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Low-income housing in high-amenity areas:

Long-run impacts on residential development

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Abstract

Centre-left governments from the 1940s into the 1970s developed several large areas in the urban fringe of Dunedin, New Zealand for low-density, mostly single-family public rental housing. The public housing in these areas is now accessible, well endowed with natural amenities, and allocated to very low-income households. Analysis of sales of private housing reveals the expected discount on sales of nearby houses. But analysis of the influence of spatial variation in natural amenities on incomes and structural characteristics indicates large-scale effects of the public housing developments: diversion of higher-income housing to other suburban areas and possibly maintenance of older high-quality housing in central areas. Interestingly, centre-right governments may have opened the door to market forces by encouraging tenants to purchase their public rental house. We find evidence that the recent increase in house prices has encouraged relatively high income households to purchase ex-state rentals in these high natural amenity areas.

Keywords: housing, local public goods, neighbourhood amenities

I. Introduction

From the late 1930s into the 1970s, centre-left central governments developed five relatively large areas for subsidised public rental housing in Dunedin, New Zealand. An unusual aspect of these developments is that they were built in what was then the undeveloped urban fringe. Informed by the principles of the Garden City movement, the aim was to build simple but solid, mostly detached single-family housing at suburban densities in areas well endowed with natural amenities. At the time, these houses were targeted toward credit-constrained low-wage worker households many of whom lived in crowded central city housing. Thus, the public housing developments provided an opportunity for the families of workers on modest incomes to access a suburban lifestyle, though at the cost of what at the time would have been a relatively long commute.

This major market intervention by the central government may have had large-scale and long-term effects on private residential development. A key aspect of the public housing developments we observe is that they were not built in areas that were already poor. Instead, they were built on greenfield sites in areas that were, at the time, in the urban fringe. Importantly, the siting of these developments appears exogenous in that these sites do not appear inferior to others, with natural characteristics typical of those in private single-family suburban areas. Indeed, choosing sites with good natural amenities was an objective of central government planners. This contrasts with the more typical endogenous siting of publicly subsidised housing in areas that are already poor, which leads to small and localised effects (Lee et al. 1999). Indeed, recent interest has shifted toward tests of whether new low-income housing that replaces dilapidated or vacant buildings in poor neighbourhoods might actually increase the sale prices of houses nearby (Schwartz et al., 2006).

To investigate, we start by estimating proximity effects in a cross section of private single-family houses in 2005. Estimates from a standard hedonic sale price model indicate that private houses close to public housing sell at a discount relative to otherwise similar houses elsewhere. The discount is, however, not terribly large, similar to that associated with mobile home parks reported by Munneke and Slawson (1999), which are endogenously sited. Further investigation reveals that private houses proximate to public housing are relatively small and household incomes relatively low. It turns out that most of these private houses were built contemporaneously with the public housing as private builders took advantage of the infrastructure installed to serve it. The private houses differ in style, but are otherwise similar in quality to the public housing, potentially reinforcing the perception of these neighbourhoods as lower income enclaves.

The large-scale effects of these early suburban developments occur as subsequent higher-income housing developments are diverted to alternative areas. We find that household income and house sizes vary strongly with the quality of natural amenities. This suggests that had these public housing developments not been built, these high-amenity areas would instead have been developed for higher-income housing. Estimates of CBD income and floor area distance gradients reflect the scale of these long-run effects: both gradients are positive in directions away from public housing as higher income households demand larger houses in high-amenity suburbs, but are negative in directions toward the public housing. Though difficult to test, the limiting effect of the public housing developments on the supply of land with attractive characteristics may have discouraged filtering to lower-income households of older but relatively high quality housing in central areas.

More recently, as alternative areas have fully developed, we expect the high-natural-amenity areas proximate to public housing to attract relatively high-income households. We explore this hypothesis by analysing sales since 1980 of “ex-state” houses. Centre-right

governments since the 1950s have offered to sell state rental houses to their tenants under favourable terms. By year 2000, when an entering centre-left government halted additional sales of state rentals, over half (53%) of the state rentals in the large public housing neighbourhoods had converted to private ownership. Census data indicate that median block incomes rose faster between 2001 and 2006 in blocks in which a higher proportion of houses originally built as public rentals are in private ownership. In addition, the sale price premium on an ex-state house in an area with a small proportion of state rentals nearly doubles after 2004, consistent with a desire by new higher-income arrivals to avoid living near especially low-income renters.

The remainder of the paper is organised as follows. Section II provides a conceptual framework. