HOW WILL WE KNOW IF THE AUCKLAND UNITARY PLAN IS WORKING?

ACCOUNTING FOR THE REDEVELOPMENT PREMIUM IN HOUSE PRICE MEASUREMENT

Ryan Greenaway-McGrevy

Kade Sorensen

October 2017

CENTRE FOR APPLIED RESEARCH IN ECONOMICS

WORKING PAPER NO. 001

CENTRE FOR APPLIED RESEARCH IN ECONOMICS

DEPARTMENT OF ECONOMICS

UNIVERSITY OF AUCKLAND

Private Bag 92019

Auckland, New Zealand

www.business.auckland.ac.nz/CARE

How will we know if the Auckland Unitary Plan is working? Accounting for the redevelopment premium in house price measurement

Ryan Greenaway-McGrevy*
Department of Economics, The University of Auckland

Kade Sorensen
Department of Economics, The University of Auckland

October 2017

Abstract

One of the stated goals of the Auckland Unitary Plan (AUP) is to ensure that housing in Auckland is affordable. To achieve this, the plan encourages housing supply by relaxing a variety of land use regulations in targeted areas of the region, including constraints on residential density. However, relaxing restrictions on density increases the value of land, which inflates the value of properties that can be redeveloped to support additional dwellings. Disentangling the deflationary effect of increased housing supply from the inflationary effect of an increased redevelopment premium will therefore be key to evaluating the efficacy of the plan.

In this paper we present a set of price indices that are designed to assist policymakers in assessing whether the AUP is restoring affordability to the housing market. Our approach is based on sorting property transactions according to their potential for redevelopment and constructing a different price index for each group. The indices show that residential properties with the greatest potential for redevelopment under the AUP have experienced substantially more inflation over the 2011 to 2015 period. This result is consistent with upzoning increasing the redevelopment premium. Going forward, the price indices for properties that have less potential for redevelopment will tell us whether intensification is bringing affordable housing options to the market.

*Corresponding author. Email: r.mcgrevy@auckland.ac.nz. This work was supported by the Marsden Fund Council from Government funding, administered by the Royal Society of New Zealand. Sorensen gratefully acknowledges support from the Kelliher Charitable Trust. We thank Corelogic New Zealand for providing data, and Peter Nunns and Shane Martin for their comments.

1 Introduction

It is well-established that land use regulations (LURs) – such as minimum lot sizes (MLS) per dwelling and building coverage ratios – affect property prices. Housing costs are higher in cities that have more restrictive planning regulations (Quigley and Rosenthal, 2005; Gyourko and Molloy, 2014) and in cities that take longer to issue building permits (Glaeser and Gyourko, 2005; Glaeser, Gyourko and Saks, 2005, 2006). Moreover, Ihlanfeldt (2007) and Dalton and Zabel (2011) demonstrate that a causal relationship often underlies these observed correlations – tighter LURs led to an increase in house prices in their respective samples.

A natural corollary of this research is that relaxed planning regulations may restore or maintain affordable housing within a jurisdiction. If tighter regulations increase house prices, then local governments may be able to encourage construction and lower prices by relaxing their LURs. However, policies that encourage intensification could inflate the redevelopment premium embedded in the price of extant houses, potentially increasing – rather than decreasing – the value of upzoned housing. The option to improve, augment, or teardown and replace an existing residential structure can generate a significant positive premium in house prices (Clapp and Salavei, 2010; Clapp, Salavei Bardos and Wong, 2012). The size of this redevelopment premium is affected by a variety of property characteristics, such as the existing extent of site development and the age of the structure (Clapp and Salavei, 2010), but the regulatory environment should also directly affect the size of the redevelopment premium, since restrictions such as minimum lot sizes and building coverage ratios are explicitly designed to limit the scope of site development.

Relaxing LURs on density could therefore result in a bifurcation in the housing market that will make it difficult to assess whether housing is becoming more affordable. Properties that are able to be profitably redeveloped to support additional dwellings may experience an increase in price as the option to redevelop the site becomes more valuable under the newly relaxed restrictions on density. Meanwhile, the relative price of high intensity housing may decline as redevelopment brings additional supply of this kind of housing to the market. Furthermore, existing housing located in areas that have not been upzoned may be subject to spillover effects from construction elsewhere in the city. Therefore – although the literature suggests that relaxing LURs can decrease house prices on average – there may be very different effects on individual houses depending on the how the redevelopment potential of the property is affected by the change in regulations.

In this paper we suggest a simple methodology for constructing price indices that can be used to evaluate whether policies that encourage intensification are restoring or maintaining affordability. The approach is straightforward. First, we sort housing transactions into separate groups according to the potential for redevelopment of the property under the new LURs. Second, we construct a separate price index for each group. We use two key indicators in order to sort properties according to their redevelopment potential: (i) the *planning zone* in which the property is located; and (ii) the *intensity ratio* of the property – i.e. the ratio of the value of improvements to the total value of the property. The planning zone is a regulatory variable that tells us how much development is permitted on a given parcel of land. The intensity ratio is an economic variable that is indicative of the opportunity cost (and thus the economic profitability) of redevelopment. A small house sitting on a large lot has a low opportunity cost of redevelopment in terms of forgone rent, and it will also exhibit a relatively low intensity ratio since much of the value of the property is embedded in the underlying land. A multi-storey apartment building has a high opportunity cost of redevelopment, and an apartment will exhibit a relatively high intensity ratio as more of the value of the property is embedded in the structure. We follow Clapp and Salavei (2010), Clapp Salavei Bardos and Wong (2012) and Clapp, Jou and Tan (2012) in using the intensity ratio as an empirical measure of the redevelopment premium.

Upzoned houses that have a relatively low intensity ratio should appreciate in value after the intensification policies are announced. Our price indices for these properties will tell us whether this is happening. But if intensification succeeds in bringing supply to the market, we should also observe a decline in the price indices for high intensity housing (such as apartments and terraced housing) located in the high density planning zones. Meanwhile, the price indices for housing located in areas that have not been upzoned may also tell us whether intensification effects are spilling over into areas not targeted for redevelopment.[1]

We implement the approach using a dataset of individual residential transactions for Auckland, New Zealand, spanning 1990 to 2015. The recent history of Auckland provides a unique opportunity to implement the methodology. In early 2013 the Auckland City Council announced changes to LURs in the "Draft Auckland Unitary Plan". After a review and consultation process, these changes in LURs were finalised in late 2016 and published as the "Auckland Unitary Plan". The final plan directly relaxed restrictions on urban density in targeted areas of the city by, among other things, (i) abolishing MLS for existing parcels and relaxing MLS for subdivisions, and (ii) relaxing restrictions on building heights, height-in-relation-to-boundary ratios, and site coverage ratios. Both the proposed and final versions of the LURs were well-publicised and accessible to the public online, including a detailed map of proposed planning zones, allowing any member of the public to look-up the residential zone of any particular property or address.

Our price indices exhibit a marked divergence that is consistent with the announcement of the intensification policy inflating the redevelopment premium of affected properties. Specifically, low intensity houses that were rezoned to the highest permissible level of residential density appreciated by 95% between Q1 2011 and Q4 2015. Meanwhile, high intensity dwellings located in the same (high density) planning zone appreciated by only 77% over the same period. The difference is substantial, and consistent with upzoning inflating the redevelopment premium of existing houses that have a low opportunity cost of redevelopment. Furthermore, houses rezoned to the lowest level of residential density increased by approximately 75% over the same five-year period, regardless of the opportunity cost of redevelopment of the properties.[2] As the plan was only made partially

[1] The net spillover effect from intensification remains ambiguous. On the one hand, if low and high intensity housing are highly substitutable, then an increase in the dwelling stock will put downward pressure on prices in areas that have not been upzoned. On the other, intensification makes large lot housing and neighborhoods more scarce. If low and high intensity housing are not that substitutable, a reduction in the stock of low intensity real estate will put upward pressure on prices in areas that have not been upzoned.

[2] Specifically, high intensity properties in this low density planning zone appreciated by 74% over the five-year

operational in late 2016, it is too early to tell whether the plan restoring affordability by bringing high intensity housing to the market. However, the price indices for high intensity housing located in high density planning zones will assist in this regard going forward.[3]

The remainder of the paper is organized as follows. In the following section we review the relevant literature. In section three we introduce our dataset and regulatory context. We also present some descriptive statistics on the intensity ratio variable that is used to sort transactions. In section four we present our sorting method, price indices and main results. Section five concludes.

2 Related Literature

The effect of land use regulation on housing markets has received a substantial amount of attention within the urban economics and planning disciplines. Basic economic thinking suggests that LURs constrain housing supply, resulting in higher house prices and fewer dwellings in response to increases in housing demand (Glaeser, Gyourko and Saks, 2006; Gyourko and Saks, 2014). Restrictions on density may also preserve local amenities, thereby increasing demand and further reinforcing the supply-side effect on prices (Helsley and Strange, 1995). Many empirical studies illustrate patterns consistent with this line of thought; cities with restrictive LURs and delayed permitting processes tend to have higher house prices and lower rates of new construction. For example, Malpezzi (1996) shows that US cities with higher levels of regulation were associated with higher house prices and lower rates of construction. Glaeser and Gyourko (2005) and Glaeser, Gyourko and Saks (2005) show that housing costs are higher in US cities that take longer to issue building permits or approve subdivisions. Mayer and Somerville (2000) show that cities that take longer to approve subdivisions have lower levels of construction. Quigley and Rosenthal (2005) provide a survey of the literature, and conclude that "[c]aps on development, restrictive zoning limits on allowable densities, urban growth boundaries, and long permit-processing delays have all been associated with increased housing prices."

However, observed correlations between measures of LURs and house or land prices do not bear on questions of causality due to the potential endogeneity of regulation and house prices (Quigley and Rosenthal, 2005; Gyourko and Saks, 2014). More recent studies have tackled the endogeneity of regulations using a variety of methods. By using fixed effects in a panel data framework to control for unobserved heterogeneity, Dalton and Zabel (2011) find that increases in minimum lot sizes increased prices in the greater Boston area over the 1987 to 2006 period. Similarly, Glaeser and Ward (2009) use a panel data approach to show that issued building permits declined in response to increases in minimum lot sizes in Massachusetts. Jackson (2014) demonstrates a reduction in construction after regulatory tightening in a panel of Californian cities spanning 1970 to 1995. Ihlanfeldt (2007) instruments for the potential endogeneity of LURs, showing that tighter LURs increased house prices in a cross section of approximately 100 jurisdictions in Florida.

period, while low intensity properties appreciated by 76%.

[3] These appreciation rates may strike a reader unfamiliar with the Auckland housing market as excessively large. Between 2010 and 2015 the Auckland real estate market experienced substantial price appreciation. See Greenaway-McGrevy and Phillips (2016) for further discussion.

A related literature documents the opposite relationship between LURs and land prices. Gao, Asami and Katsumata (2006) show that land prices are cheaper in areas of Tokyo with tighter restrictions on floor area ratios (FARs). Brueckner, Fu, and Zhan (2015) document a similar pattern between FARs and land lease prices in a large sample of Chinese cities. Meanwhile, Ihlanfeldt (2007) shows that tighter LURs lowered the price of vacant land in his sample of cities in Florida.

Other studies have examined how LURs restrict metropolitan growth by moderating the long-run effects of increases in labor demand. Employing a vector auto-regressive approach, Saks (2007), Zabel (2011) and Greenaway-McGrevy and Hood (2016) show that increases in labor demand result in higher house prices and lower rates of in-migration to cities with more restrictive LURs. Glaeser, Gyourko and Saks (2006) document a similar effect based long-run changes in population and house prices. Meanwhile, Paciorek (2013) shows that cities with more restrictive land use regulation experience greater volatility in house prices.

A related literature focuses on the measurement of LURs. Measures of LUR differ significantly across studies making it difficult to compare findings (Gyourko and Molloy, 2014). Nonetheless, extant measures include time to issue development permits (Glaeser and Gyourko, 2005; Glaeser, Gyourko and Saks, 2005, 2006), direct observation of specific LURs such as minimum lot sizes (Ihlanfeldt, 2007; Dalton and Zabel, 2011), the volume of regulations (Saks, 2008; Malpezzi, 1996), as well as indices that aggregate these and other measures (Gyourko, Saiz, and Summers, 2008). Our approach circumvents these measurement issues by sorting transactions into planning zones and ranking the zones according to the intensity of site development permitted.

Our approach to house price measurement builds on the many papers that examine the redevelopment option embedded in developed real estate. The option to improve, augment, or teardown and replace a structure can carry a significant positive premium that is reflected in property values (Clapp and Salavei, 2010; Clapp, Salavei Bardos and Wong, 2012). The premium can be significant. For example, using a sample covering fifty three towns in Connecticut from 1994 to 2007, Clapp, Salavei Bardos and Wong (2012) show that this redevelopment option is non-zero for at least one fifth of the towns in the sample, and within these towns, properties that were most similar to vacant land sold for a 29–34% premium. Empirical work on the redevelopment premium often uses the intensity ratio as an empirical proxy for the premium, which is defined as the ratio of the value of improvements to the total value of the property (Clapp and Salavei, 2010; Clapp, Salavei Bardos and Wong, 2012; Clapp, Jou and Tan, 2012). The ratio is typically based on assessed valuations made by local government for the purpose of levying property taxes. We follow this literature and use the intensity ratio as an empirical proxy for the redevelopment premium in our dataset.

The intensity ratio is related to other measures that capture the relative value of land and capital in housing. It is equal to one minus the "land leverage" ratio (the ratio of land value to total value) proposed by Bostic, Longhofer and Redfearn (2007) and employed by Bourassa et al (2009) and Bourassa et al (2011). Meanwhile, Davis and Heathcote (2007) use a measure analogous to land leverage in their analysis of land and house prices in the United States.

In the New Zealand context there has recently been a renewed interest in LURs. Grimes and Liang (2007) and Zheng (2013) document a significant disparity in land prices directly inside and directly outside the metropolitan urban limits (MULs) of New Zealand cities. Grimes and Mitchell (2015) examine the costs of administrative aspects of LUR in New Zealand. Mimicking the methodology of the Wharton Residential Land Use Regulatory Index, NZIER (2015) survey the land use regulation of various city councils. More recently, Lees (2017) estimates the costs of land use regulation embodied in average house prices for various cities.

3 Data and Institutional Background

In this section we introduce our dataset and give a brief summary of the recent institutional and regulatory changes affecting Auckland.

3.1 Data

Our dataset consists of all residential sales in the Auckland metropolitan area between 1990 and 2015 (inclusive). The transaction data include the sales price; the value of any chattels included in the sale; the assessed value of improvements, land and total value of the property; the land area (in hectares) of the property; the latitude and longitude of the property; whether the property is leasehold or freehold; and dwelling type (house, flat, apartment or vacant land). The dataset also includes a unique identifier for each property that will be used in the construction of repeat sales indices. Properties without an exclusive land title (such as apartments or cross-leased sites) are recorded as having zero land area in the dataset. Assessed values are based on Council valuations made for the purpose of levying property taxes. Assessments recur approximately every three years.[4]

We clean the data in order to remove transactions that appear to have had information incorrectly coded or omitted, or that appear to be non-market transactions. First, any transactions with missing information on sales price, assessed value, assessed land value, land area or latitude and longitude are removed.[5] Second, transactions for vacant lots or leasehold sales were removed, and transactions that omitted this field were removed. Finally, we remove transactions relating to properties that were bought and sold more than twice within a quarter.[6] After cleaning the data we are left with 500,167 transactions over the twenty-six year period.

Using the latitude and longitude coordinates we match each transacted property to its corresponding planning zone under the AUP. The method is described in detail in the Appendix. For constructing our indices we focus on four main residential zones (listed in declining intensity): 'Terrace Housing and Apartment Building'; 'Mixed Housing Suburban'; 'Mixed Housing Urban';

[4] This means that the most recent assessment usually occurred within three years prior to sale. As a robustness check we also constructed our price indices using the ratio of the assessed value of improvements to the sales price (less the value of chattels) as the intensity measure. The resultant indices are very similar to those reported below, and our qualitative conclusions remain unchanged.

[5] This does not mean we exclude, for example, apartments from the dataset, as the majority of these have land area listed as zero.

[6] Many of these transactions appear too low to represent credible market prices. Because repeat sales that occur close in time receive a comparatively large weighting in the repeat sales index, such transactions can have a big impact on measured price inflation.

and 'Single House'. These four categories account for 462,014 of our 500,167 transactions (approximately 92% of all transactions). In the Appendix we provide a brief summary of the specific LURs for each zone.

For each transaction we construct the intensity ratio (IR) as follows:

$$IR := \frac{IV}{AV} = 1 - \frac{LV}{AV}$$

where AV is the total assessed value, LV is the assessed land value, and IV is the improved value (or capital value) of the property, where $IV = AV - LV$ holds as an identity. By construction the ratio lies between zero and one. Bostic, Longhofer and Redfearn (2007) also use assessed values when constructing land leverage LV/AV (which is one minus the intensity ratio used in our analysis).[7]

We set the intensity ratio to one for transactions on properties that do not carry exclusive ownership of the land underlying the residential structure. This includes apartments and cross leased sections. Our supposition is that it is harder to redevelop a site that has multiple owners – since all (or perhaps at least a majority of) owners must first agree.[8]

The median intensity ratio across all transactions in each quarter is used sort transactions before constructing the index. Figure 1 exhibits the median ratio for Auckland between 1990 and 2015. The ratio fluctuates between 0.65 and 0.7 between 1990 and 2005, thereafter sharply declining to between 0.5 and 0.55.

The histograms below also exhibit the distribution of the intensity ratio at the beginning and the end of the sample period. The mode at one represents the properties without an exclusive land title (such as apartments).

3.2 Timeline of the Auckland Unitary Plan.

In this subsection we briefly describe recent events affecting town planning in Auckland.[9] Prior to 2010, the Auckland metropolitan region comprised seven independent local authorities. After amalgamation in 2010, the newly-formed Council was required by the central government to develop a consistent set of planning rules for the region under the *Local Government (Auckland Transitional Provisions) Act 2010*. The first draft of the unitary plan was released in early 2013 and was followed by a consultation period, which included public submissions and public hearings on the plan. The

[7] Reliance on assessed values is not without its critics. Bourassa et al (2009) point out that assessed improvements and land values can be inaccurate. They suggest using hedonic regressions to estimate the price of land. We do not follow this suggestion for two reasons. First, as pointed out by Glaeser and Gyourko (2005), there is a substantial difference between the extensive value of land (as implied by direct measures of vacant land) and the intensive value of land (as measured in a hedonic regression), especially when LURs are binding. Second, as pointed out by Clapp and Salavei (2010) and Clapp, Jou and Tan (2012), hedonic regressions are misspecified when the redevelopment option is not controlled for in the regression. In any event, our sorting relies on an ordinal ranking of intensity ratios, meaning that we can tolerate a certain amount of measurement error in the intensity ratio. For example, the method could be modified to classify low intenisty properties as having an intensity ratio below the 45th percentile, and high intensity above the 55th percentile, thereby permitting an amount of measurement error.

[8] Our price indices turn out to be largely invariant to whether we make this supposition or not, since apartments and cross-leased houses tend to have assessed intensity ratios in the top half of the distribution.

[9] Adapted from http://ourauckland.aucklandcouncil.govt.nz/articles/news/2016/07/a-timeline-of-the-auckland-unitary-plan/

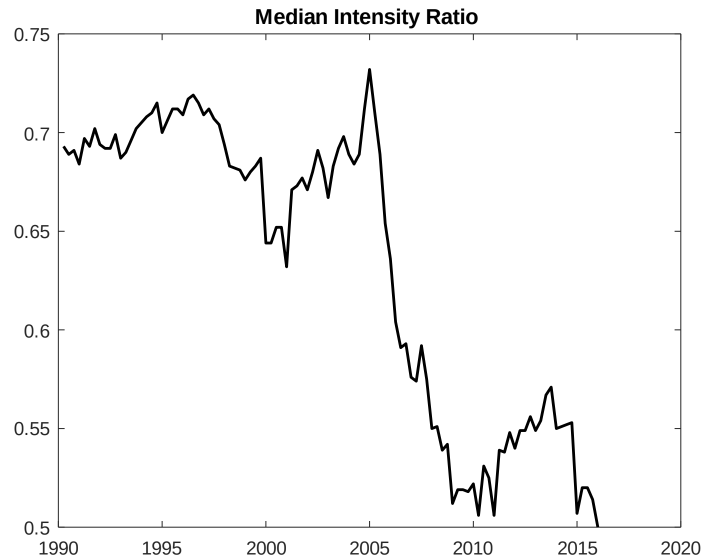

Figure 1: The median intensity ratio for residential housing transactions in Auckland, 1990–2015. The intensity ratio is the ratio of the value of improvements to total value.

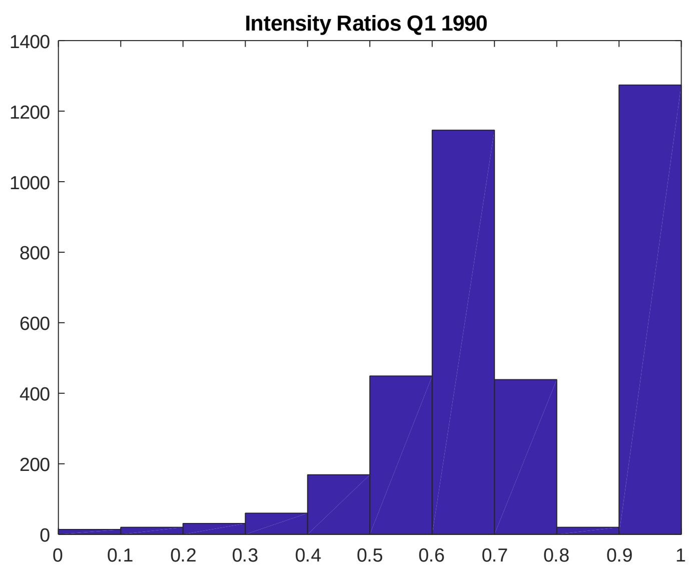

Figure 2: Distribution of the Intensity Ratio for Quarter 1 1990.

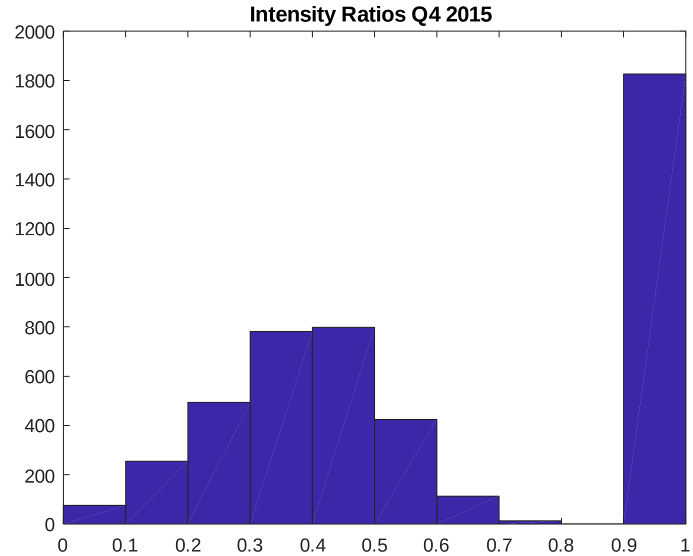

Figure 3: Distribution of the Intensity Ratio for Quarter 4 2015.

final version of the plan was released in 2016 and approved by the Auckland Council in late 2016.

We will use Q1 2011 as the baseline period for studying the trends in property prices subsequent to the Unitary Plan. Notably this is approximately two years before the Draft Unitary Plan was formally released (along with maps illustrating which parts of the city were being considered for upzoning), but immediately after the *Local Government (Auckland Transitional Provisions) Act 2010* came into force in November 2010. Our goal is to select a baseline period that precedes any anticipation of the Unitary Plan and its potential effects on the location of housing construction in the future. We therefore select a relatively early baseline date in order to minimise the potential effects of anticipation of the plan on prices. In any event, the utility of the indices proposed below do not depend on whether the market has or has not anticipated the effects of the AUP prior to Q1 2011.

4 House Price Indices for Transactions Sorted by Redevelopment Potential

In this section we outline and present repeat sales price indices for residential dwellings. First, we sort the sample of residential sales according to residential zone and intensity. We then apply the Case-Shiller Repeat Sales methodology to each sub-sample.

Our approach can be decomposed into three steps:

(i) Sort all residential transactions in the sample into four groups according to the residential zone of the property: Terraced housing and apartments (THA); Mixed Housing Urban (MHU); Mixed Housing Suburban (MHS); Single House (SH). Transactions that fall outside of these four groups are discarded. This leaves us with 37,362, 115,167, 244,712 and 64,773 transactions in the THA, MHU, MHS and SH zones, respectively, over the Q1 1990 to Q4 2015 period.

(*ii*) Within each zoning group, sort transactions according to whether the intensity ratio of the property is above or below the median intensity ratio for all transactions in the quarter. We refer to the former group as high intensity (HI) properties, and the latter as low intensity (LI) properties. This yields 24,276 HI and 13,086 LI transactions in the THA zone; 60,671 HI and 54,496 LI transactions in the MHU zone; 117,572 HI and 127,140 LI transactions in the MHS zone; and 23,058 high intensity HI and 41,715 low intensity LI transactions in the SH zone. Altogether we have eight separate groups.

(*iii*) Apply the Case-Shiller repeat sales methodology to each of the eight groups of transactions. The indices are normalized to one at the beginning of the sample. The Case-Shiller method is described in detail in the Appendix. We use the repeat sales method for measuring house prices for two reasons. First, using repeat sales is a straightforward way to account for changes in the characteristics of houses sold in each time period (Case and Shiller, 1987). Note, however, that there are drawbacks to the repeat sales method (see Bourassa et al, 2006, for a detailed discussion). Second, the Repeat Sales method is very similar to the predominant house price index used in New Zealand, which is a Sales-Price Appraisal Ratio (SPAR) index (see figure 8 in the Appendix). A SPAR index is based on both repeat sales and assessed valuations of the property.

Figure 4 exhibits the low intensity price indices for the four residential zones over the 1990 to 2015 period. Figure 5 exhibits the price indices for high intensity properties. Figures 6 and 7 exhibit the indices from Q1 2011 onwards – approximately two years before the announcement of the AUP. Several patterns are evident.

First, there has been much less appreciation in high intensity properties (Figure 5) than low intensity properties (Figure 4) over the 1990 to 2015 period. The former have increases by a factor of approximately five, whereas the latter have increased by a factor between six and seven. This pattern is consistent with an increase in the redevelopment premium over time – regardless of where the property is located.

Second, there is substantially more heterogeneity among the low intensity indices (Figure 4) than the high intensity indices (Figure 5). Within the LI indices, inflation rates have been higher for THA, MHU and SH zoned properties – which have increased by a factor of about seven since 1990 – than MHS properties – which have increased by a factor of approximately six.

However, the low intensity indices from 2011 onwards tell a slightly different story. Since Q1 2011, inflation as been highest in the THA zone (14.3% per annum between Q1 2011 and Q4 2015), followed by the MHU zone (14.2%), the MHS zone (13.2%), and finally the SH zone (11.9%). Turning to the high intensity indices, inflation rates across each of the four planning zones are rather similar. Inflation in the THA zone averaged 12.1% per annum; the MHU averaged 12.4%;

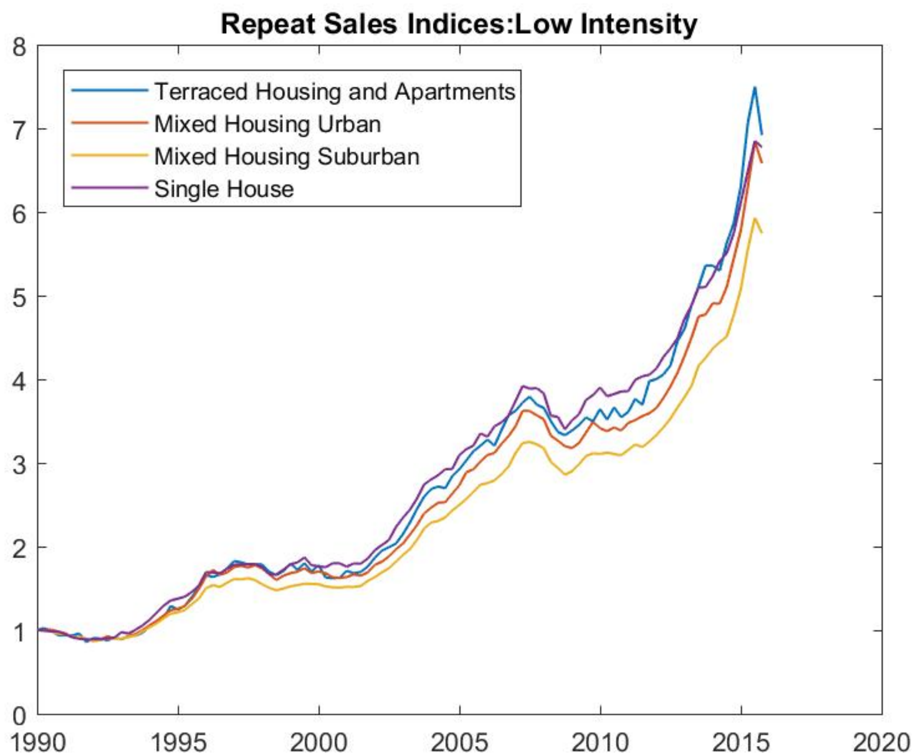

Figure 4: Price indices for low intensity housing in each planning zone, 1990-2015. Low intensity houses are defined as having an intensity ratio (IR) below the median IR of all residential transactions occuring in the quarter of sale. The IR is the ratio of the value of improvements to the total value of the property. A lower intensity ratio indicates a smaller opportunity cost of redevelopment.

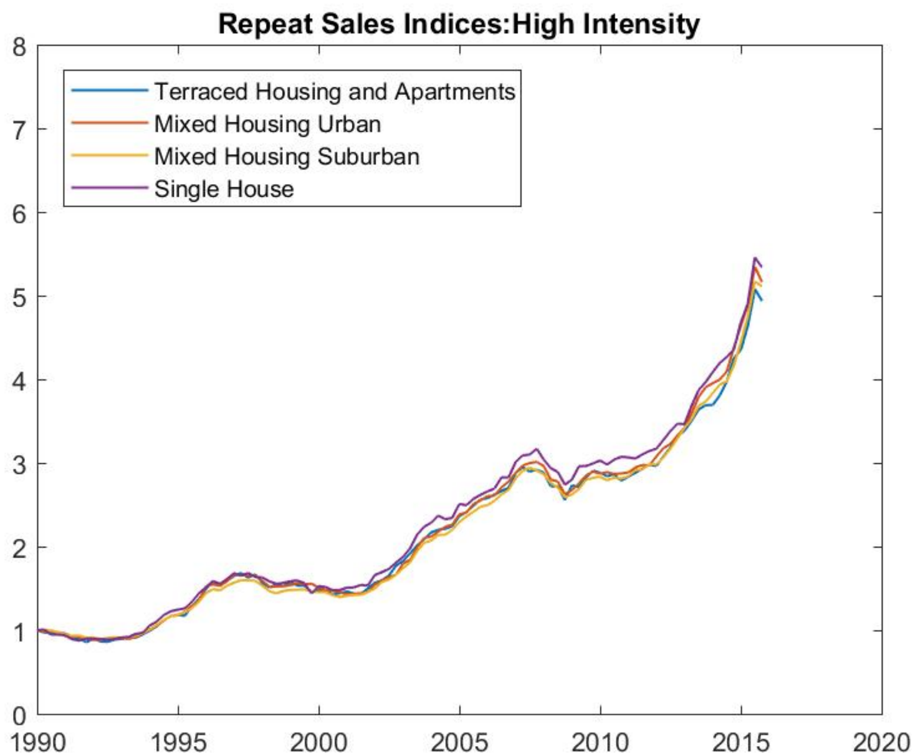

Figure 5: Price indices for high intensity housing in each planning zone, 1990-2015. High intensity houses are defined as having an intensity ratio (IR) above the median IR of all residential transactions occuring in the quarter of sale. The IR is the ratio of the value of improvements to the total value of the property. A higher intensity ratio indicates a larger opportunity cost of redevelopment.

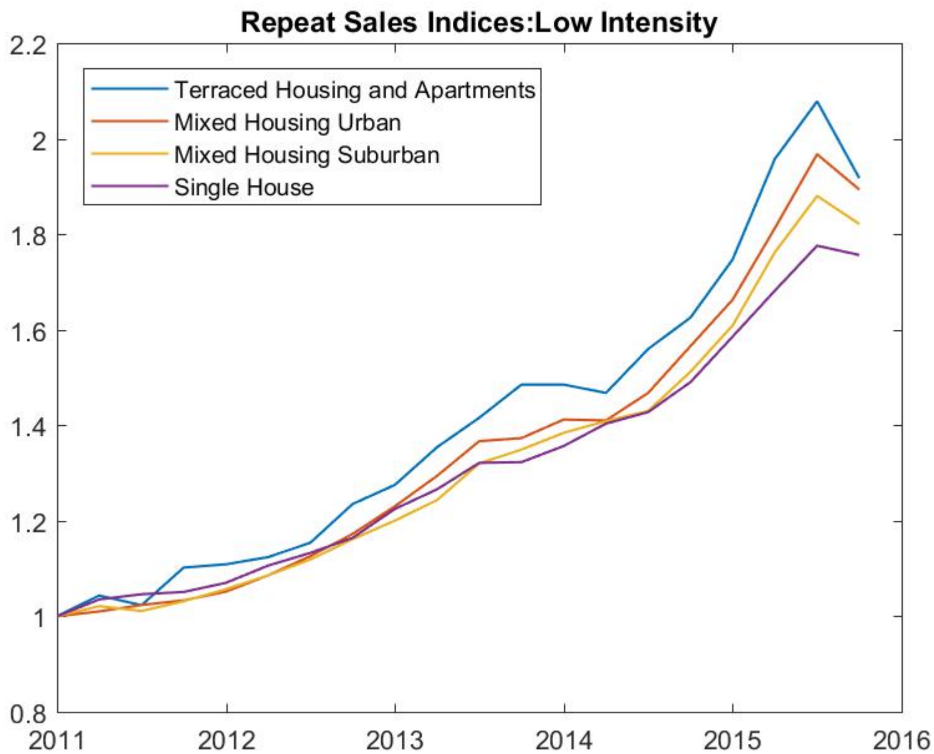

Figure 6: Price indices for low intensity housing in each planning zone, 2011-2015. Low intensity houses are defined as having an intensity ratio (IR) below the median IR of all residential transactions occuring in the quarter of sale. The IR is the ratio of the value of improvements to the total value of the property. A lower intensity ratio indicates a smaller opportunity cost of redevelopment.

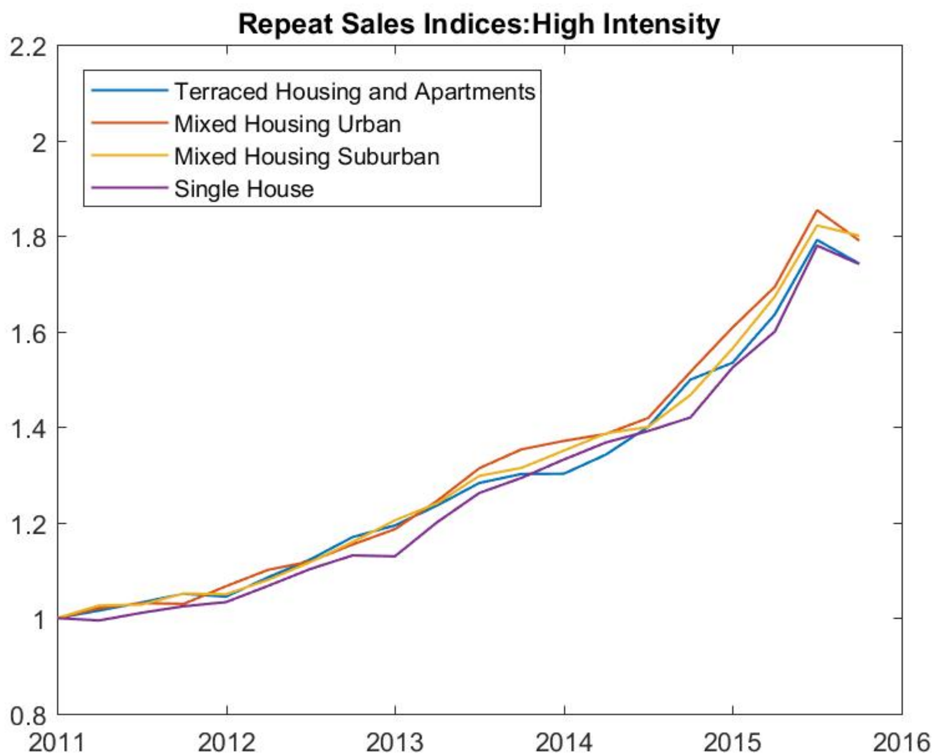

Figure 7: Price indices for high intensity housing in each planning zone, 2011-2015. High intensity houses are defined as having an intensity ratio (IR) above the median IR of all residential transactions occuring in the quarter of sale. The IR is the ratio of the value of improvements to the total value of the property. A higher intensity ratio indicates a larger opportunity cost of redevelopment.

the MHS zone averaged 12.7%; and inflation in the single house zone averaged 11.7%. These trends are consistent with the announcement (or the anticipated announcement) of the AUP increasing the redevelopment premium. Low intensity housing upzoned for greater density has experienced substantially more inflation since 2011 than low intensity housing that has not been upzoned. For example, between 2011 and 2015, low intensity properties that were upzoned for the highest permissible residential density (THA) appreciated by approximately 18% more than low intensity properties located in the most restrictive residential planning zone (SH).

Finally, within each planning zone, inflation rates have been generally been higher for low intensity properties than for high intensity properties since 2011. (Figures 10 through 13 in the Appendix illustrate these patterns most clearly.) But the divergence is more pronounced in the high density zones (THA and MHU) than for the low density zones (MHS and SH). For example, high intensity properties within THA (the highest density residential zone) appreciated by 77% percent between Q1 2011 and Q4 2015, but low intensity properties appreciated by 95% over the same five-year period. Meanwhile, high intensity properties within SH (the lowest density residential zone) appreciated by 74% percent between Q1 2011 and Q4 2015 – which is qualitatively indistinguishable from the 76% increase in low intensity properties within SH over the same period. Again, these patterns are consistent with upzoning increasing the redevelopment premium.

5 Concluding Remarks

It is useful to think of a house as a bundle of two assets: A structure and a plot of land (Davis and Heathcote, 2007). Policies that encourage urban intensification are likely to have different effects on individual house prices depending on the relative value of these two components. Intensification increases the value of land, which means that dwellings that can be profitably redeveloped to support additional dwellings are likely to increase in value. But if intensification succeeds in bringing supply to the market, we should also expect a decrease in the price of high intensity housing, such as apartments and terraced housing. This bifurcation in the housing market makes it difficult to track the effect of intensification policies on house prices using conventional price indices that aggregate across all transactions.

In this paper we suggest a simple approach to measuring house price inflation when evaluating policies that encourage urban intensification. We sort properties into groups based on their redevelopment potential before constructing a price index for each group. We suggest sorting transactions according to a regulatory variable (the planning zone of the property), which tells us about the scope of redevelopment permitted, and an economic variable (the intensity ratio of the property), which tells us about the opportunity cost of redevelopment.

We implement the approach using a residential sales transaction dataset from Auckland, New Zealand, that spans the announcement of an urban intensification policy in 2013. Our results are consistent with intensification inflating the redevelopment premium. Between 2011 and 2015, houses with a low intensity ratio (and thus a low opportunity cost of redevelopment) that were rezoned for the highest permissible residential density appreciated by approximately 18% more than high intensity housing located in the same planning zone, and by about 20% more than housing located in areas that were not upzoned.

6 Appendix

6.1 Auckland Unitary Plan Zones

The Table below provides a brief summary of various land use regulations for each of the four residential zones considered.

Summary of Land Use Regulation by Residential Planning Zone

Land Use Regulation	Terrace Housing & Apartments	Mixed Use Urban	Mixed Use Suburban	Single House
Height	between 16 to 22.5m (5 to 7 storeys)	11m + 1m roof (three storeys)	8m + 1m roof (two storeys)	8m + 1m roof (two storeys)
Height in relation to boundary	3m + 45° side & rear boundaries	2.5m + 45° side & rear boundaries	2.5m + 45° side & rear boundaries	2.5m + 45° side & rear boundaries
Site Coverage Ratio	50%	45%	40%	35%
Min. dwelling size (1 bedroom)	45m^2	45m^2	45m^2	n/a
Density	do not apply (DNA)	do not apply (DNA)	DNA for sites > 1000m^2 200m^2 otherwise	1 dwelling per site
Min. Lot Size (Vacant land)	1200m^2	300m^2	400m^2	600m^2

6.2 Case-Shiller Repeat Sales Methodology

The following is based on Nagaraja, Browny and Wachterz (2010). Note that notation defined in this subsection only applied within the subsection. The (log) sales price of house i at time t is given by

$$p_{i,t} = \beta_t + h_{i,t} + u_{i,t}$$

where $h_{i,t}$ is a Gaussian random walk, so that $\Delta h_{i,t} = \upsilon_{i,t}$, $\upsilon_{i,t} \sim iidN\left(0, \sigma_\upsilon^2\right)$. Therefore

$$\begin{aligned} p_{i,t} - p_{i,s} &= \beta_t - \beta_s + h_{i,t} - h_{i,s} + u_{i,t} - u_{i,s} \\ &= \beta_t - \beta_s + \textstyle\sum_{r=s+1}^{t} \upsilon_{i,r} + u_{i,t} - u_{i,s} \end{aligned}$$

Case and Shiller assume that $u_{i,t} \sim iidN\left(0, \sigma_u^2\right)$, and that $u_{i,t}$ is independent of $\upsilon_{i,t}$. The price index are based on estimates of $\{\beta_t\}_{t=1}^{T}$ from the following steps:

(i) We estimate (1) by OLS, treating the $\{\beta_t\}_{t=1}^{T}$ as parameters, where

$$p_{i,t} - p_{i,s} = \beta_t - \beta_s + \varepsilon_{i,t,s} \tag{1}$$

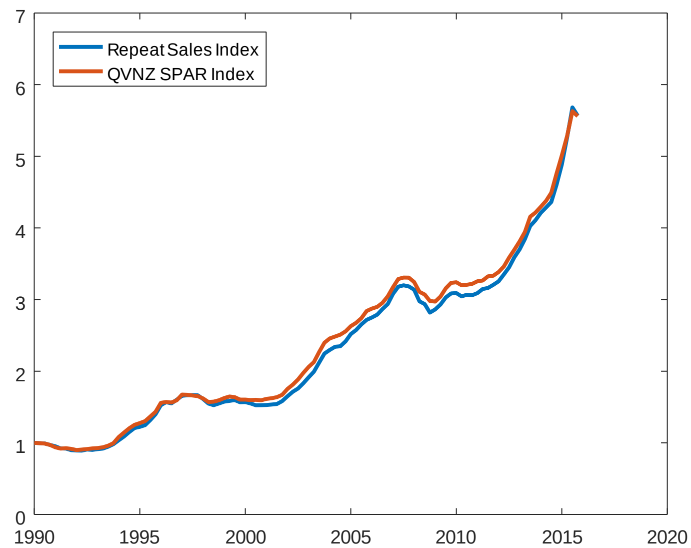

Figure 8: Repeat Sales Index for all residential transacions and the QVNZ Sales-Price Appraisal Ratio Index, 1990–2015.

(*ii*) Obtain residuals $\hat{\varepsilon}_{i,t,s}$ from (1), and estimate the following by OLS.

$$\hat{\varepsilon}^2_{i,t,s} = \delta_0 + \delta_1 (t - s) + e_{i,t,s}$$

(*iii*) We re-estimate (1) by weighted least squares, using the fitted values from the above regression, namely $\hat{w}_{i,t,s} := \hat{\delta}_0 + \hat{\delta}_1 (t - s)$, for the estimated variance of each error $\varepsilon_{i,t,s}$.

The Repeat Sales method is very similar to the QVNZ Sales-Price Appraisal Ratio (SPAR) index, which is based on both repeat sales and assessor valuation of the property. Figure 8 exhibits a simple Repeat Sales Index (based on all transactions in the sample) against the QVNZ Index for Auckland. Both indices are normalized to one in quarter one 1990. Evidently, the two indices are very similar.

6.3 Algorithm for matching transactions to planning zones

The AUP master Geodatabase files were obtained from the Department of Geography at the University of Auckland. These represent the most up-to-date geospatial data on the AUP (published November 2016). We then project the data layers from New Zealand Transverse Mercator to decimal degrees formatting (WGS 1984) in order to match the longitude and latitude from the sales transaction dataset. The number of zone polygons within the AUP geospatial files was approximately 133,000.

Approximately 222,234 unique properties underlying the transaction dataset were matched to an AUP zone prior to the filtering described in the Section 3.1 above. The matching process is as follows:

(i) We allocate an AUP zone polygon to each unique property in the transaction dataset according to the property's reported longitude and latitude coordinates. We then allocate the AUP zone (e.g. "Terrace Housing and Apartments") associated with the selected polygon to the property identifier.

(ii) Approximately 5% of the longitude-latitude coordinates fall exactly on the boundary of two or more polygons, resulting in an unmatched zone for the property. Another 40% or so fall just outside a lot, usually on the road frontage of the property, resulting in a returned AUP zone of 'road' or 'public'. We perform a second stage repair for these matches by searching for the nearest residential or commercial zone polygon in the immediate vicinity of the reported coordinates. The procedure is as follows.

  (a) First, we identify all properties with either an unmatched zone or a matched zone that is non-residential or non-commercial (such as 'road' or 'public'). We generate an approximate circle around the original coordinates of the property. This new polygon is based on a radius of 0.00001 decimal degrees ($\sim$ 1.11m) and has 50 sides - equivalent to 51 coordinates. One of the coordinates in the circle is directly north of the reported longitude-latitude coordinates of the property.

  (b) We match an AUP zone polygon to each of the 51 points. We then allocate the most frequently selected residential or commercial zone among these 51 matches to the property. If a residential zone is not among the 51 returned zones, the property is not allocated an AUP zone, and is filtered out of the dataset during the cleaning process described in the main text.

6.4 Additional Price Indices

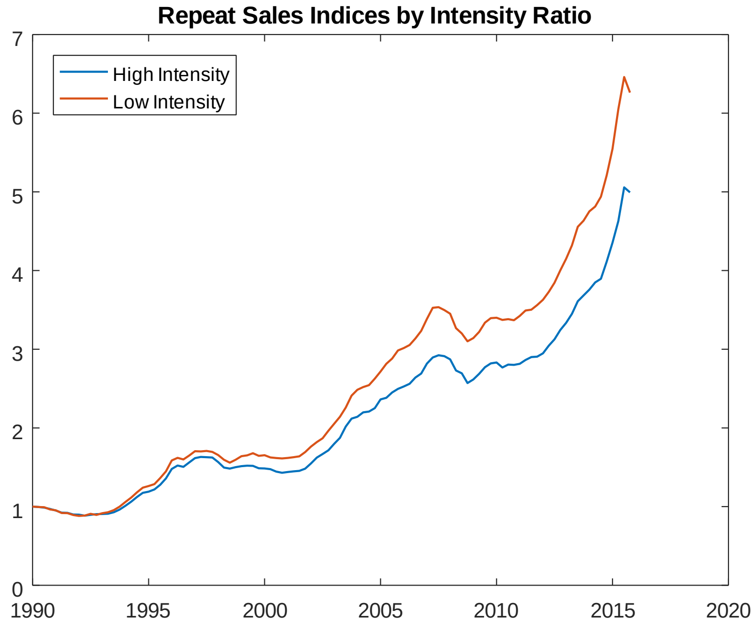

Figure 9: Price indices for low and high intensity housing for all residential transactions, 1990–2015.

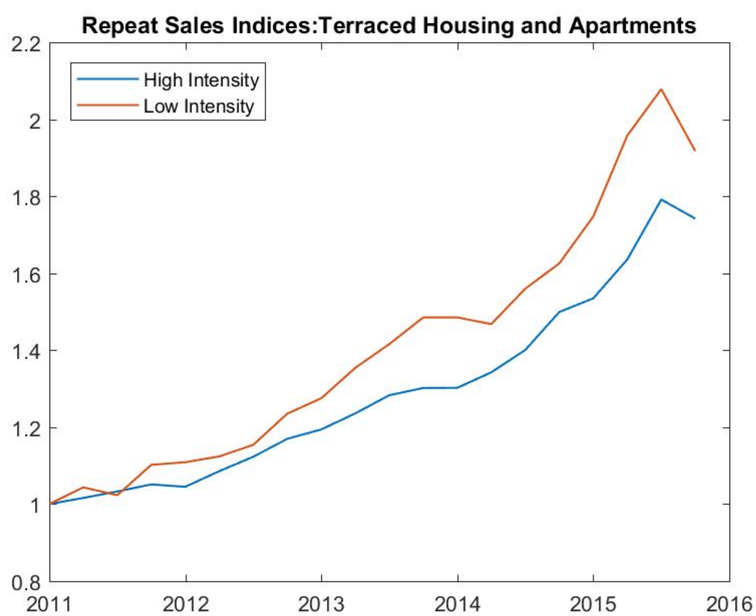

Figure 10: Price indices for low and high intensity housing in the Terrace Housing and Apartments residential zone, 2011–2015.

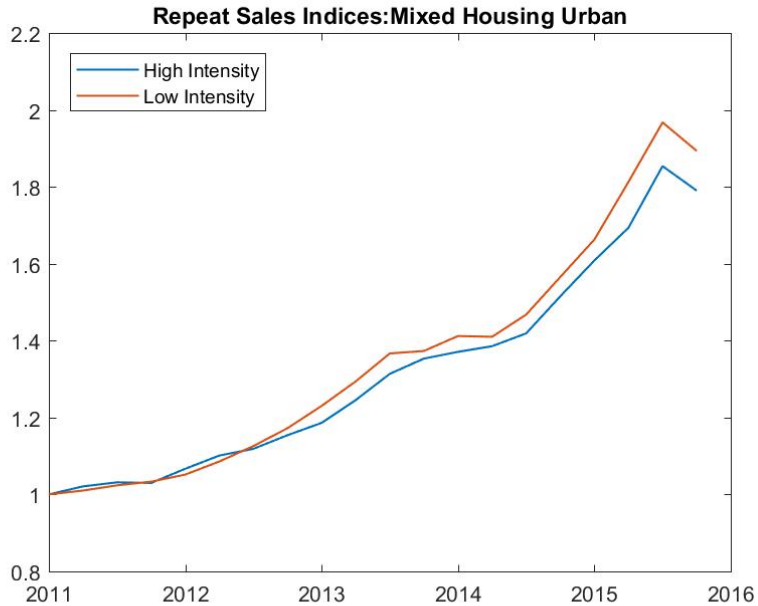

Figure 11: Price indices for low and high intensity housing in the Mixed Housing Urban residential zone, 2011–2015.

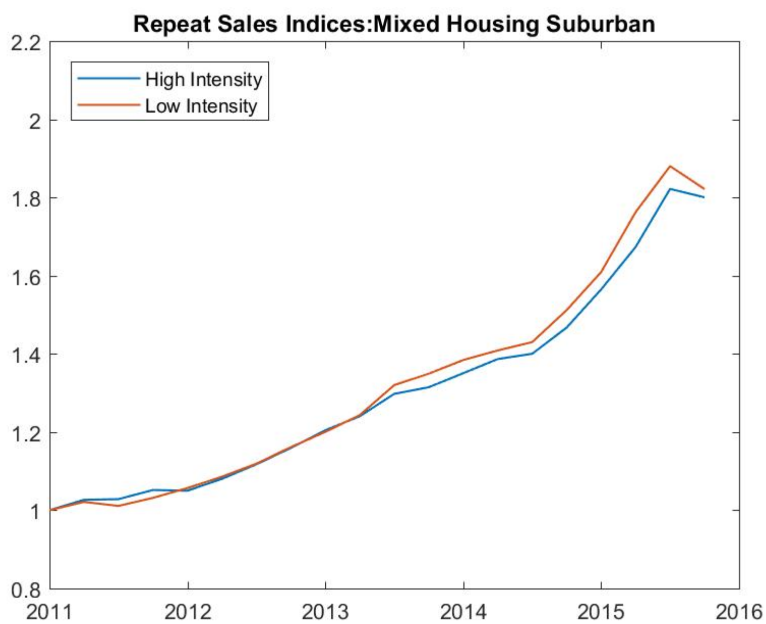

Figure 12: Price indices for low and high intensity housing in the Mixed Housing Suburban residential zone, 2011–2015.

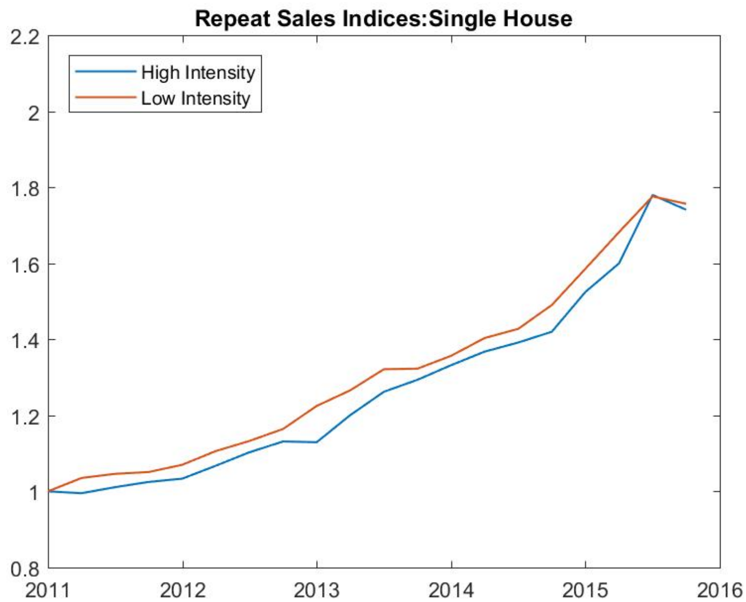

Figure 13: Price indices for low and high intensity housing in the Single House residential zone, 2011–2015.

References

[1] Auckland City Council. (2013). Capacity for growth study 2013 (proposed Auckland unitary plan): Results. Retrieved from http://www.aucklandcouncil.govt.nz /EN/planspoliciesprojects/reports /technicalpublications/Documents /tr2014010capacityforgrowthstudy2013results.pdf

[2] Bostic, R., Longhofer, S., and C. Redfearn (2007). Land leverage: decomposing home price dynamics. Real Estate Economics 35, 183–208.

[3] Bourassa, S., Haurin, D., Haurin, J., Hoesli, M., and J. Sun (2009). House price changes and idiosyncratic risk: the impact of property characteristics. Real Estate Economics 37, 259–278.

[4] Bourassa, Hoesli, M., and J. Sun (2006). A simple alternative house price index method. Real Estate Economics 15, 80–97.

[5] Bourassa, S., Hoesli, M., Scognamiglio, D., and S. Zhang (2011). Land leverage and house prices. Regional Science and Urban Economics 41 (2), 134–144.

[6] Bruenecker, J. K., Fu, S, Gu, S., and J. Zhang (2015). Measuring the Stringency of Land-Use Regulation: The Case of China's Building-Height Limits, *Working Paper*

[7] Case, K.E., and R.J Shiller (1987). Prices of single-family homes since 1970: new indexes for four cities. New Engl. Econ. Rev., 45–56.

[8] Clapp, J.M. and K. Salavei.(2010). Hedonic Pricing with Redevelopment Options: A New Approach to Estimating Depreciation Effects. Journal of Urban Economics 67: 362–377.

[9] Clapp, J.M., Salavei Bardos, K., and S.K. Wong (2012). Empirical estimation of the option premium for residential redevelopment. Regional Science and Urban Economics 42: 240–256.

[10] Dalton, M., and J. Zabel (2011). The impact of minimum lot size regulations on house prices in Eastern Massachusetts. Regional science and urban economics, 41(6), 571-583. doi: 10.1016/j.regsciurbeco.2011.06.002

[11] Gao, X., Asami, Y., and W. Katsumata (2006). Evaluating land-use restrictions concerning the floor area ratio of lots. Environment and Planning C: Government and Policy, 24, 515–532.

[12] Glaeser, E., and B. Ward (2009). The causes and consequences of land use regulation: Evidence from Greater Boston. Journal of Urban economics, 65(3), 265-278. doi: 10.1016/j.jue.2008.06.003

[13] Glaeser, E., Schuetz, J., and W. Bryce (2006). Regulation and the rise of housing prices in greater Boston: A study based on new data from 187 communities in eastern Massachusetts. Retrieved from http://pioneerinstitute.org/download/regulation-and-the-rise-of-housing-prices-in-greater-boston-a-study-based-on-new-data-from-187-communities-in-eastern-massachusetts/

[14] Glaeser, E.L., and J. Gyourko (2003). The Impact of Building Restrictions on Housing Affordability. Economic Policy Review, 9(2), 21–39.

[15] – (2005). Urban Decline and Durable Housing. Journal of Political Economy, 113(2), 345–375.

[16] – (2017) The Economic Implications of Housing Supply. (Zell/Lurie Working Paper #802).

[17] Glaeser, E.L., Gyourko, J., and R. Saks (2005). Why is Manhattan so expensive? Regulation and therise in housing prices. Journal of Law and Economics, October, 331–369.

[18] Glaeser, E.L., and B.A. Ward (2006). The Causes and Consequences of Land Use Regulation: Evidence from Greater Boston. (NBER Working Papers 12601). National Bureau of Economic Research, Inc.

[19] Greenaway-McGrevy, R. and K. K. Hood (2016). Worker migration or job creation? Persistent Shocks and Regional Recoveries. Journal of Urban Economics 96, 1–16.

[20] Greenaway-McGrevy, R. and Phillips P.C.B. (2016). Hot property in New Zealand: Empirical evidence of housing bubbles in the metropolitan centres. New Zealand Economic Papers, 50(1), 88-113.

[21] Grimes, A. and Y. Liang (2009). Spatial Determinants of Land Prices: Does Auckland's Metropolitan Urban Limit Have an Effect? Applied Spatial Analysis and Policy, 2, 23-45.

[22] Grimes, A. and I. Mitchell (2015). Impacts of Planning Rules, Regulations, Uncertainty and Delay on Residential Property Development, Working Papers 15_02, Motu Economic and Public Policy Research.

[23] Gyourko, J., and R. Molloy (2014). Regulation and housing supply. (NBER No.20536). United States: National Bureau of economic research.

[24] Gyourko, J., Saiz, A., and A. Summers (2008). A new measure of the local regulatory environment for housing markets: The Wharton residential land use regulatory index. Urban Studies Journal Limited, 45(3), 693–729. doi: 10.1177/0042098007087341

[25] Helsley, R.W. and W.C. Strange (1995). Strategic Growth Controls, Regional Science and Urban Economics, Vol. 25: 435-460.

[26] Ihlanfeldt, K. (2007). The effect of land use regulation on housing and land prices. Journal of Urban Economics, 61(3), 420–435. doi:10.1016/j.jue.2006.09.003

[27] Jackson, K. (2016). Do land use regulations stifle residential development? Evidence form California cities. Journal of urban economics, 91, 45-56. doi:10.1016/j.jue.2015.11.004

[28] Lees, K. (2017) Quantifying the impact of land use regulation: Evidence from New Zealand. Sense Partners. Report for Superu, Ministerial Social Sector Research Fund. June 2017

[29] Levine, N. (1999). The Effect of Local Growth Controls on Regional Housing Production and Population Redistribution in California. Urban Studies 36(12), 2047–2068. doi:10.1080/0042098992539

[30] Malpezzi, S, (1996). Housing Prices, Externalities, and Regulation in U.S. Metropolitan Areas. Journal of Housing Research 7(2) 209–242.

[31] Mayer, C., and T. Somerville (2000). Land use regulation and new construction. Regional science and urban economics, 30(6), 639-662. doi: 10.1016/S0166-0462(00)00055-7

[32] NZIER (2015). Land use regulation in New Zealand: Improving the evidence base. https://www.productivity.govt.nz/sites/default/files/using-land-nzier-land-use-regulation-report.pdf [accessed 28 Sept 2017].

[33] Paciorek, Andrew (2013). Supply Constraints and Housing Market Dynamics, Journal of Urban Economics, Vol. 77: 11-29.

[34] Quigley, J., and L. Rosenthal (2005). The effects of land use regulation on the price of housing: What do we know? What can we learn? Journal of Policy Development and Research, 8(1), 69-137. Retrieved from http://escholarship.org/uc/item/90m9g90w

[35] Saks, R. (2008). Job creation and housing construction: Constraints on metropolitan area employment growth. Journal of Urban Economics, 64, 178–195. doi: 10.1016/j.jue.2007.12.003

[36] Saiz, A. (2010). The Geographic Determinants of Housing Supply. Quarterly Journal Of Economics, 125(3), 1253-1296.

[37] Yusif, S., Wu, W., and S. Evenett (2000). Local dynamics in an era of globalization. Oxford university press: New York, United States.

[38] Zheng, G. (2013). The effect of Auckland's Metropolitan Urban Limit on land prices. Retrieved from http://www.productivity.govt.nz/sites/default/files/research-note-mar-13-auckland-mul.pdf