Housing markets and migration – Evidence from New Zealand

Dean R. Hyslop, Trinh Le, David C. Maré and Steven Stillman

Document information

Author contact details

Dean R. Hyslop

Senior Fellow, Motu Economic and Public Policy Research Trust

dean.hyslop@motu.org.nz

Trinh Le

Fellow, Motu Economic and Public Policy Research Trust

trinh.le@motu.org.nz

David C. Maré

Senior Fellow, Motu Economic and Public Policy Research Trust

dave.mare@motu.org.nz

Steven Stillman

Professor, Department of Economics and Management, Free University of Bozen-Bolzano, Italy

steven.stillman@unibz.it

Abstract

This paper analyses the relationship between local area housing and population size and migrant-status composition, using population data from the 1986–2013 New Zealand Censuses, house sales price data from Quotable Value New Zealand, rent data from the Ministry of Business, Innovation and Employment, and building consents data from Statistics New Zealand. Measured at the Territorial Local Authority and Auckland Ward (TAW) area level, we estimate the elasticity of house prices with respect to population is 0.4-0.65, similar but smaller elasticity of apartment prices, but find no evidence of any local population effects on rents. We also estimate the elasticity of housing quantity with respect to population of about 0.9. Although international migration flows are an important contributor to population fluctuations, we find little evidence of systematic effects of international or domestic migrant composition of the local population on prices or quantity. In particular, despite there being a strong correlation between immigration and house price changes nationally, there is no evidence that local house or apartment prices are positively related to the share of new immigrants in an area. Repeating the analysis for more narrowly defined areas within Auckland, we estimate a smaller house price elasticity with respect to population in the range 0–0.15. Finally, our analysis suggests that longer-term housing supply is relatively elastic, and demand inelastic, with respect to price.

Summary haiku
People need houses.

More people higher prices,

wherever they're from.

Table of Contents

Table of Figures

1 Introduction

There has been widespread recent concern that strong increases in immigration flows have caused a housing crisis in New Zealand.[1] In fact, aggregate time series analyses by Coleman and Landon-Lane (2007) and McDonald (2013) estimate that a one percent increase in population from immigration is associated with an increase in house prices on the order of 10 percent. In this paper, we examine the aggregate and local area relationships between population changes and house price growth over the census-based period from 1986 to 2013: although this period does not capture the substantial changes that have occurred since 2013, it does cover earlier periods of similarly strong increase. Between 1986 and 2013, the population of New Zealand increased by 37%, from 3.2m to 4.4m. Although the majority of this increase was due to natural increase (80%), migration flows did change the composition of the NZ population as well as the size. The number of foreign-born New Zealanders more than doubled (108%), whereas the New Zealand-born population rose by only 8%. Over the same period, the average real (inflation-adjusted) house price increased by about 140%.

There are several issues with aggregate time series analyses of the effects of immigration on house prices.[2] Both immigration and house prices are pro-cyclical over the business cycle, and also tend to co-vary with other asset prices, so attributing cause and effect from correlated movements is difficult. Previous NZ research has found far more muted local and regional house price responses to population shocks (Maré, Grimes, and Morten 2009; Stillman and Maré 2008).[3] This may be because while an immigration-driven population shock into an area will increase the demand for local housing, it may also affect the location decisions of the native population.[4] In addition, immigrants can affect housing supply through factors such as housing investment and expertise in the building industry.

---

[1] See, for example, Economist: Cut migrant numbers to bring down Auckland house prices (https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=11651226), Reserve bank: Migration key to housing crisis (https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11670498), Immigration peak to fuel house prices (https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11453363). Auckland's population grew by 62%. However, the number of NZ-born grew by 20%, whereas the number of foreign-born grew by 160%. It is probably the increased presence of foreign born, rather than immigration flows, that lead people to think that immigration is causing house price increases.

[2] See Fry (2014) for a recent review of the broader macroeconomic effects of migration in New Zealand. Cochrane and Poot (2016) provide a recent review of the New Zealand literature on the impact of international migration on house prices; and Cochrane and Poot (2020) provide an international review of the local housing market effects of immigration.

[3] For example, Stillman and Maré (2008) estimate the local housing price elasticity with respect to area population is in the range of 0.2–0.5. They find no evidence that local house prices are positively related to the inflow of foreign-born immigrants to an area, but that there is a strong positive relationship between inflows of New Zealanders previously living abroad into an area and the appreciation of local housing prices, with a one percent increase in population due to returning New Zealanders associated with a 6-9 percent increase in house prices.

[4] For example, Saiz and Wachter (2011) and Sá (2014) find significant local area out-migration of the native population following increases in immigration, which affects the spatial demand for housing by natives.

We focus on how local area population change, both in terms of its size and composition, affects the price and supply of housing in those areas. To do this, we outline a simple demand and supply model for local housing, from which we derive reduced form equations for both the price and quantity of housing. Our primary focus is the price of housing, as measured by average house prices in an area, but we also consider average apartment prices as well as average rents and also quantity measures of housing supply.

Our analysis builds on Stillman and Maré (2008), and we extend their analysis in several ways. First, we extend the period of analysis to include data from the 2013 census. Second, we include information on building consents to proxy for local area housing supply conditions. Finally, we consider the responsiveness of housing supply over the period. Our main focus is on the local area level relationship between the price of housing, as measured by housing prices and rents, and population, with emphasis on whether the relationship depends on the migrant-status composition of the population. To do this, we define various sub-populations by whether or not they are New Zealand born, and their recent (inter-censal) international and domestic migration status, and analyse the relationship between house prices and the share of the local population in each group.

We first provide a connection to the aggregate time series literature, with an exploratory analysis of the relationship between local-area house sale prices and local-area and aggregate (NZ) population.[5] The results of simple regressions show that aggregate population has a more dominant effect on local house prices than local-area population: in a house-price change regression, we estimate an elasticity of house prices with respect to aggregate population of 9.9, which is in the range of long-run elasticities estimated by Coleman and Landon-Lane (2007), while the elasticity with respect to local population is about 0.4.[6] Our subsequent analysis abstracts from the possible confounding effects of macroeconomic factors, and focuses on the relationship between housing and population measured at the local area.

We then provide a more detailed analysis of the relationship between local area housing prices and rents, and population size and composition. We outline a conceptual demand and supply framework for the local-area housing market, which motivates a reduced-form equation approach to estimating the relationship between the price (and quantity) of housing and population characteristics. Recognising that there may be significant segmentation of the housing market between owning and renting, and also possibly between houses and apartments, we consider four alternative 'price' specifications: house sale prices, apartment sale prices, house rents, and apartment rents. Considering these different measures is also important

---

[5] Our primary analysis is based on Statistics New Zealand's 78 territorial authorities and Auckland wards (TAW), which consist of 66 territorial local authorities (TLA), with the Auckland TLA disaggregated into 13 wards. We also repeat our main analyses using 140 labour market areas (LMA).

[6] Although the estimates are similar in our preferred regression specifications that control for the local-area population composition and other factors, the magnitude and statistical significance of the estimated aggregate population effects depend on the particular specification adopted, and can be statistically insignificant, substantially smaller, and even negative.

because house and apartment prices are likely to reflect both the consumption value of housing and asset price effects, while rents should be dominated by the value of housing services. In addition, we estimate regressions for two measures of housing 'quantity': the number of occupied dwellings, and the number of bedrooms. For each of these outcomes, we estimate both (log(price) or log(quantity)) 'levels' and 'changes' regression specifications.

In our primary analysis of house sale prices at the TAW area level, we find consistently positive population size effects on house prices. The estimated local area price elasticities with respect to population range from 0.4 in our preferred 'levels' specification to 0.65 in our preferred 'growth' specification, meaning that a ten percent increase in local area population is associated with a 4–6.5 percent higher house prices. However, conditional on the population size, we find little evidence that the composition of the local-area population systematically affects house prices, after controlling for observable differences in the socio-demographic characteristics of areas. In particular, the only consistent result is that, relative to the share of staying New Zealanders in an area, a higher share of moving New Zealanders is associated with higher house prices. We find no evidence that a higher share of new immigrants is associated with higher house prices. Our analysis of apartment prices provides qualitatively similar, although weaker and less precisely estimated, population results. The results from LMA level analysis are qualitatively similar, but with relatively stronger population effects on apartment prices than house prices.

In contrast to the analysis of prices, we find consistently small and statistically insignificant population size effects on both house and apartment rents. However, we do find significant population composition effects on rents, with the relative shares of all 'moving' subgroups positively affecting local area rents – i.e. relative to those who are New Zealander born and don't move area, all other population groups positively affect rents. The absence of any population size effects on rents provides suggestive evidence of the importance of asset price factors underlying the population effects on house and apartment prices.

Our analysis of housing quantity finds strong population effects on both the number of dwellings and the number of bedrooms, with elasticities of close to 0.9 for both quantity measures. We also find that the share of returning New Zealanders in an area is most positively associated with each quantity measure. Combined with the house prices estimates, these results suggest that longer-term housing supply is relatively elastic with respect to price (1.2), and housing demand is inelastic (-0.3).

Finally, given the importance of Auckland as an immigrant destination and the strength of recent and past housing markets there, we reanalyse the population effects on house prices in Auckland using more narrowly defined area unit (AU) data. The results from this analysis find smaller house price elasticities with respect to population (0–0.15), and are robust to allowing for neighbouring area spillover effects. Together with broader area analyses, these results are

consistent with the hypothesis that the smaller the area of focus the smaller will be the impact of population on housing.

The rest of the paper is organised as follows. The next section provides some background context for the research. In section 3 we discuss the data collated from various sources that are used in the analysis, describe summary statistics and patterns, and present the exploratory analysis of the relationship between house prices and population. Section 4 outlines a conceptual model of the housing market; we present and discuss the analysis and results in section 5; and the paper concludes with a discussion in section 6.

2   Background and literature review

A strong associative relationship between New Zealand's real (inflation-adjusted) house price changes and net international migration flows is apparent and motivates ongoing public and policy concern about the effect that immigration has on housing affordability. However, given the cyclical nature of both immigration and house price growth, disentangling confounding common cyclical factors to identify the causal effect of immigration on house prices is potentially difficult. For example, Figure 1 describes the historical relationship, which highlights two features. First, there is a strong co-movement between the two series: the correlation coefficient between the series is 0.56. Second, the annual house price percentage increases are an order of magnitude greater than the net migration as a percentage of the population: the estimated coefficient in a simple regression of house price changes on net migration is 8.7. We suspect these two features largely underpin Coleman and Landon-Lane's (2007) and McDonald's (2013) macro estimates that a 1 percent population increase from migration is associated with about a 10 percent increase in house prices nationally.

In contrast to these large macro-estimated elasticities of the relationship between national population and house price growth, micro-focused analyses of the relationship between local area house prices to population find much smaller elasticities. Cochrane and Poot (2020) reviews the international literature, together with a case study focus on New Zealand. We briefly highlight some of the main findings here. In fact, the recent international literature finds mixed evidence on the impact of immigration on house prices at the local area. For example, in the US, Saiz (2003) estimated a housing rent elasticity of about 1 in Miami following the large increase in the immigrant population associated with the Mariel boatlift in 1980. Saiz (2007) also estimated similar magnitude rent and house price elasticities associated with immigration driven population growth in major immigrant destination cities. In Switzerland, Degen and Fischer (2017) estimate the elasticity of house prices with respect to population growth from immigration was close to 3. In contrast, Akbari and Aydede (2012) estimate trivially small house price elasticities in Canada, and Sá (2014) finds that immigration has a negative effect on house

prices in UK.[7] Sá attributes the negative effect to an outward mobility response of the native population following immigrant inflows; strong spatial sorting effects following immigration shocks have also been found by Saiz and Wachter (2011).

The only previous New Zealand study to examine the local impacts of population on house prices is by Stillman and Maré (2008). Using census level population data linked to house prices and rents over the period from 1991–2006, Stillman and Maré (2008) estimate relatively small local area house prices elasticities with respect to population on the order of 0.2–0.5, and rent elasticities that are generally zero or negative. More detailed analysis of the relationship by the population components finds no evidence that stronger growth of recent immigrants to an area positively affects house prices; however, they do find that a higher rate of recently returned New Zealanders from abroad strongly affects house prices, and also generally positively affects rents (although with weak statistical significance).

3 Data and descriptive analysis

The analysis presented in this paper uses data assembled from several sources. First, we use population and dwelling data from New Zealand Censuses of Population and Dwellings between 1986 and 2013;[8] second, we use data from Quotable Value New Zealand (QVNZ) to derive average house sales prices; third, we use data from the Ministry of Business, Innovation & Employment's (MBIE) Tenancy Bonds database to derive average rents; and finally, we derive information on new houses and apartments, as well as alterations and extensions, from building consents data provided by Statistics New Zealand. In this section, we discuss the main characteristics of each of these data sources.

3.1 Population data

This paper uses unit-record data for the usually resident population from the 1986, 1991, 1996, 2001, 2006 and 2013 Censuses to identify the population and characteristics of different local areas in New Zealand. The Census collects information on each individual's country of birth, their current usual residential location and their usual residential location (including overseas) five years before the census date. We use this information to classify individuals as being 'new immigrants', 'returning New Zealanders', 'previous immigrants', or 'local New Zealanders' where 'new immigrants' are individuals not born in New Zealand who resided outside the country 5 years previously, 'returning New Zealanders' are individuals born in New Zealand who resided

---

[7] However, Aitken (2014) estimates modest positive effects of immigration on local area rents in the UK, with an elasticity of about 0.15.
[8] See the disclaimer on page ii.

outside the country 5 years previously and the remaining two categories consist of non-NZ born and NZ born individuals, respectively, who resided in New Zealand 5 years previously.[9]

Each individual's current usual residence is coded to a census meshblock, which is the smallest geographic area used by Statistics New Zealand in the collection and processing of data and is typically aligned to cadastral boundaries. Meshblock boundaries vary across censuses and we allocate each year's meshblocks to a consistent set of more aggregated geographic areas. In the current paper, we consider two definitions of housing markets, namely 78 territorial local authorities and Auckland wards (TAW) and 140 labour market areas (LMA).[10] The TAWs are based on 66 territorial local authorities (TLA) but with the Auckland disaggregated into 13 wards.[11] This definition is similar to the 73 TLAs studied by Stillman and Maré (2008). The LMAs used in our analysis are identical to the 140 LMAs examined by Stillman and Maré (2008), which were derived by Newell and Papps (2001).[12]

The population base for our analysis of housing demand is the usually resident population aged 18 and over in each geographic area, excluding individuals for whom there is insufficient information for classifying whether they are NZ-born or foreign-born or in which geographic area they currently reside.[13] We include all non-institutionalised adults regardless of whether they live in private dwellings or group quarters. Thus, we include in our population counts

---

[9] Note, in this classification, new immigrants may have previously resided in New Zealand more than 5 years ago or may have been abroad temporarily 5 years ago. The Census typically asks foreign-born individuals their year of first arrival in New Zealand; however, because this question was not included in 1991, for consistency over time we rely on this alternative way of identifying new immigrants. Also, using the previous location question provides consistency with returning New Zealanders who are identified in the same manner. Furthermore, while actual year of first arrival is obviously more ideal for classifying immigrant when examining immigrant outcomes and assimilation, it is unclear whether this is the case when examining impacts on housing markets. In any case, approximately 2-4% of individuals in the 1986 and 1991 census and 7-8% of individuals in the 1996-2013 census do not provide a valid 5-years previous census address, although almost all of these individuals provide enough information to identify that they were in New Zealand. Maré and Stillman (2010) compare mobility rates using addresses from 5-years previously and inter-censal population changes, and conclude that the majority of individuals who do not report a valid previous address were at the same location as five years ago. Thus, we code all individuals with an invalid previous address as being in the same LMA five-years ago. The majority of the analysis in this paper is done at the housing market level and all population movements at this level are identified using inter-censal population changes.

[10] Stillman and Maré (2008) considered four progressively aggregated definitions of local housing markets and found that the results typically held across definitions of markets (except that they are less likely to be statistically significant for more aggregated markets, due to the small counts issue). For this reason, we do not consider 58 LMAs and 16 regional councils (RC): Stillman and Maré (2008) found similar results for 58 LMAs to those for 140 LMAs, while results for 16 RCs tended to be statistically insignificant due to higher standard errors associated with small counts.

[11] There are 67 TLAs but we drop the Chatham Islands Territory as this TLA has very few data points (number of residents, number of house sales, number of rents, etc).

[12] Newell and Papps (2001) use travel-to-work data at area unit level drawn from the 1991 Census to derive LMAs in New Zealand using an algorithm that ensures that most people who live in a LMA work in it, and most people who work in a LMA live in it. Two sets of LMAs are defined – one with 140 areas and one with 58. The main difference is that the former provides greater disaggregation of some relatively small areas. The 140 LMAs are defined by enforcing a minimum employed population of 2,000 and 75% self-containment of workers (allowing for some trade-off between the two). These LMAs have an average size of approximately 1900 square kilometres. In main urban areas, LMAs generally encompass the urban area and an extensive catchment area. In rural areas, LMAs tend to consist of numerous small areas, each centred on a minor service centre.

[13] Although we exclude the under-18 population as directly demanding housing, we control for the presence of children in households. Approximately 1% of individuals in the 1986 and 1991 census and 4-6% of individuals in the 1996-2013 census do not provide enough information to classify whether they are NZ-born or foreign-born and 0.02-0.03% of individuals have an undefined current address. Imputation was used more extesively by Statistics NZ prior to 1996, which likely explains the increase in individuals missing country of birth.

students and military personnel living in group quarters. Our concern with excluding these individuals is that for many the choice whether to reside in a private dwelling is endogenously determined with characteristics of local housing markets. As discussed further below, we allow for the possibility that the local population composition in different areas could differentially impact the housing market, we include extensive controls for the demographic and socio-economic characteristics of local area populations and examining changes over time in both population and housing markets.

3.2   Housing market data

The housing market data used in this paper come from three different sources. First, data on sales prices come from QVNZ, which is New Zealand's largest valuation and property information company and currently conducts legally required property valuations for rating (tax) purposes for over 80 percent of New Zealand local government areas (councils). In earlier years QVNZ conducted valuations for all councils. Although the remaining councils use competing valuation companies to conduct their property valuations, these data are purchased by QVNZ to create a complete database of all New Zealand properties. QVNZ maintains a comprehensive database of all property sales that have occurred since 1982 and provides data for several categories of residential dwellings. This database was matched by QVNZ to census meshblocks and made available to us in an aggregate form at the meshblock level on an annual basis.[14]

Second, data on rents come from the MBIE Tenancy Bonds database. Weekly rent data for all rental properties with new tenants are collected from tenancy bonds which landlords are required by law to lodge with MBIE's Tenancy Services at the beginning of a tenancy. While it is not compulsory for a landlord to require a bond from a tenant, any bond that is required from the tenant must legally be lodged by the landlord with Tenancy Services; thus the data cover most arms-length rentals in New Zealand. The data that we use are publicly available from the MBIE website and cover quarterly data from March 1993, disaggregated by (2001) census area units (which are aggregations of meshblocks) and property types. We use mean rent, based on (newly) lodged bonds during the quarter.

We use the QVNZ data to create average sales prices in each geographic area for two different categories of residential dwelling in each of the census years: dwellings of a fully detached or semi-detached style on their own clearly defined piece of land ('houses'); and rental flats that have been purpose built ('apartments'). For each of these categories, we aggregate the

---

[14] Property-level data are not available because of confidentiality and privacy reasons. There is likely a changing composition of properties being sold over time in different areas because of the building of new properties, the upgrading of older properties, and selective selling of particular type of properties. Given that we are examining fairly aggregated local areas over 5-year periods, we have not attempted to mix-adjust the data. We also have information on the valuation of all properties in each meshblock, however we focus on sales prices since they provide the more accurate information on market values.

mean sales price in each meshblock up to the appropriate geographical area weighting by the population of each meshblock in that year.[15] Similarly, we use the Tenancy Bonds data to measure average weekly rents in each geographic area and census year separately for houses and for apartments. We first aggregate these series over the four quarters (July to June) in each census year, and then over the appropriate geographical area weighting by the population of each area unit in that year.[16] As the rent data cover only 1993 onwards, we exclude 1986 and 1991 when we examine the relationship between population changes and rents.

Finally, we use building consents data provided by Statistics New Zealand to derive information on new houses and apartments, as well as alterations and extensions. The data are available monthly at the (2013) area unit level since 1990, and provide information on the number of building consents, the number of units (i.e. house or apartments) that each consent is for, the (floor) area under consent, and the consented value.[17]

3.3   Descriptive statistics

Table 1 summarises the characteristics of the population in each census year from 1986–2013. Some well-known demographic trends are apparent in these statistics. There was a steady increase in the population, from 2.3 million adults in our analytical sample for 1986, rising to 3.0 million in 2013; and the population was ageing, with the average age of the adults increasing from 42.9 in 1986 to 47.2 in 2013. There are noticeable trends in household structure, with a declining share of couple-headed families and increases in other types of household, although the average household size remained comparatively stable over time.

The growth in the migrant population is apparent, with the foreign-born share of the adult population rising from 18.8% in 1986 to 29.6% in 2013. Not surprisingly, those born in NZ who lived in the same TAW five years previously (staying New Zealanders) are the largest group across each census. The steady increase in migrants is reflected in the increasing shares of the three sub-groups determined by their international and/or domestic migration over the previous 5 years (new, moving, and staying immigrants), and the declining shares of the NZ-born sub-groups, although the share of returning New Zealanders has fluctuated around 2 percent in each census.

The summary of building consents information in the next panel imply that, on average, the total number of consents amount to about 10-15% of the number of dwellings in an area,

---

[15] This aggregation was done after dropping the meshblocks with the highest 1% and lowest 1% of median sales price to median government valuation ratio. We further drop area units whose average rateable valuation to average sale price is greater than 2 or smaller than 0.5. In general, overall sales prices and valuations should be similar in an area, so these outliers either reflect measurement error or that properties way outside the norm for an area have been sold.
[16] We also create additional data series which use the number of sales (rentals) in each meshblock (area unit) as the weighting variables. Our main results are all qualitatively similar when we use these alternative measures, thus we focus on the population-weighted means since this is the average sales price or weekly rent a randomly allocated person would pay for a home in a particular geographic area.
[17] Floor area is not available for alteration consents. Also, consent value tends to underestimate the true value under consent – e.g. Page and Fung (2011) find that consented value is about 4-16% lower than contract value.

and about half of the consents are for new-builds (versus extensions). Also, as a rough comparison of the consistency of the building consents data with the number of occupied dwellings, we have calculated the predicted increase in number of dwellings between censuses (estimated as the number of new-build consents) and compared this with actual change in occupied dwellings. The ratio of predicted to actual change in dwellings is expected to be greater than 1 because of unrealised consents, but may vary empirically because of the timing of building versus consent, possible destruction of dwellings, or changes over time in whether dwellings are occupied.[18] The average ratio across the censuses is greater than 1 for three of the four censuses that provide a meaningful comparison, and varies between 0.9 in 2006 and 1.4 in 1996.

Our main analyses examine the relationship between local population changes and local changes in house prices and rents. The next part of Table 1 summarises population characteristics in each of the census years and are weighted to be representative of the adult population. This shows the average adult population in a TAW increased by 32 percent from 60,000 in 1986 to 79,000 in 2013. In contrast, the mean real house sales price increased 140 percent over the period from $194,000 in 1986 to $469,000 in 2013. There were particularly large house price increases occurred between 1991 and 1996 (average house prices increased 28%, and average log(prices) increases 0.2), and between 2001 and 2006 (average house prices by 64%, and average log(prices) by 0.5). Although apartment prices followed similar trends to house prices, the average increases (in both level-prices and log(prices)) were somewhat lower than for house prices. In contrast, average rents for both houses and apartments generally increased less than prices, which suggests the owner and renter markets operate quite differently and the importance of asset price effects in house sales. In terms of housing supply, the average number of private, permanent dwellings in each TAW increased by 40% while the average number of bedrooms in those dwellings increased by 48% over the period 1986-2013.

To provide a sense of whether the population composition (by New Zealand versus foreign born, and recent international and domestic migration status) may have important effects on the housing market, Table 2 presents the characteristics of the six subpopulations of interest. Various differences suggest the demand for housing may differ across the subpopulations. For example, the populations vary by stage of the life cycle, with settled residents (both New Zealand and foreign born) being older on average, and new immigrants and returning New Zealanders being younger. There are noticeable differences in the housing tenure across the columns: settled (stayer) New Zealanders and immigrants have significantly higher rates of home ownership; new immigrants are much more likely to live in rental accommodation; and the

---

[18] Coleman and Karagedikli (2018) report that old house are replaced at the rate of 2.5-3.0 dwellings per 1,000 people annually which, given an average TAW population of 60,000–70,000, represents about 75-100 dwellings over a 5-year census period.

other groups are somewhere in between. Of interest is that, although the average age of returning New Zealanders is similar to that of new immigrants, they have much higher rates of home ownership. There are also differences in the household composition of the different subpopulations: for example, new immigrants live in larger households which suggests that each new immigrant may contribute relatively less to housing demand. These differences suggest that each group may differentially affect house prices, and/or affect segments of the housing market, such as home-ownership versus renting. To flexibly allow for different population effects in our analysis, we will examine different housing market segments separately, and also control for socio-economic characteristics of the subpopulations.

3.4   Exploratory analysis of house prices and population

In order to provide something of a cross-walk to the macroeconomic time series literature (Coleman and Landon-Lane 2007; McDonald 2013) and our local area analysis, we begin with a descriptive analysis of the relationships between population and house price changes. This involves first graphical description, and second regression analysis, of the relationships.

In Figure 2 and Figure 3 we describe the relationship between intercensal house price and population changes: Figure 2 pools the inter-censal periods, while Figure 3 plots relationships separately for each period. The top row of Figure 2 summarises the aggregate changes in house prices versus total population (column 1), and foreign-born (immigrant) and New Zealand born populations in columns 2 and 3 respectively. The first two graphs show similar strong aggregate times series relationships between house price changes and total population or immigrant-population changes (of 12 percent and 10 percent in response to a 1 percent population change respectively) to those reported by Coleman and Landon-Lane (2007) and McDonald (2013); while the third graph shows no relationship between price changes and NZ-born population changes.

The second row of Figure 2 disaggregates the aggregate house price and population data to the local (TAW) level and presents scatterplots of local average price changes against population changes. The size of each data-circle is proportional to the average local-area population across consecutive censuses, while the (red) line gives the population-weighted linear fit of the data. Pooled across census periods, this shows a much weaker local-area house price versus population change relationship than in the aggregate data: the estimated price elasticities with respect to the full population is 1.0, and with respect to the immigrant and NZ-born populations is 1.9 and 0.6 respectively.

To see whether areas whose populations grow relatively faster than the national average have higher house price growth, the final row of Figure 2 plots the local average price changes against population changes relative to the aggregate changes in each period. This again shows a weaker local-area house price versus population change relationship, with estimated price

elasticities of 0.3, 0.1, and 0.5 with respect to the full population, immigrant, and NZ-born populations respectively. In this case the relationship between price and immigrant changes is statistically insignificant, so the overall population effect appears to be most strongly associated with local-area NZ-born population changes.

To clarify the separate census-period patterns, Figure 3 disaggregates the scatterplots from row 2 of Figure 2, separately by census period. These graphs clearly show strikingly different patterns of both (higher) price and population changes between 2001 and 2006 than the other inter-censal periods. In addition, the local-area weighted-average relationship between either total population or immigrant population change and average house price change was negative in this period, compared to generally mild positive relationships for other periods.

We next provide an exploratory regression analysis of the relationship between local-area and (aggregate) New Zealand population and local-area house prices.[19] For this, we use TAW-level data from the 1986–2013 censuses, and summarise the results in Table 3. Regression results for house prices in levels (logarithms) are presented in panel (A), and results for house price log-changes in panel (B). In column (1) we present results from simple regressions on log(local area population): the estimates are each positive and significant, implying local-area population elasticities of 0.3 in levels and 0.92 in changes. We next include log(NZ population), which has large positive coefficients in both the level (3.2) and change (9.9) regressions: in fact, the estimated log-change regression coefficient of 9.9 is in the range of long-run elasticities that Coleman and Landon-Lane (2007) estimate. In addition, although the estimated local-area population coefficients in column (2) remain positive and statistically significant, they are somewhat lower than in column (1), particularly in the log-change regression. Consistent with the pattern of results seen in Figure 2 and Figure 3, this is suggestive of omitted variable bias inflating the population elasticities.

In column (3) we include census-year fixed effects to control for aggregate effects common across areas, which also absorbs the aggregate population variable. There are two comments of note from this specification. First, the local-area population elasticities are the same as in column (2), implying any coefficient 'bias' from omitted aggregate effects are adequately controlled by the aggregate population variable. Second, as measured by its contribution to the increase in the R-squared associated with the year fixed effects between columns (1) and (3) regressions, population is a substantial contributor (or proxy for) unobserved aggregate factors – i.e. it accounts for 92% of the increase in level-regression R-squared, and 50% of the increase in the log-change R-squared.

Finally, in columns (4) and (5), we report results for regressions that correspond to our 'preferred' specifications discussed in section 5.1 below, including either census-year fixed

---

[19] Coleman and Landon-Lane (2007) and McDonald (2013) focus on the link between migration (rather than population) and house prices: nonetheless, this exploratory analysis is informative.

effects (column (4)) or log(NZ population) (column (5)).[20] The results in 'levels' imply that, controlling for other area-level characteristics, the (column (5)) effects of both local and aggregate population on local-area house prices are smaller (particularly the coefficient on aggregate population) than reported in column (2) and no longer statistically significant. In contrast, the 'changes' estimates are broadly similar to the simple regression estimates, with larger local area population elasticities of 0.5–0.6, and only a slightly smaller aggregate population elasticity of 8.7 in column (5).

As expected, this descriptive analysis demonstrates that aggregate population is strongly associated with local-area house prices, and also accounts for a large fraction of the variation associated with the census-year fixed effects. Because of the possible confounding macroeconomic factors associated with this variation, in what follows we abstract from these effects and focus on the relationship between housing and population effects at the local-area.

4   Model framework

In this section we briefly outline the conceptual framework used to analyse the relationship between alternative measures of housing demand and supply, and population growth and immigration, and then derive the empirical specification used in the analysis. This begins with a stylised structural supply and demand system for housing, from which we derive reduced-form equations used to estimate the relationship between measures of the price and quantity of housing, and population and other exogenous variables in the system. The framework will be applied at the local area level separately for both Territorial Authorities and Auckland Wards (TAW), and Labour Market Areas (LMA), and within these also to different housing market segments – i.e. stratified by houses versus apartments, and sales versus rental markets.

We posit that a local housing market can be characterised by demand for, and supply of, housing equations as follows:

$$Q_{jt}^D = \beta_D . P_{jt} + \delta_D . Pop_{jt} + X_{jt}^{D\prime} . \gamma_D + \epsilon_{jt}^D, \qquad \text{(1a)}$$

$$Q_{jt}^S = \beta_S . P_{jt} + X_{jt}^{S\prime} . \gamma_S + \epsilon_{jt}^S, \qquad \text{(1b)}$$

where Q_{jt}^D and Q_{jt}^S represent the quantity of housing demanded and supplied in local market-j in year-t, P_{jt} is a measure of the price of housing, Pop_{jt} is (possibly) a vector of variables capturing the population size and composition effects on housing demand, and X_{jt}^D and X_{jt}^S are vectors of other exogenous variables that affect local housing demand and supply respectively.[21] In this framework, we expect the price effects on housing demand (β_D) and supply (β_S) to be negative

---

[20] Our preferred 'changes' specification estimates presented here are based on all available observations, in contrast to those in section 5.1 which are based on a balanced panel sample.

[21] For emphasis and focus, we include the population variable(s) explicitly in the demand equation, separately from the other exogenous variables X_{jt}^D.

and positive respectively: i.e. all else equal, when the price of housing is higher, we expect less demand, perhaps in the form of smaller houses; while supply will increase, because it will be more attractive to supply housing. We also expect that population size will increase housing demand, so the coefficient (δ_D) will be positive. Other variables that are likely to affect housing demand even controlling for the size of the population include the socio-demographic and economic characteristics of the local population, such as the marital status, age, qualification, employment, and household size. Similarly, we will use building consent information on alterations relative to new-buildings as controls to proxy for regulations and/or geographical constraints on housing supply.

Equations (1a) and (1b) represent the demand and supply structural equations for the housing market. Assuming housing markets are in equilibrium then the realised price and quantity of housing observed at any point in time represent the equilibrium price (P_{jt}) and quantity (Q_{jt}). Our primary interest is understanding the relationship between housing prices and rents and population changes; and our secondary focus is on the responsiveness of housing (supply) to population changes. For these purposes, we derive the (so-called) reduced-form equations for the price and quantity, in terms of all the exogenous variables, as follows:

$$P_{jt} = \frac{-\delta_D}{\beta_D - \beta_S}.Pop_{jt} - X_{jt}^{D\prime}.\frac{\gamma_D}{\beta_D - \beta_S} + X_{jt}^{S\prime}.\frac{\gamma_S}{\beta_D - \beta_S} + \frac{\epsilon_{jt}^S - \epsilon_{jt}^D}{\beta_D - \beta_S}$$

$$= \pi_{PPop}.Pop_{jt} + X_{jt}^{D\prime}.\pi_{PXD} + X_{jt}^{S\prime}.\pi_{PXS} + u_{jt}^P \qquad (2a)$$

$$Q_{jt} = \frac{-\beta_S\delta_D}{\beta_D - \beta_S}.Pop_{jt} - X_{jt}^{D\prime}.\frac{\beta_S\gamma_D}{\beta_D - \beta_S} + X_{jt}^{S\prime}.\frac{\beta_D\gamma_S}{\beta_D - \beta_S} + \frac{\beta_D\epsilon_{jt}^S - \beta_S\epsilon_{jt}^D}{\beta_D - \beta_S}$$

$$= \pi_{QPop}.Pop_{jt} + X_{jt}^{D\prime}.\pi_{QXD} + X_{jt}^{S\prime}.\pi_{QXS} + u_{jt}^Q \qquad (2b)$$

where the $\pi_{P.}$ And $\pi_{Q.}$ are the reduced-form coefficients on the exogenous variables affecting housing demand or supply, and u_{jt}^P and u_{jt}^Q are residuals, which depend on the structural equation parameters and errors. Given the expected signs of the structural coefficients ($\delta_D > 0, \beta_D < 0, \beta_S > 0$), the reduced-form relationships between price and population, and between quantity and population, in equations (2a) and (2b) will each be positive ($\pi_{PPop} > 0, \pi_{QPop} > 0$).

Our empirical analysis below will focus on specifications of these reduced-form equations for housing prices and quantities. It is important to realise that the adequacy of these reduced-form equations will depend on the adequacy of the structural equations (1a and 1b) and market equilibrium assumptions. For example, if the structural equations are misspecified due to the omission of relevant variables, such misspecification will also flow through to the reduced-form equations (2a and 2b) and affect the estimation of these equations.

Following Stillman and Maré (2008), we assume the basic relationship between the price of housing and population involves log-log specifications for quantities, prices and population in

both the demand and supply equations. For demand shifters, we include control variables for the average socio-demographic and physical characteristics of the households in an area.[22] For supply shifters, we use information on building consents to proxy for regulation and/or physical constraints on supply in an area. Our main variable in this regard is the share of housing consents that are for new-build houses and apartments rather than extensions, which we interpret as affecting the relative supply flexibility in an area. For example, we expect this share variable will be higher in areas with more flexible regulations or less binding geographic constraints that facilitate an increase in the quantity of available housing at lower marginal cost.[23] As the available information on factors that affect housing demand and supply is limited, we will also use area-level fixed effects to control for constant unobserved differences across areas.

For brevity of notation, we combine the main population size (log(Pop)) and composition (population-share) variables of interest, and denote these simply as $\log(Pop_{jt})$ and summarise the combined set of demand and supply control variables in the vector X'_{jt}. The main reduced-form regressions of interest are expressed in levels as:

$$\log(P_{jt}) = \pi_{PPop}.\log(Pop_{jt}) + X'_{jt}.\pi_P + u^P_{jt} \qquad (3a)$$

$$\log(Q_{jt}) = \pi_{QPop}.\log(Pop_{jt}) + X'_{jt}.\pi_Q + u^Q_{jt}. \qquad (3b)$$

In our analysis of the relationship between population and house prices and rent, we will consider various extensions to the basic specification of equations (3a and 3b), to allow the relationship between the price of housing and population to vary with either population growth, perhaps reflecting short term supply constraints, and/or the immigrant versus native mix of the population, perhaps reflecting heterogeneous housing demand across such sub-populations. We will also consider estimating regressions for alternative specifications of equations (3a and 3b) in levels, including area-level fixed effects to control for persistent differences in house prices and rents across areas that are not adequately controlled for by observed factors; and also in first-differences between census years.

As discussed in section 3.3, to flexibly allow differential population effects across the housing market, we will estimate separate reduced form price equations for the various house versus apartments and sales-price versus rental housing market segments. However, we will estimate reduced form quantity equations just for the combined market.

---

[22] The physical characteristics (such as the number of bedrooms), in particular, can be thought of as providing hedonic regression adjustments for house prices or rents.

[23] In contrast, areas where the share of new-builds are lower because of with more stringent regulations that inhibit new builds, and may result in increases in the relative quality of the housing stock. Our analysis does not control for such quality changes, e.g. through a hedonic housing adjustment.

5   Analysis and results

Our initial focus is on residential house prices as the primary outcome (dependent) variable, and conduct the analysis using TAW-level observations. We then consider corresponding results for the other housing outcomes of interest (the number of dwellings, price of apartments, rents of houses, and rents of apartments), and alternative LMA-level observations.

5.1   Residential house prices

We now turn to our main house price regressions for equation (3a) in levels using TAW-level data, which are summarised in Table 4. The first specification, in column (1), simply regresses the logarithm of average house prices, log(House prices), on log(Adult population) , as well as the share of the number of building consents for housing units that are for <u>new</u> (houses and apartments) as opposed to alterations as a housing supply shifter proxy for supply constraints due to (e.g.) building regulations or land availability, and census-year fixed effects using all available observations over the period 1991–2013.[24] The estimated coefficient on log(population) is +0.25 and statistically significant, and implies, controlling for general house price differences across census years, that house prices are about 2.5% higher in areas with 10% higher population. To the extent that the new-build share measure is a positive supply-shift proxy, we would expect it to positively affect housing quantity and negatively affect prices: in contrast, the estimated effect of this measure on house prices is positive but not statistically significant.

To examine whether there are heterogeneous population effects on the price of housing related to the immigration versus native mix of the population, in column (2) we include the fractions of the population that are (since the last census) new immigrants, returning New Zealanders, moving immigrants, moving New Zealanders, and staying immigrants.[25] In this specification the log(Pop) coefficient is substantially lower, and implies house prices are on average 1% higher in areas with 10% higher population(from 'staying New Zealanders', the omitted population-share category). The included population-share variables are each positive, suggesting these other subpopulations have greater effect on house prices, although only the 'returning New Zealanders' and 'moving immigrants' coefficients are statistically significant. For example, in areas with a 1% (0.01) higher share of returning New Zealanders (and 1% fewer staying New Zealanders), house prices are about 29% higher on average, in addition to any

---

[24] This building consents measure is calculated over the period between census dates, and may be (conceptually) better suited to a house price <u>change</u> specification, with its 'integrated equivalent' measure used in the log (level) specification. In the absence of such an integrated measure, we will include this measure in both the levels and changes specifications.
[25] Together with the fraction of staying (i.e. non-migrating) New Zealanders (the omitted category), these fractions sum to 1.

population-size (main) effect.[26] Similarly, an area with a 1% redistribution of population from staying New Zealanders to moving immigrants has about 6.7% higher house prices. The estimated coefficient on the new-build consent share is now significant: a 10% increase in the new-build share increases house prices by 3.2% on average.

In column (3), we include controls for various observable socio-demographic characteristics. Including these controls, has a small effect on the population size coefficient (which falls about 10% to 0.09), but substantially reduces most of the coefficients on the population-composition shares. As discussed above, these effects are consistent with the composition subgroups having observably different characteristics that systematically affect their demand for housing.

To allow for possible dynamic responses of house prices to population growth, we next include population growth ($\Delta \log(Pop_{jt}) = \log(Pop_{jt}) - \log(Pop_{jt-1})$) in the regression. In column (4) we include just $\Delta \log(Pop)$ to the regression, and in column (5) we also include the changing shares of the population subgroups. The results from these regressions are comparable to those in column (3) and imply that neither population growth nor composition changes have noticeable effects on house prices. The absence of dynamic responses suggests the analysis based on the census-timing of the data provides long run estimates of the relationship between population and house prices.

The results in columns (6) – (8) are for regressions that include TAW fixed effects to control for constant unobserved differences across areas. We first exclude the population growth and change in population shares (column (6)), then include these variables (column (7)). Including the area fixed effects results in a statistically significant estimated log(population) coefficient of 0.29–0.3 and appears to absorb much of the population share effects, as well as the population growth effects. This suggests that (e.g.) the large and significant returning New Zealanders and moving immigrant share effects observed earlier are largely associated with these groups moving into areas with higher average house prices. Based on these results, we adopt the specification in column (6) as our preferred 'levels'-specification.

Finally, for consistency of samples across other outcomes, we re-estimate the preferred regression specification (column (6)) on the sample restricted to a balanced panel of TAWs observed from 1996 to 2013 and with no missing observations between 1991 and 2013.[27] The results from this regression, presented (in **bold**) in column (8), imply that areas with 10% higher population have 3.9% higher house prices on average, controlling for observable covariates and fixed unobservable factors, while there is no strong evidence that population effects vary systematically across population subgroups. In fact, these results imply that a higher

---

[26] Strictly speaking, the reported coefficient of 0.29 implies the average log(price) is 0.29 log-points higher in areas with 1% more returning New Zealanders, which transforms to 34% higher house prices. To simplify the discussion, we will interpret such log-point effects as "percentage" effects.

[27] This will provide a consistent sample to compare results with those estimated in differences, as well as to those of other outcomes (numbers of dwellings and apartment prices).

share of new immigrants is associated with lower TAW house prices, while a higher share of moving New Zealanders is associated with higher house prices.

We next estimate analogous census first-difference regressions:

$$\Delta\log(P_{jt}) = \pi_{PPop}.\Delta\log(Pop_{jt}) + \Delta X'_{jt}.\pi_P + \tilde{u}^P_{jt},$$

where $\Delta\log(P_{jt}) = \log(P_{jt}) - \log(P_{jt-1})$ etc, and the differencing operates between censuses – i.e. over 5 years, except between 2006 and 2013 censuses. We summarise the results from several specifications in Table 5, using the balanced panel of TWA13 changes over 1996 – 2013. The first specification again includes just population growth, the new-build share variable and census-year fixed effects and finds areas with 10% stronger population growth have about 5.6% stronger house price growth, while the new-build share effect on price changes is weakly negative.

In the next two specifications we first include the change in population shares, and then also the (changes in) socio-demographic controls. Although the population share coefficients suggest heterogeneous effects across subgroups (column 2), when covariates are included there are no significant population-share effects (column 3), and the population growth coefficient is higher (0.65). In column (4), we consider an alternative specification to the change in population-shares, which categorises the contributions to between-census population growth associated with new immigrants, returning New Zealanders, existing (i.e. non-new) immigrants and existing New Zealanders.[28] The results show somewhat larger population growth (0.93) and new-build share of consents (-0.18) coefficients than in column (3), and a lower R-squared.

The final specification we present, in column (5), reconsiders the dynamic population effects by including the (current) log(population) and population-shares. Although some of the population-share coefficients are significant in this regression, the main population growth is largely unaffected, and the log(population) coefficient is small and insignificant. For this reason, we treat column (3) as our preferred 'changes'-specification.

In addition to the OLS regression results we present in Table 5, we have also considered the possibility that people choose to locate in areas partly on the basis of (lower) house prices, in which case population changes and the mix of population may be endogenously determined. This may be particularly important for more mobile population subgroups, such as new immigrants and returning New Zealanders. To investigate this, we estimated an instrumental variables regression of the preferred column (3) specification, in which we adopted the lagged log(population) and population shares as instruments for population growth and the changes in

---

[28] This alternative specification of population shares corresponds to that used by Stillman and Maré (2008). We exclude the population growth from existing New Zealanders.

population shares respectively.[29] The results from this regression (not presented) were quite poor statistically: tests of the 'first stage' indicate the set of instruments have very weak predictive power for the population growth and changes in shares variables, resulting in the 'second stage' results of interest having no precision.

5.2   Alternative housing price outcomes

Given that housing represents a durable asset as well as a source of shelter, house prices will reflect asset price effects as well as the consumption value of housing services. In contrast, the rent price of housing should more fully reflect the value of housing services. To examine this issue, in this section we repeat the main analysis above for the alternative housing price outcomes of house and apartment rents, as well as apartment prices and housing quantity. We summarise the results, again estimated using TAW-level data, based on the preferred 'levels' specification (from column (8) in Table 4) in Table 6, and the results from the preferred 'changes' specification (from column (3) in Table 5) in Table 7. To facilitate direct comparison with the log(House prices) results discussed above, we have repeated these results in the first columns of these tables.

First, the results for apartment prices in column (2) are broadly in line with those for house prices, although the population size effects are somewhat smaller, with price elasticities of 0.3–0.4, and less precisely estimated. In addition, the population share coefficients generally have the same signs as in the house price regressions, but again are less precisely estimated.

Next, the results for house and apartment rents, presented in columns (3) and (4), show small and no statistically significant population size effects on rents.[30] However, the estimates imply that, compared to the omitted group of staying New Zealanders, the shares of new residents (including new and moving immigrants, and returning and moving New Zealanders) have stronger positive effects on rents. This result is particularly strong for returning New Zealanders, and generally more significant in the changes specification in Table 7. The absence of any population size effects on rents provides suggestive evidence of the importance of asset price factors underlying the population effects on house and apartment prices.[31]

In the two final columns of Table 6 and Table 7, we report regression estimates for two alternative measures of log(Housing quantity): first, where quantity is measured as the number of census (occupied) private, permanent dwellings, and second, with quantity measured as the

---

[29] This follows and extends the approach pioneered by Bartel (1989), Altonji and Card (1991), and others based on the evidence that new immigrants settlement decisions are strongly influenced by (previous) migrant networks – for New Zealand, see Maré and Stillman (2010).

[30] As information on rents is only available from 1993, the analysis sample period (1996–2013) is shorter than for house and apartment prices.

[31] However, there are important caveats associated with being able to formally interpret the price effects as being due to population effects on asset prices. These include that the housing in the sales and rental markets is comparable, that rent reflects only the consumption value of housing, and the respective relationships are stable over time (given the rent regressions are estimated over a shorter period).

number of bedrooms in those dwellings. Because we use occupied dwellings as our measure, our estimated supply elasticity will include increased availability of dwellings achieved by a reduction in unoccupied dwellings. The 'levels' results imply that the local-area elasticity of housing quantity with respect to population is close to 1 (0.91-0.94), while the 'changes' estimated elasticity is lower (0.82-0.88) but still strong, and the estimates are 4-6 percent higher for the 'bedrooms' than 'dwellings' quantity measure. These results suggest little evidence of household crowding, which is broadly consistent with the relative constancy of the average household size (of just over 3).[32]

The estimated population share effects on housing quantity are somewhat variable across the level and change regressions. However, compared to staying New Zealanders, the share of moving New Zealanders is associated with lower local area housing quantity, suggesting this population group tends to migrate to more slowly growing areas – e.g., areas that have 1% more moving New Zealanders (and 1% fewer staying New Zealanders) have, on average, about 0.4% less housing growth.

Although our analytical focus is primarily on the reduced-form estimates, subject to acceptable specification of these equations, they can be used to identify the price elasticities of demand and supply. Using the framework discussed in section 4, the housing demand equation is exactly identified by the new-build share of building consents variable, which is included in the supply equation but excluded from the demand equation, and so can be used as an instrument (IV) for log(price). In contrast, the housing supply equation is over-identified by the log(population) size and composition variables, which can be used as instruments for log(price). Given this over-identification, we will present a variety of estimates based on the population size and composition-share instruments.

Table 8 summarises our results of this analysis: panel (a) shows results from levels specifications, and panel (b) from changes specifications. For comparison, we also present OLS estimates of the same regressions. The IV estimated price elasticity of demand is -0.5 in levels and -0.3 in changes (with only the changes estimate being statistically significant), compared to the OLS estimates of -0.02. The supply elasticity estimates are somewhat more variable, for both the levels and changes specifications and also based on the alternative instruments. Compared to the OLS estimates of 0.03–0.04, using just log(population) as an instrument for log(price), we estimate supply elasticities of 3.5 (in levels) and 1.2 (in differences). In contrast, the estimates using the composition-share variables as instruments are both small (-0.1–0.03) and statistically insignificant; while the estimates based on the (full) combined set of instruments lie between the separate estimates (0.2–0.3). The composition-share based IV estimates are consistent with the notion that, conditional on the size of the population, composition changes in the population

---

[32] These results are also consistent with Coleman and Karagedikli's (2018) estimates that 0.25–0.3 houses are built for each additional person in a region – i.e. 0.75–0.9 dwellings will be built for an average household size of 3.

do not systematically affect the price or quantity of housing.[33] Also, given the greater stability of the reduced form estimates of the log(population) versus composition-share effects, we expect the housing supply elasticities based on the log(population) instrument to be more reliable.

Given the building consents are flow variables and conceptually more consistent with the difference specification, we consider the regression in changes to be the preferred specification. For example, the coefficients on the new-unit share of building consents (0.24) are remarkably consistent across the four supply-equation regressions, implying a 10 pp increase in the new-unit share of consents leads to a 2.4% increase in supply of houses. In addition, we estimate the population elasticity of demand is 1 in changes. Thus, the changes estimates suggest the housing supply is relatively elastic with respect to price (1.2), while housing demand is relatively inelastic (-0.3).[34] Although elastic housing supply may appear counter to perceived wisdom, given the five (or seven) year frequency of the census data, we interpret these elasticities as representing medium-to-longer term response elasticities. Also, our analysis uses 'occupied dwellings', so our estimates reflect adjustment due to changes in occupancy rates as well as changes in the number of dwellings.

5.3 Alternative area-level observations

We have re-estimated regressions for these outcomes using labour market area (LMA) level data. A summary of the results, analogous to Table 6 and Table 7, are presented in the appendix Table A1 and Table A2. The results are comparable to the TAW results discussed here, although we find somewhat weaker population effects on house prices and stronger effects on apartment prices using the LMA-level data.

Given the strength of housing price increases in Auckland, as well as the importance of Auckland as a destination for new immigrants, we next focus analysis within Auckland. To do this, we analyse area unit level (AU01) data for the subset of area units within Auckland Wards. The results are summarised in Table 9. The results in the first and third columns are for the preferred log-level and log-change specifications respectively. These indicate that, at the area unit level within Auckland, the population effects on house prices are much smaller than found nationally for higher levels of aggregation: e.g. in the log-change regression 10% local population growth is estimated to raise house prices by only 1.6% (compared to 6.7% and 6.0% for TAW and LMA-level estimates), while the log-level regression estimate is smaller and insignificant.

An increasingly important issue with more finely defined areas is that house prices are likely to be affected by factors outside the local area, for example as a result of demand spillovers from nearby areas. One simple way to gauge the strength of such spillovers is to

---

[33] Nonetheless, over-identification tests, and redundancy tests (not reported), of the composition-shares as instruments are always rejected.
[34] These elasticity estimates are broadly in line with long-run supply elasticities estimated by Malpezzi and Maclennan (2001) for the US and UK, and demand elasticities estimated by Hanushek and Quigley (1980) for the US.

include coarser-area controls. In particular, in the regressions reported in the second and fourth columns, we include the Ward-level log(population) and population shares (or changes) as control variables. Including these variables does not alter the basic results shown in first and third columns. For example, in the log-change regression (column 4), the effect of Ward-level population growth is small (0.007) and insignificant, so that, combined with this effect, the local area population effect on house prices is almost the same as in column 3.

5.4   Miscellaneous analyses

To assess the robustness of our main results we have examined whether the price-population relationship is asymmetric across areas with growing versus contracting populations. To do this we revert to the preferred specifications for the outcome change regressions and TAW-level data. In these regressions, we include an indicator for whether the local-area population declined in the period since the previous census, and interactions between this indicator and the population change and population-share change variables. The results from these regressions are presented in Table 10. The coefficients on the population-decline indicator show that prices rise more slowly in areas that contract, although the effect is not statistically significant except for apartment prices. Furthermore, the interactions with log(population) change are all insignificant, implying no systematic evidence of significantly different population effects on prices in growing and contracting areas. The interactions with population-share changes are sometimes significant, and difficult to interpret.

6   Concluding discussion

In this paper we re-examine the relationship between the size and composition of local area population and housing market price and quantity outcomes, using New Zealand data for 1986–2013. We derive a reduced-form model for estimating the effects of demand-side and supply-side factors on housing prices.

Our main analysis gives estimates of the elasticity of local area house prices with respect to population of between 0.4 and 0.65, mean that on average a 10-percent increase in local-area population is associated with an increase in house sale prices of 4-6.5 percent. We find similar but somewhat weaker effects of population on apartment sales prices; but no effects on rents. Furthermore, after controlling for observable differences in the socio-demographic characteristics of areas, there is little systematic evidence of a relationship between the composition of the local-area population and housing market prices, but we do find rents are positively related to higher shares of recent movers. In particular, we find no evidence that a higher share of new (international) immigrants in an area is associated with higher house prices. Although these estimates are smaller than those found internationally, they are broadly similar

to the previous New Zealand analysis by Stillman and Maré (2008) using similar data and methodology. Our analysis also shows that the smaller the local-area level, the smaller the effect of population on housing prices.

We also find strong local area quantity responses to population changes, with the elasticities of the number of dwellings and the number of bedrooms with respect to population growth of about 0.9. These results suggest little evidence of increased household crowding, which is broadly consistent with the relative constancy of the average household size (of just over 3). We again find little evidence that housing quantity is related to the composition of the population, other than a negative association with the share of moving New Zealanders to an area. Although these estimates should be interpreted with caution, taken on face value they suggest relatively elastic longer-term housing supply with respect to prices (1.2), and inelastic housing demand (-0.3).

Finally, we have presented a range of results based on aggregate, regional and narrowly defined areas within Auckland that are consistent with the hypothesis that the smaller the area of analysis the weaker will be the impact of population on housing. In part, this reflects the difficult trade-off between being able to better control for local factors that affect housing in narrowly defined areas versus missing broader aggregate or spillover factors that are also important in affecting housing market outcomes. Developing a better framework for analysis or finding suitable opportunities to advance knowledge remains a considerable challenge for this literature.

References

Aitken, Andrew. 2014. "The Effects of Immigration on House Prices and Rents: Evidence from England and Wales." Manuscript. Royal Holloway, University of London.

Akbari, Ather H, and Yigit Aydede. 2012. "Effects of Immigration on House Prices in Canada." Applied Economics 44 (13): 1645–58.

Altonji, J G, and David Card. 1991. "The Effects of Immigration on the Labor Market Outcomes of Less-Skilled Natives." In Immigration, Trade, and the Labor Market, edited by John M Abowd and Richard B Freeman, 201–34. Chicago: University of Chicago Press.

Bartel, Ann P. 1989. "Where Do the New US Immigrants Live?" Journal of Labor Economics, 371–391.

Cochrane, W, and Jacques Poot. 2016. "Past Research on the Impact of International Migration on House Prices: Implications for Auckland."

Cochrane, William, and Jacques Poot. 2020. "Effects of Immigration on Local Housing Markets." In The Economic Goeography of Cross-Border Migration. K. Kourtit, B. Newbold, P. Nijkamp, and M. Partridge (Eds). Springer Verlag.

Coleman, Andrew, and Özer Karagedikli. 2018. "Residential Construction and Population Growth in New Zealand: 1996-2016." 2018/02. Discussion Paper. Reserve Bank of New Zealand.

Coleman, Andrew, and John Landon-Lane. 2007. "Housing Markets and Migration in New Zealand, 1962-2006." Reserve Bank of New Zealand.

Degen, Kathrin, and Andreas Fischer. 2017. "Immigration and Swiss House Prices." Swiss Journal of Economics and Statistics (SJES) 153 (I): 15–36.

Fry, Julie. 2014. "Migration and Macroeconomic Performance in New Zealand: Theory and Evidence." 2014/10. Working Paper. Wellington, New Zealand: The Treasury.

Hanushek, Eric A, and John M Quigley. 1980. "What Is the Price Elasticity of Housing Demand?" The Review of Economics and Statistics, 449–54.

Malpezzi, S., and D. MacLennan. 2001. "The Long-Run Price Elasticity of Supply of New Residential Construction in the United States and the United Kingdon." Journal of Housing Economics 10: 278–306.

Maré, David C., Arthur Grimes, and Melanie Morten. 2009. "Adjustment in Local Labour and Housing Markets." Australasian Journal of Regional Studies 15 (2): 229–48.

Maré, David C, and Steven Stillman. 2010. "The Impact of Immigration on the Geographic Mobility of New Zealanders." Economic Record 86 (273): 247–59.

McDonald, Chris. 2013. "Migration and the Housing Market." 2013–10. Analytical Note. Reserve Bank of New Zealand.

Newell, James O., and Kerry L. Papps. 2001. "Identifying Functional Labour Market Areas in New Zealand: A Reconnaissance Study Using Travel-to-Work Data." Occasional Paper 2001/6. Wellington, NZ: Labour Market Policy Group, Department of Labour. http:\\www.dol.govt.nz.

Page, I. C., and Fung, J. 2011. "Cost Efficiencies of Standardised New Housing." Study Report SR247. BRANZ.

Sá, Filipa. 2014. "Immigration and House Prices in the UK." The Economic Journal 125 (587): 1393–1424.

Saiz, Albert. 2003. "Room in the Kitchen for the Melting Pot: Immigration and Rental Prices." Review of Economics and Statistics 85 (3): 502–21.

———. 2007. "Immigration and Housing Rents in American Cities." Journal of Urban Economics 61 (2): 345–71.

Saiz, Albert, and Susan Wachter. 2011. "Immigration and the Neighborhood." American Economic Journal: Economic Policy 3 (2): 169–88.

Stillman, Steven, and David C. Maré. 2008. "Housing Markets and Migration: Evidence from New Zealand." Motu Working Paper 08–06.

Figure 1: New Zealand net migration and house price changes, 1963–2016
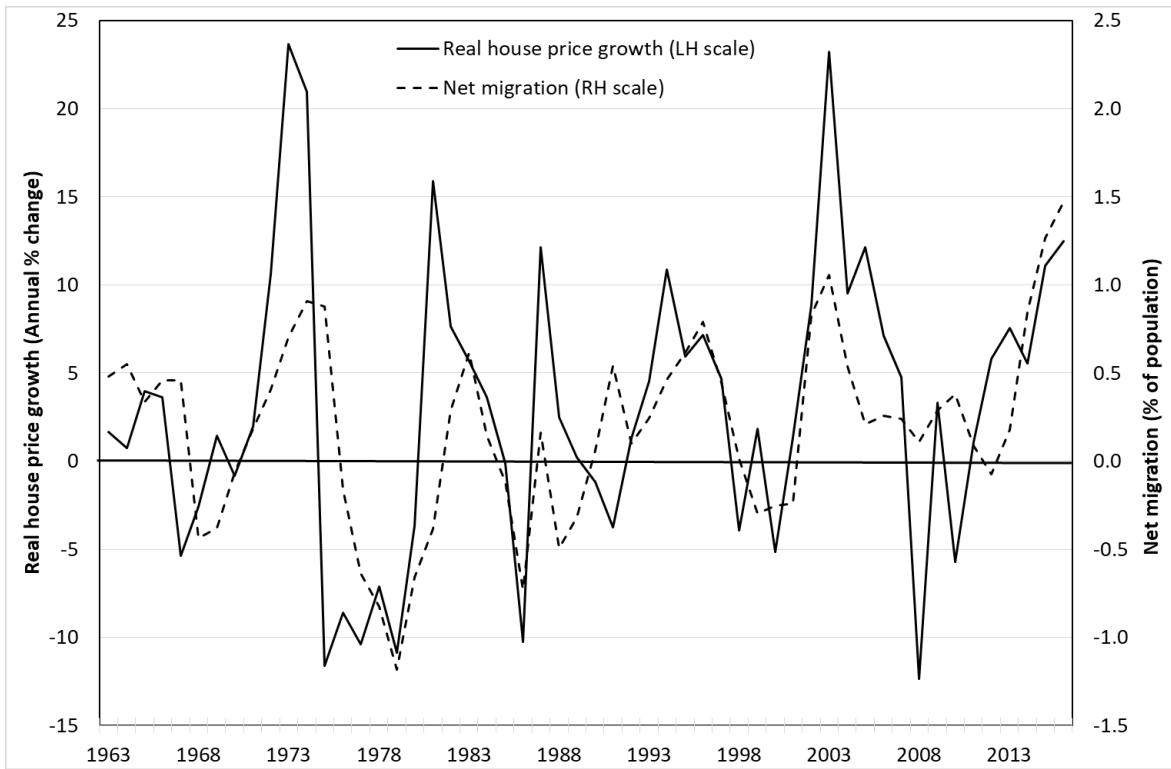
Source: Statistics New Zealand and Reserve Bank of New Zealand.

Figure 2: New Zealand house price versus population changes, Census 1986–2013
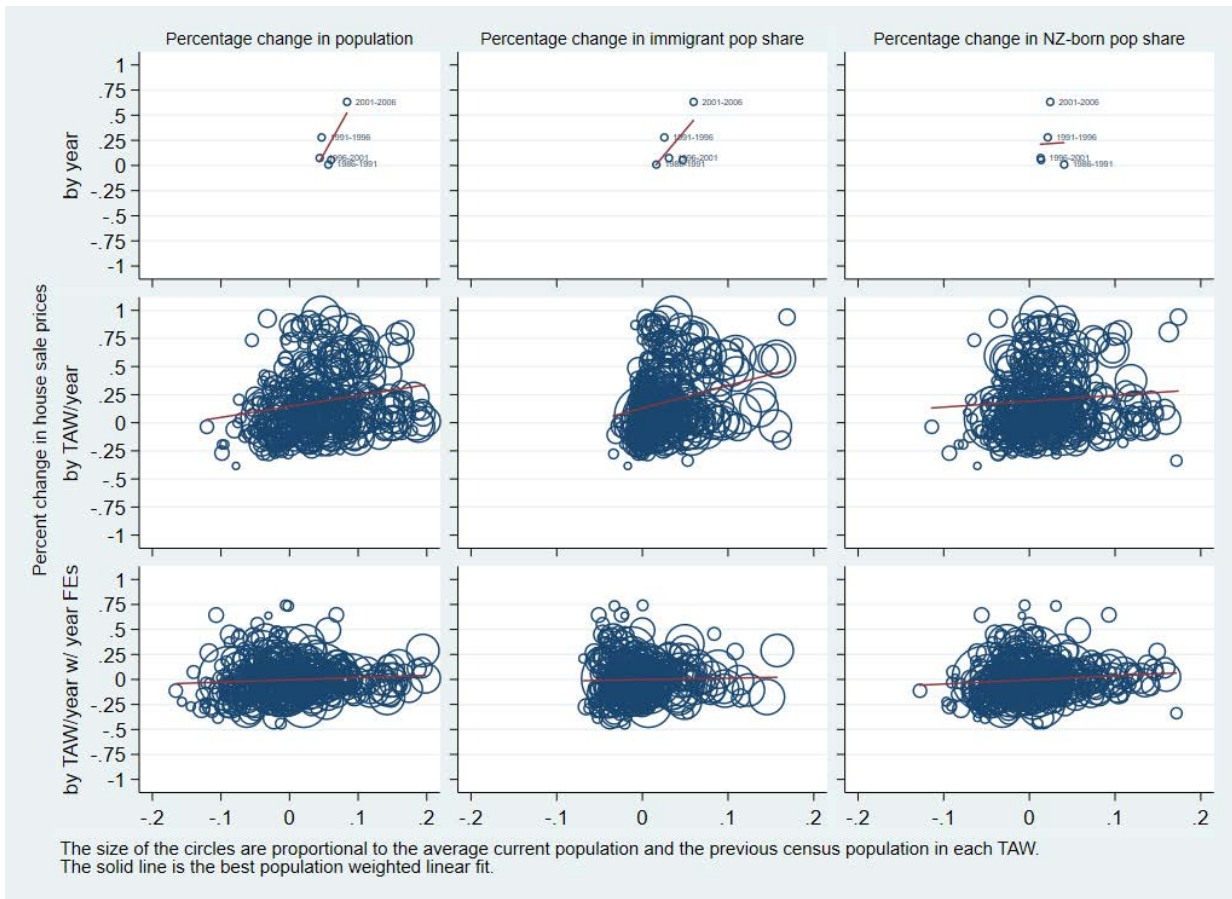
Figure 3: Inter-censal house price versus population changes, Census 1986–2013
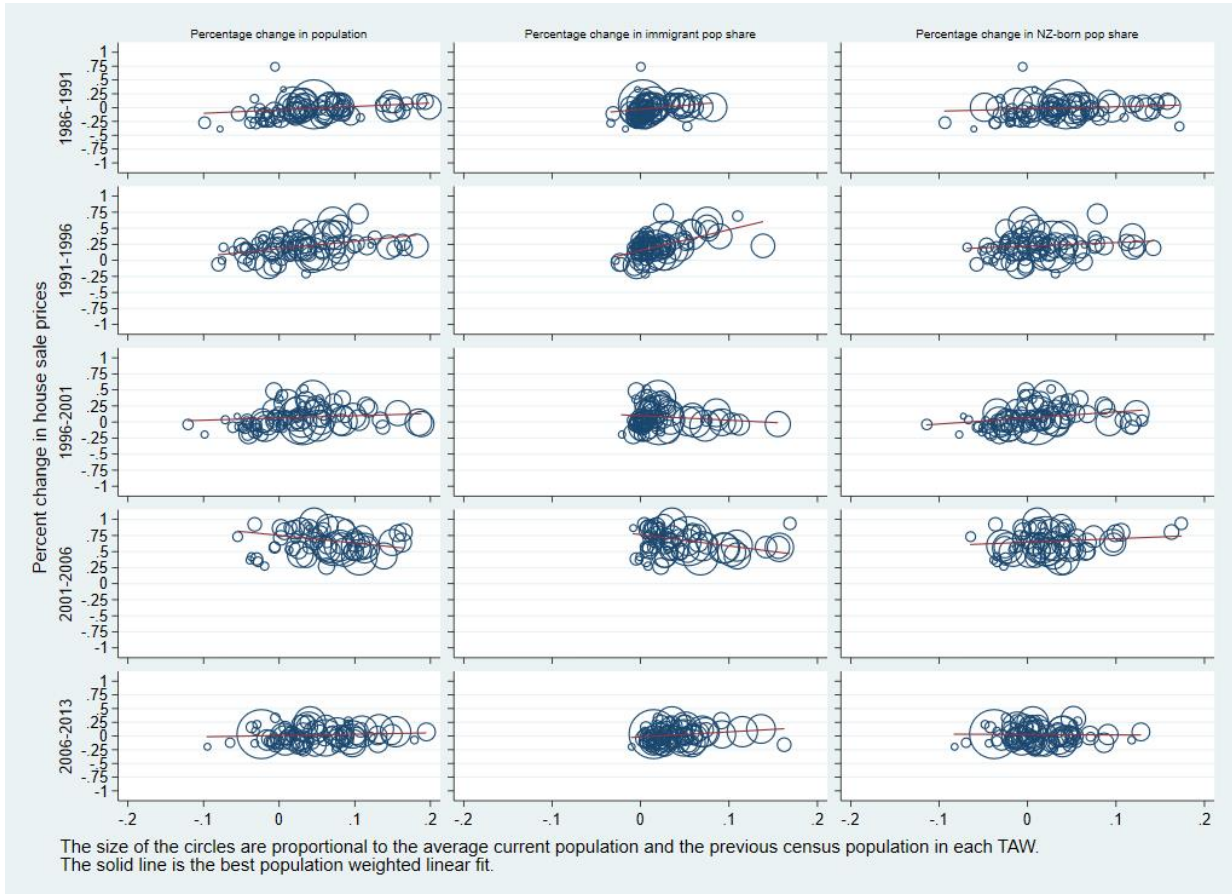
Table 1: Sample characteristics, 1986–2013 Census years

	Census year					
	1986	1991	1996	2001	2006	2013
Population counts:						
Adult (18+)	2,268,774	2,396,142	2,507,211	2,616,201	2,834,460	3,004,737
Total population	3,237,489	3,334,233	3,458,487	3,593,322	3,841,506	3,989,190
Demographics:						
Age	42.9	43.3	44.1	45.2	45.8	47.2
Female	0.511	0.515	0.519	0.522	0.521	0.523
No qualifications	0.379	0.322	0.328	0.240	0.223	0.189
School qualifications	0.228	0.243	0.262	0.347	0.314	0.330
Post school qualifications	0.260	0.313	0.194	0.192	0.238	0.221
University qualifications	0.056	0.066	0.089	0.111	0.158	0.199
Qualifications missing	0.078	0.056	0.127	0.109	0.067	0.061
Never married	0.210	0.223	0.211	0.204	0.199	0.207
Married/De facto	0.647	0.622	0.627	0.632	0.641	0.637
Div/Sep/Widow	0.136	0.149	0.134	0.143	0.137	0.133
Employed	0.630	0.566	0.615	0.632	0.669	0.647
Unemployed	0.037	0.061	0.047	0.046	0.031	0.045
Not in LF	0.333	0.373	0.338	0.323	0.301	0.308
Income	$33,652	$31,343	$33,348	$36,033	$39,026	$39,964
log(income)	10.42	10.34	10.40	10.48	10.56	10.58
Missing/Zero income	0.069	0.062	0.091	0.108	0.097	0.099
Household structure:						
Household size	3.15	3.05	3.01	2.96	3.01	3.01
Single adult	0.092	0.102	0.103	0.119	0.114	0.114
Couple adults	0.220	0.231	0.242	0.248	0.253	0.254
Sole parent family	0.058	0.068	0.065	0.070	0.069	0.066
Couple family	0.412	0.375	0.341	0.308	0.312	0.304
Mixed household	0.217	0.225	0.238	0.209	0.253	0.262
TAW Population shares:						
Staying Nzers	0.622	0.614	0.603	0.592	0.556	0.549
New Immigrants	0.024	0.033	0.045	0.054	0.072	0.058
Returning Nzers	0.020	0.018	0.023	0.017	0.023	0.019
Moving Immigrants	0.031	0.032	0.032	0.034	0.039	0.050
Moving Nzers	0.170	0.174	0.166	0.161	0.155	0.137
Staying Immigrants	0.133	0.128	0.132	0.141	0.155	0.188
Building consents®[1]						
Total units (H&A)	—	232	4,479	5,120	5,350	7,178
Share new units	—	0.537	0.507	0.498	0.494	0.434
New units/Change in dwellings	—	—	1.430	1.169	0.914	1.063
TAW-level averages:						
Population	60,228	63,272	67,044	70,173	76,820	79,070
House prices	$194,277	$196,563	$251,974	$271,316	$443,598	$468,942
Apartment prices	$172,203	$162,950	$197,630	$198,098	$308,964	$316,451
House rents (weekly)	—	—	$300	$295	$348	$389
Apartment rents (weekly)	—	—	$230	$220	$255	$281
Number of dwellings	28,483	30,752	33,372	35,568	38,960	39,758
Number of bedrooms	78,530	86,405	94,272	102,116	112,968	116,188
Relative intercensal (log) changes:						
House prices	—	-0.013	0.203	0.064	0.500	0.023
Apartment prices	—	-0.062	0.152	-0.014	0.450	0.009
House rents	—	—	—	-0.024	0.164	0.105
Apartment rents	—	—	—	-0.062	0.147	0.089
Number of dwellings	—	0.088	0.076	0.062	0.088	0.059
Number of bedrooms	—	0.102	0.080	0.075	0.092	0.066

Notes: Population base is usual resident population, aged 18+, with no missing country of birth or regional council of current residence. Adult and total population are counts; all other statistics are means, weighted by area adult population count (of RR3 TAW counts), except log-changes which are weighted by average adult population across the two censuses. All price, rent and income values are in 2013-$ values.
[1] Building consent information is cumulative over the period since last census, except 1991 which is only since 1990.

Table 2: Sample characteristics, by sub-population

	Full Pop'tion	Stayer NZer	New Immig	Return NZer	Mover Immig	Mover NZer	Stayer Immig
Private dwelling	96.7	97.1	96.1	97.2	95.8	94.9	97.3
Housing tenure:							
Owned with mortgage	38.2	40.5	29.3	40.9	35.8	33.5	37.3
Owned without mortgage	28.2	32.6	12.1	16.3	18.3	15.0	34.3
Rent	25.0	19.0	48.8	35.1	36.4	40.8	20.3
Free	3.6	3.5	3.6	3.8	3.6	4.3	3.3
Missing	5.0	4.4	6.2	3.9	5.9	6.4	4.9
Average age	44.9	46.6	35.9	35.8	42.7	37.2	51.0
Female	51.9	52.1	51.8	51.6	50.5	52.2	51.5
Ethnicity:							
European	75.7	82.3	40.0	82.9	57.5	79.1	61.5
Maori	7.1	9.0	0.1	6.5	0.3	10.3	0.2
Pacific	3.5	1.0	7.5	1.4	11.5	1.0	13.2
Asian	5.8	0.5	42.7	0.6	21.5	0.5	16.9
Other ethnic	1.1	0.5	5.7	0.5	2.8	0.4	2.4
Mixed	6.8	6.7	4.0	8.0	6.4	8.8	5.7
Qualifications:							
No qualifications	27.4	31.9	9.6	13.8	17.7	23.5	24.3
School qualifications	29.1	27.8	32.4	28.8	31.3	31.8	29.3
Post-school qual's	23.5	23.4	20.3	29.5	23.1	25.3	22.3
University degree	11.8	8.5	27.0	23.0	20.6	13.3	14.4
Missing qualifications	8.3	8.5	10.8	4.9	7.4	6.1	9.8
Labour force status:							
Employee	48.2	47.7	47.4	59.3	48.0	54.0	42.8
Non-employee	13.4	14.8	7.2	13.1	12.5	11.1	12.8
Employed, not stated	1.2	1.1	3.1	1.0	1.3	1.0	1.6
Unemployed	4.4	3.8	7.2	5.8	5.5	6.5	3.5
Not in labour force	32.7	32.7	35.1	20.8	32.8	27.5	39.2
Income	35,855	36,291	30,675	42,454	35,972	35,621	35,062
Missing income	5.3	5.0	10.6	3.9	5.2	4.5	6.1
Marital status:							
Never married	20.9	20.3	23.3	28.2	18.6	29.8	12.3
Currently married	52.6	53.5	54.4	43.8	53.7	40.1	62.9
De facto	10.8	9.8	11.5	16.8	12.3	16.7	7.0
Divorced/ Separated	7.6	7.6	3.5	8.6	8.9	8.6	7.4
Widowed	6.2	7.1	1.8	1.2	4.8	3.4	8.4
Not specified	1.9	1.7	5.4	1.4	1.6	1.5	2.0
Household structure:							
Single occupant	10.9	12.2	4.6	9.6	8.8	8.9	11.2
Mixed	23.8	18.8	42.3	28.1	32.3	34.6	22.9
Couple only	24.4	25.5	17.4	22.5	23.2	21.8	25.8
Couple with kids	34.2	36.1	32.4	33.0	30.6	28.3	34.5
Single-parent family	6.7	7.4	3.4	6.7	5.0	6.4	5.6
Number of children	0.8	0.8	0.9	0.7	0.8	0.8	0.8
Number of adults	2.2	2.2	2.6	2.2	2.4	2.2	2.4
Household size	3.0	2.9	3.6	2.9	3.2	3.0	3.2
Populations share	100.0	58.7	4.9	2.0	3.7	15.9	14.8
Adult population (18+)	15,628,527	9,168,414	766,902	310,740	575,652	2,492,532	2,314,287
Average (per census)	2,604,755	1,528,069	127,817	51,790	95,942	415,422	385,715
Total population	21,455,211	12,570,483	1,073,781	428,346	791,529	3,460,740	3,130,332
Average (per census)	3,575,869	2,095,081	178,964	71,391	131,922	576,790	521,722

Notes: See notes to Table 1. Populations are pooled across the 1986–2013 censuses.

Table 3: Exploratory log(House price) regressions, 1986–2013 Census years

	(1)	(2)	(3)	(4)	(5)
(A) log(House price) regressions					
Log(local population)	0.300***	0.254***	0.254***	0.286*	0.178
	(0.090)	(0.078)	(0.078)	(0.148)	(0.154)
Log(NZ Pop)	—	3.242***	—	—	0.345
		(0.129)			(1.240)
Constant	9.261***	-38.14***	9.413***	-3.777	-6.011
	(0.923)	(1.39)	(0.793)	(4.599)	(16.54)
Year fixed effects	N	N	Y	Y	N
Pop'n composition	N	N	N	Y	Y
No. Observations	468	468	468	390	390
R-squared	0.227	0.554	0.582	0.988	0.986
(B) log(House price)-change regressions					
Δlog(local population)	0.917***	0.397***	0.397***	0.503***	0.589***
	(0.139)	(0.099)	(0.094)	(0.183)	(0.182)
Δlog(NZ Pop)	—	9.900***	—	—	8.657**
		(0.562)			(3.452)
Constant	0.107***	-0.425***	-0.0348**	0.207***	-0.356
	(0.005)	(0.032)	(0.015)	(0.074)	(0.224)
Year fixed effects	N	N	Y	Y	N
Pop'n composition	N	N	N	Y	Y
No. Observations	390	390	390	390	390
R-squared	0.057	0.390	0.725	0.835	0.831

Notes: All regressions are estimated using OLS using TAW-level data from 1986–2013. Estimated standard errors are in parentheses, adjusted for area-level clustering. Results in columns (1) – (3) are simple regressions (1), and including either aggregate NZ population (2) or census-year fixed effects (3). Column (4) reports the results from our 'preferred' specifications including census-year fixed effects (see Table 4 and Table 5) but using all available data, and column (5) replaces the census-year fixed effects with aggregate population.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Regressions of log(House prices), 1991–2013, TAW

