescriptions." Urban Studies 41 (2) (February), pages 261 – 283.

Irwin, Elena G and Carmen E Carrion-Flores (2005), "Using Regression Discontinuity Design to Identify the Effect of Zoning", 2005 Annual meeting, July 24-27, Providence, RI 19258, American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

Knaap, Gerrit J and Lewis D Hoskins, (2001), "Land use regulations and the value of land and housing: An intra-metropolitan analysis," *Journal of the American Planning Association*, vol. 67(3), pages 136 – 148.

Kok, Nils & Monkkonen, Paavo & Quigley, John M., (2014), "Land use regulations and the value of land and housing: An intra-metropolitan analysis," *Journal of Urban Economics*, Elsevier, vol. 81(C), pages 136 – 148.

Kulish, Mariano, Anthony Richards and Christian Gillitzer, (2012), "Urban Structure and Housing Prices: Some Evidence from Australian Cities", The Economic Record, 88(282), pages 303 – 322.

Lees, Kirdan, (2014), "Big city life? Challenges and trade-offs for Auckland city", NZIER Working Paper 2014/2, New Zealand Institute of Economic Research.

Lees, Kirdan (2015), "Moving on up Relaxing land use restrictions can lift Auckland city", NZIER report to Auckland Council 13 February 2015.

Malpezzi, S. (1996). Housing prices, externalities, and regulation in U.S. Metropolitan areas. Journal of Housing Research, 7(2), pages 209 – 241,

Mikelbank, Brian A. (2004), "Spatial analysis of the relationship between housing values and investments in transportation infrastructure", *The Annals of Regional Science*, Springer, vol. 38(4), pages 705-726, December.

Ministry for the Environment (2010), "Building competitive cities: Reform of the urban and infrastructure planning system: A discussion document", Wellington: Ministry for the Environment.

New Zealand Productivity Commission (2012), "Housing Affordability inquiry", Wellington, New Zealand.

New Zealand Productivity Commission (2015a), "A research note A history of town planning", June, Wellington

New Zealand Productivity Commission (2015b), "Land for Housing inquiry, Draft", Wellington, New Zealand.

Nunns, Peter, Hitchins, Hadyn and Balderston, Kyle (2015). The value of land, floorspace and amenities: a hedonic price analysis of property sales in Auckland 2011-2014. Auckland Council technical report, TR2015/012.

Ossokina, Ioulia (2010), "Geographical range of amenity benefits: Hedonic price analysis for railway stations,"CPB Discussion Paper 146, CPB Netherlands Bureau for Economic Policy Analysis.

Perkins, Harvey C and David C Thorns, (2001), "A decade on: reflections on the Resource Management Act 1991 and the practice of urban planning in New Zealand" 28 *Environment and Planning B: Planning and Design* 639

Quigley, John, and L.A. Rosenthal (2005), "The effects of land use regulation on the price of housing: What do we know? What can we learn?" *Cityscape* 8 (1), pages 69 – 137.

Quigley, J.M. & Raphael, S. (2005), "Regulation and the high cost of housing in California", American Economic Review, Vol. 95 No. 2, pages. 323 – 328.

Rosen, S. (1974), "Hedonic prices and implicit markets: product differentiation in pure competition", *Journal of Political Economy*, 82, pages 34 – 55.

Sheppard, Stephen, (1999) "Hedonic analysis of housing markets," Handbook of Regional and Urban Economics, in: P. C. Cheshire & E. S. Mills (ed.), edition 1, volume 3, chapter 41, pages 1595 – 1635, Elsevier.

Torshizian, E and A Grimes (2014a), "Residential Satisfaction, Crowding and Density: Evidence over Different Geographic Scales in Auckland." Auckland: New Zealand Association of Economists 2014 Conference.

Turner, Matthew A. Andrew Haughwout and Wilbert van der Klaauw, (2014), "Land Use Regulation and Welfare", *Econometrica*, Econometric Society, vol. 82(4), pages 1341 – 1403.