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	**(8)**
Log(Pop)	0.248***	0.102***	0.088***	0.089***	0.086***	0.286*	0.309**	**0.394****
	(0.084)	(0.035)	(0.026)	(0.026)	(0.029)	(0.148)	(0.136)	**(0.182)**
Change in log(Pop)	—	—	—	-0.086	-0.020	—	-0.155	**—**
				(0.321)	(0.316)		(0.252)	
Population share:								
New Immigrant	—	0.881	0.143	0.186	1.953*	-0.953	-0.420	**-3.000****
		(0.841)	(0.649)	(0.650)	(1.126)	(0.778)	(1.448)	**(1.162)**
Return NZ	—	28.50***	16.17***	16.43***	16.67***	4.549	-5.771	**5.227**
		(6.218)	(3.523)	(3.956)	(5.201)	(3.448)	(5.372)	**(3.888)**
Moving Immigrant	—	6.660***	2.936***	3.036***	3.040**	0.0335	0.529	**1.004**
		(2.456)	(0.961)	(1.038)	(1.332)	(1.655)	(2.015)	**(1.721)**
Moving NZ	—	0.314	0.874*	0.894*	0.656	2.043***	1.888**	**1.524****
		(0.726)	(0.518)	(0.524)	(0.607)	(0.715)	(0.844)	**(0.730)**
Staying Immigrant	—	0.921	-0.282	-0.290	-0.586	0.380	1.464	**-0.581**
		(0.792)	(0.522)	(0.518)	(0.547)	(0.767)	(0.899)	**(1.124)**
Change in population share:						—		
New Immigrant	—	—	—	—	-2.763**	—	0.520	**—**
					(1.321)		(1.474)	
Return NZ	—	—	—	—	-1.267	—	6.711**	**—**
					(2.944)		(2.881)	
Moving Immigrant	—	—	—	—	-1.587	—	-1.905	**—**
					(2.241)		(2.318)	
Moving NZ	—	—	—	—	0.590	—	0.488	**—**
					(0.582)		(0.598)	
Staying Immigrant	—	—	—	—	-1.870	—	-3.495**	**—**
					(1.310)		(1.523)	
New share consents	0.474	0.324**	0.119	0.129	0.176	0.0224	-0.011	**-0.091**
	(0.321)	(0.151)	(0.092)	(0.111)	(0.114)	(0.114)	(0.116)	**(0.174)**
Constant	9.21***	9.92***	-7.657***	-7.499***	-8.31***	-3.777	-4.734	**-5.020**
	(0.84)	(0.33)	(2.834)	(2.776)	(2.61)	(4.599)	(5.110)	**(5.636)**
Controls:								
Census-FEs	Y	Y	Y	Y	Y	Y	Y	**Y**
Covariates	N	N	Y	Y	Y	Y	Y	**Y**
Area-FEs	N	N	N	N	N	Y	Y	**Y**
No. Obs	390	390	390	390	390	390	390	**308**
R-squared	0.580	0.898	0.966	0.966	0.967	0.988	0.989	**0.989**

Notes: All columns estimated using OLS, with estimated standard errors (in parentheses) adjusted for area-level clustering. The regressions in columns (1) – (7) use all observations for which complete data is available; for comparison with the change in log(House prices) regressions in Table 5, and the log(Number of dwellings) and log(Apartments prices) outcomes, the regression in **bold** in column (8) repeats the specification in column (6) using the balanced sample of TAWs with complete observations over 1991–2013, and is the *preferred specification* that we use for comparing results across alternative outcomes. Observable covariates include controls for the fractions of the adult population who are female, in various age-groups, educational qualifications, employment status, marital status, household composition, and income.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Regressions of log(House prices) changes, 1991–2013, TAW

	(1)	(2)	**(3)**	(4)	(5)
Change in	0.564***	0.564***	**0.650*****	0.930***	0.342
log(Population)	(0.168)	(0.202)	**(0.218)**	(0.262)	(0.234)
Log(Population)	—	—	**—**	—	-0.0003
					(0.011)
Change in pop-share:					
New Immigrants	—	0.991	**-0.141**	—	2.372*
		(0.597)	**(0.962)**		(1.418)
Return NZs	—	7.658***	**8.632****	—	8.346**
		(2.709)	**(3.525)**		(3.882)
Moving Immigrants	—	0.421	**0.147**	—	-1.834
		(1.564)	**(1.666)**		(1.859)
Moving NZs	—	2.905***	**1.970*** **	—	2.553***
		(0.514)	**(0.621)**		(0.642)
Staying Immigrants	—	1.200**	**0.292**	—	1.668
		(0.567)	**(1.087)**		(1.271)
Population share of:					
New Immigrants	—	—	**—**	—	-0.431
					(0.588)
Return NZs	—	—	**—**	—	1.133
					(1.955)
Moving Immigrants	—	—	**—**	—	2.945***
					(0.744)
Moving NZs	—	—	**—**	—	-0.319
					(0.233)
Staying Immigrants	—	—	**—**	—	0.0342
					(0.253)
New H&A share of	-0.136**	-0.124	**-0.147****	-0.178***	-0.132*
Building consents	(0.068)	(0.085)	**(0.066)**	(0.061)	(0.072)
Growth contribution:					
New Immigrants	—	—	**—**	-0.678	—
				(0.551)	
Return NZs	—	—	**—**	-0.764	—
				(1.858)	
Existing Immigrants	—	—	**—**	-0.430	—
				(0.579)	
Constant	0.246***	0.221***	**-0.309***	-0.290	-0.246
	(0.041)	(0.049)	**(0.181)**	(0.201)	(0.235)
Controls:					
Census-FEs	Y	Y	**Y**	Y	Y
Covariates	N	N	**Y**	Y	Y
No. Observations	308	308	**308**	308	308
R-squared	0.716	0.760	**0.841**	0.824	0.848

Notes: All regression are estimated by OLS on the balanced sample of TAWs with complete observations over 1991–2013. Estimated standard errors (in parentheses) adjusted for area-level clustering. The results in **bold** in column (3) are for the *preferred specification* that we use for comparing results across alternative outcomes.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6: Regressions of Other outcomes, 1991–2013, TAW

	log(House prices)	log(Apartment prices)	log(House rents)	log(Apartment rents)	log(Number Dwellings)	log(Number Bedrooms)
Log(Population)	**0.394****	0.277	-0.0601	0.0595	0.910***	0.936***
	(0.182)	(0.222)	(0.123)	(0.156)	(0.020)	(0.020)
Pop'n share of:						
New Immigrants	**-3.000****	-2.256	2.418***	2.797**	0.359**	0.216
	(1.162)	(1.423)	(0.773)	(1.241)	(0.163)	(0.141)
Return NZs	**5.227**	7.977	4.970**	11.47***	0.566	0.604
	(3.888)	(5.270)	(2.132)	(4.033)	(0.517)	(0.426)
Moving Immigrants	**1.004**	0.227	3.165***	2.883*	0.409	0.228
	(1.721)	(2.407)	(0.944)	(1.637)	(0.285)	(0.217)
Moving NZs	**1.524****	1.103	1.023**	1.871**	-0.363***	-0.427***
	(0.730)	(0.955)	(0.460)	(0.717)	(0.126)	(0.088)
Staying Immigrants	**-0.581**	1.017	3.671***	3.261**	-0.0884	0.205
	(1.124)	(1.464)	(0.966)	(1.442)	(0.162)	(0.140)
New H&A share of	**-0.091**	0.204	-0.111	-0.044	0.047**	0.078***
Building consents	**(0.174)**	(0.171)	(0.081)	(0.117)	(0.022)	(0.016)
Constant	**-5.020**	-3.410	-4.442	-4.719	0.641	-0.411
	(5.636)	(8.225)	(5.321)	(7.681)	(0.781)	(0.749)
No. Observations	**308**	308	210	210	308	308
R-squared	**0.989**	0.972	0.996	0.990	1.000	1.000

Notes: All regressions estimated by OLS and include census-year fixed effects, observable covariates, and area-level fixed effects. Estimated standard errors (in parentheses) are adjusted for area-level clustering. The log(House prices), log(Apartments prices), log(Number of dwellings) and log(Number of bedrooms) regressions are estimated over 1996 – 2013 on the balanced sample of TAWs with complete observations over 1991 – 2013. The log(House rents) and log(Apartment rents) regressions are estimated over 2001 – 2013 on the balanced sample of TAWs with complete observations over 1996 – 2013.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 7: Regressions of Other outcome changes, 1991–2013, TAW

	log(House prices)	log(Apartment prices)	log(House rents)	log(Apartment rents)	log(Number Dwellings)	log(Number Bedrooms)
Change in	0.650***	0.376	-0.110	-0.051	0.817***	0.884***
log(Population)	(0.218)	(0.260)	(0.107)	(0.120)	(0.035)	(0.031)
Change in pop-share:						
New Immigrants	-0.141	-0.768	1.622***	1.691**	0.132	0.203
	(0.962)	(1.352)	(0.417)	(0.701)	(0.127)	(0.144)
Return NZs	8.632**	10.92**	5.636***	10.27***	0.201	0.350
	(3.525)	(5.184)	(1.549)	(2.310)	(0.375)	(0.379)
Moving Immigrants	0.147	-2.157	3.024***	2.656**	0.260	0.299
	(1.666)	(2.543)	(0.749)	(1.191)	(0.242)	(0.212)
Moving NZs	1.970***	2.333**	0.945***	1.692***	-0.366***	-0.342***
	(0.621)	(0.956)	(0.344)	(0.410)	(0.132)	(0.0730)
Staying Immigrants	0.292	-0.512	2.698***	2.234***	-0.327**	-0.0779
	(1.087)	(1.738)	(0.516)	(0.770)	(0.157)	(0.144)
New H&A share of	-0.147**	0.019	0.056*	0.058*	0.044***	0.038***
Building consents	(0.066)	(0.081)	(0.031)	(0.034)	(0.015)	(0.010)
Constant	-0.309*	-0.936***	-0.151*	-0.331***	0.008	0.062**
	(0.181)	(0.271)	(0.078)	(0.094)	(0.026)	(0.024)
No. Observations	308	308	210	210	308	308
R-squared	0.841	0.727	0.861	0.808	0.952	0.966

Notes: All regressions estimated by OLS and include census-year fixed effects, and observable covariates. Estimated standard errors (in parentheses) are adjusted for area-level clustering. The log(House prices), log(Apartments prices), log(Number of dwellings) and log(Number of bedrooms) regressions are estimated on the balanced sample of TAWs with complete observations over 1991 – 2013. The log(House rents) and log(Apartment rents) regressions are estimated on the balanced sample of TAWs with complete observations over 1996 – 2013.
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Housing Demand and Supply elasticities, 1991–2013, TAW

	Demand-equation		Supply-equation			
		IV:		Instrumental Variables		
	OLS	New-units BC share	OLS	Log(Pop)	Pop Shares	Log(Pop) &Shares
(a) Levels						
Log(price)	-0.021	-0.516	0.030	3.487**	-0.101	0.173*
	(0.016)	(0.717)	(0.043)	(1.583)	(0.096)	(0.091)
Log(Population)	0.936***	1.113***	—	—	—	—
	(0.022)	(0.254)				
Building Consents share new units	—	—	0.214**	0.139	0.216***	0.210***
			(0.096)	(0.482)	(0.078)	(0.079)
Diagnostics:						
First-stage F-stat	—	0.27	—	3.07	15.97	12.43
		(0.61)		(0.08)	(0.00)	(0.00)
Over-identification (Hansen J-statistic)	—	—	—	—	[a]	[a]
(b) Changes						
ΔLog(price)	-0.020	-0.297***	0.038**	1.184***	0.028	0.341***
	(0.012)	(0.105)	(0.018)	(0.310)	(0.066)	(0.085)
ΔLog(Population)	0.900***	1.009***	—	—	—	—
	(0.017)	(0.053)				
Building Consents share new units	—	—	0.237***	0.236***	0.237***	0.237***
			(0.031)	(0.045)	(0.029)	(0.026)
Diagnostics:						
First-stage F-stat	—	4.99	—	14.54	8.50	6.83
		(0.03)		(0.00)	(0.00)	(0.00)
Over-identification (Hansen J-statistic)	—	—	—	—	12.09	26.85
					(0.02)	(0.00)

Notes: All regressions are based on the balanced sample of 308 TAW census observations, and include census-year fixed effects, and observable covariates. Estimated standard errors are in parentheses (except p-values for diagnostic statistics) are adjusted for area-level clustering. The instrumental variable (IV) estimates are from 2SLS regressions. For the demand equation, we use the share of building consents for new-builds as an instrument for price. For the supply equation, we use either log(population size) and/or the composition shares as instruments: the specifications reported do not include these variables if they are not used as IVs.

[a] The over-identification statistics were not reported for the levels specifications, due to estimated covariance matrix of moment conditions not of full rank.

Table 9: Auckland house price regressions, 1991–2013, Area Units

	log(House prices)		Change in log(House prices)	
	Area unit FEs	Ward Controls	Observable Controls	Ward Controls
Log(Population)	0.030	0.0174	0.162***	0.154***
	(0.061)	(0.078)	(0.046)	(0.044)
Population share of:				
New Immigrants	-0.641**	-0.635**	-0.636**	-0.530*
	(0.289)	(0.281)	(0.236)	(0.297)
Return NZs	-0.907	-1.528	-0.499	-1.114
	(0.987)	(1.014)	(0.626)	(0.631)
Moving Immigrants	0.408	0.119	0.008	-0.227
	(0.244)	(0.262)	(0.163)	(0.199)
Moving NZs	0.305	0.160	0.314	0.102
	(0.220)	(0.193)	(0.244)	(0.184)
Staying Immigrants	-0.440	-0.585**	-0.659*	-0.699*
	(0.260)	(0.248)	(0.347)	(0.382)
New H&A share of	0.025	0.019	-0.0281	-0.034
Building consents	(0.032)	(0.033)	(0.025)	(0.027)
Constant	2.548	0.483	0.234**	0.276**
	(3.466)	(4.118)	(0.101)	(0.093)
No. Observations	872	872	872	872
R-squared	0.982	0.983	0.763	0.772

Notes: In the change regressions all covariates are in changes. All regressions are estimated over 1996 – 2013 on the balanced sample of Auckland Wards with complete observations over 1991 – 2013, and include census-year fixed effects, and observable covariates. The log(house price) regressions also include Area Unit (AU01) fixed effects. The specifications in columns labelled "Ward controls" also include the Ward-level log(population) and population shares to control for possible within-Ward spatial correlation effects. Estimated standard errors (in parentheses) are adjusted for W13 area-level clustering.
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Outcome changes regressions, 1991–2013, TAW – Asymmetric effects

	log(House prices)	log(Apartment prices)	log(House rents)	log(Apartment rents)	log(Number Dwellings)	log(Number Bedrooms)
1(ΔPop<0)	-0.060	-0.124***	-0.021	0.012	0.009**	0.010***
	(0.045)	(0.046)	(0.027)	(0.026)	(0.004)	(0.004)
Δlog(Pop)	0.647***	0.240	-0.058	0.008	0.833***	0.875***
	(0.180)	(0.282)	(0.102)	(0.123)	(0.033)	(0.027)
1(ΔPop<0)	0.486	-0.499	-0.141	-0.154	0.085	0.117
*Δlog(Pop)	(0.831)	(1.010)	(0.551)	(0.448)	(0.107)	(0.083)
Change in Pop-share of:						
New	-0.235	-0.879	1.879***	1.736**	0.161	0.242*
Immigrants	(0.913)	(1.197)	(0.446)	(0.741)	(0.132)	(0.143)
Return NZs	9.496***	10.39**	6.815***	11.67***	0.320	0.0244
	(3.084)	(4.720)	(1.772)	(2.501)	(0.473)	(0.326)
Moving	0.771	-1.507	3.223***	2.654**	0.426	0.298
Immigrants	(1.603)	(2.553)	(0.738)	(1.183)	(0.277)	(0.197)
Moving NZs	1.453**	2.092**	0.919***	1.704***	-0.398***	-0.364***
	(0.553)	(0.967)	(0.328)	(0.404)	(0.135)	(0.066)
Staying	0.364	-0.808	3.056***	2.380***	-0.323**	-0.113
Immigrants	(0.999)	(1.605)	(0.491)	(0.812)	(0.162)	(0.152)
1(ΔPop<0)*ΔPop-share of:						
New	4.606	13.35*	-3.322	-2.702	-0.078	0.163
Immigrants	(4.000)	(6.883)	(2.962)	(2.667)	(0.526)	(0.414)
Return NZs	2.956	0.710	-2.448	-4.893	1.270***	1.242***
	(4.114)	(5.752)	(3.298)	(4.152)	(0.392)	(0.402)
Moving	5.342	-7.581	3.986	2.586	-1.629**	-0.409
Immigrants	(5.497)	(9.608)	(2.447)	(4.220)	(0.797)	(0.577)
Moving NZs	2.015	1.130	0.895	1.010	0.192	-0.0634
	(1.556)	(1.998)	(0.723)	(1.052)	(0.203)	(0.136)
Staying	8.245**	10.75**	0.019	-1.523	0.458	-0.569**
Immigrants	(3.151)	(4.161)	(1.882)	(1.921)	(0.444)	(0.285)
New H&A						
share	-0.216***	-0.025	0.019	0.050	0.044***	0.048***
of consents	(0.064)	(0.084)	(0.032)	(0.039)	(0.013)	(0.009)
Constant	-0.228	-0.742***	-0.108	-0.336***	-0.010	0.038
	(0.169)	(0.266)	(0.079)	(0.105)	(0.026)	(0.025)
Observations	308	308	210	210	308	308
R-squared	0.852	0.744	0.869	0.822	0.956	0.969

Notes: All regressions estimated by OLS and include census-year fixed effects, and observable covariates. Estimated standard errors (in parentheses) are adjusted for area-level clustering. The log(House prices), log(Apartments prices), log(Number of dwellings) and log(Number of bedrooms) regressions are estimated on the balanced sample of TAWs with complete observations over 1991 – 2013. The log(House rents) and log(Apartment rents) regressions are estimated on the balanced sample of TAWs with complete observations over 1996 – 2013.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A1: Regressions of Housing market outcomes, 1991–2013, LMA

	log(House prices)	log(Apartment prices)	log(House rents)	log(Apartment rents)	log(Number Dwellings)	log(Number Bedrooms)
Log(Population)	0.112	0.560	0.095	0.357	0.885***	0.977***
	(0.228)	(0.339)	(0.179)	(0.314)	(0.028)	(0.030)
Population share of:						
New Immigrants	-4.681***	-1.609	2.701**	3.138	0.563**	0.485***
	(1.214)	(2.233)	(1.051)	(2.156)	(0.244)	(0.177)
Return NZs	7.052*	11.34*	1.508	9.591**	-0.136	0.063
	(3.723)	(5.852)	(2.855)	(4.692)	(0.503)	(0.436)
Moving Immigrants	3.303	0.744	1.812	0.898	-0.199	-0.374*
	(2.184)	(3.459)	(1.738)	(2.963)	(0.247)	(0.222)
Moving NZs	0.970	1.410	1.660***	2.194***	-0.175*	-0.209**
	(0.695)	(0.920)	(0.471)	(0.728)	(0.095)	(0.084)
Staying Immigrants	1.175	1.609	4.135***	4.128*	0.153	0.245
	(1.578)	(2.523)	(1.239)	(2.394)	(0.191)	(0.170)
New H&A share of	0.228	0.143	-0.081	-0.111	0.012	0.033**
Building consents	(0.144)	(0.199)	(0.098)	(0.169)	(0.022)	(0.016)
Constant	5.385	2.991	2.557	-0.579	0.717	-0.011
	(8.321)	(11.71)	(6.733)	(11.69)	(1.029)	(1.064)
No. Observations	320	320	195	195	320	320
R-squared	0.991	0.972	0.997	0.991	1.000	1.000

Notes: All regressions estimated by OLS and include census-year fixed effects, observable covariates, and area-level fixed effects. Estimated standard errors (in parentheses) are adjusted for area-level clustering. The log(House prices), log(Number of dwellings) and log(Apartments prices) regressions are estimated over 1996 – 2013 on the balanced sample of LMAs with complete observations over 1991 – 2013. The log(House rents) and log(Apartment rents) regressions are estimated over 2001 – 2013 on the balanced sample of LMAs with complete observations over 1996 – 2013.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A2: Regressions of Housing market outcome changes, 1991–2013, LMA

	log(House prices)	log(Apartment prices)	log(House rents)	log(Apartment rents)	log(Number Dwellings)	log(Number Bedrooms)
Change in	0.616**	0.972***	-0.043	0.094	0.834***	0.875***
log(Population)	(0.251)	(0.352)	(0.151)	(0.237)	(0.048)	(0.037)
Change in pop-share of:						
New Immigrants	-0.665	0.026	1.712**	1.096	0.308*	0.315**
	(0.960)	(1.832)	(0.777)	(1.300)	(0.163)	(0.146)
Return NZs	8.444**	10.07**	3.613**	7.781***	-0.372	-0.172
	(4.214)	(5.029)	(1.719)	(2.583)	(0.376)	(0.311)
Moving Immigrants	3.314*	-1.323	3.108***	2.313	-0.582*	-0.554***
	(1.753)	(2.956)	(1.157)	(2.167)	(0.298)	(0.209)
Moving NZs	2.113***	2.800***	1.231***	1.482***	-0.203**	-0.241***
	(0.559)	(0.727)	(0.326)	(0.533)	(0.083)	(0.076)
Staying Immigrants	0.431	-0.232	2.847***	0.857	-0.135	-0.005
	(1.163)	(2.258)	(0.762)	(1.360)	(0.211)	(0.175)
New H&A share of	-0.075	-0.070	0.070*	0.060	0.022	0.037***
Building consents	(0.074)	(0.101)	(0.039)	(0.061)	(0.015)	(0.008)
Constant	-0.438**	-0.506*	-0.110	-0.292**	0.0562***	0.104***
	(0.207)	(0.268)	(0.092)	(0.129)	(0.021)	(0.020)
No. Observations	320	320	195	195	320	320
R-squared	0.870	0.760	0.889	0.816	0.944	0.960

Notes: All regressions estimated by OLS and include census-year fixed effects, and observable covariates. Estimated standard errors (in parentheses) are adjusted for area-level clustering. The log(House prices), log(Number of dwellings) and log(Apartments prices) regressions are estimated on the balanced sample of LMAs with complete observations over 1991 – 2013. The log(House rents) and log(Apartment rents) regressions are estimated on the balanced sample of LMAs with complete observations over 1996 – 2013.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Recent Motu Working Papers

All papers in the Motu Working Paper Series are available on our website https://motu.nz, or by contacting us on info@motu.org.nz or +64 4 939 4250.

19-12 Winchester, Niven, Dominic White and Catherine Leining. 2019. "A community of practice for economic modelling of climate change mitigation in New Zealand."

19-11 Fleming, David A., Suzi Kerr and Edmund Lou. 2019. "Cows, cash and climate: Low stocking rates, high-performing cows, emissions and profitability across New Zealand farms."

19-10 Cortés-Acosta, Sandra, David A. Fleming, Loïc Henry, Edmund Lou, Sally Owen and Bruce Small. 2019. "Identifying barriers to adoption of "no-cost" greenhouse gas mitigation practices in pastoral systems."

19-09 Kerr, Suzi, and Catherine Leining. 2019. 'Paying for Mitigation: How New Zealand Can Contribute to Others' Efforts."

19-08 Kerr, Suzi, and Catherine Leining. 2019. "Uncertainty, Risk and Investment and the NZ ETS."

19-07 Leining, Catherine and Suzi Kerr. 2019. 'Managing Scarcity and Ambition in the NZ ETS."

19-06 Grimes, Arthur, Kate Preston, David C Maré, Shaan Badenhorst and Stuart Donovan. 2019. "The Contrasting Importance of Quality of Life and Quality of Business for Domestic and International Migrants."

19-05 Maré, David C and Jacques Poot. 2019. "Valuing Cultural Diversity."

19-04 Kerr, Suzi, Steffen Lippert and Edmund Lou. 2019. "Financial Transfers and Climate Cooperation."

19-03 Fabling, Richard and David C Maré. 2019. "Improved productivity measurement in New Zealand's Longitudinal Business Database."

19-02 Sin, Isabelle and Judd Ormsby. 2019. "The settlement experience of Pacific migrants in New Zealand: Insights from LISNZ and the IDI"

19-01 Benjamin Davies and David C Maré. 2019. "Relatedness, Complexity and Local Growth."

18-16 Hendy, Jo, Anne-Gaelle Ausseil, Isaac Bain, Élodie Blanc, David Fleming, Joel Gibbs, Alistair Hall, Alexander Herzig, Patrick Kavanagh, Suzi Kerr, Catherine Leining, Laëtitia Leroy, Edmund Lou, Juan Monge, Andy Reisinger, Jim Risk, Tarek Soliman, Adolf Stroombergen, Levente Timar, Tony van der Weerdan, Dominic White and Christian Zammit. 2018. "Land-use modelling in New Zealand: current practice and future needs."

18-15 White, Dominic, Niven Winchester, Martin Atkins, John Ballingall, Simon Coates, Ferran de Miguel Mercader, Suzie Greenhalgh, Andrew Kerr, Suzi Kerr, Jonathan Leaver, Catherine Leining, Juan Monge, James Neale, Andrew Philpott, Vincent Smart, Adolf Stroombergen, and Kiti Suomalainen. 2018. "Energy- and multi-sector modelling of climate change mitigation in New Zealand: current practice and future needs."

18-14 Preston, Kate, David C Maré, Arthur Grimes and Stuart Donovan. 2018. "Amenities and the attractiveness of New Zealand cities."

18-13 Alimi, Omoniyi, David C Maré and Jacques Poot. 2018. "Who partners up? Educational assortative matching and the distribution of income in New Zealand."

18-12 Fabling, Richard. 2018. "Entrepreneurial beginnings: Transitions to self-employment and the creation of jobs."

18-11 Fleming, David A and Kate Preston. 2018. "International agricultural mitigation research and the impacts and value of two SLMACC research projects." (also a Ministry for Primary Industries publication)

18-10 Hyslop, Dean and David Rea. 2018. "Do housing allowances increase rents? Evidence from a discrete policy change."

18-09 Fleming, David A., Ilan Noy, Jacob Pástor-Paz and Sally Owen. 2018. "Public insurance and climate change (part one): Past trends in weather-related insurance in New Zealand."

Motu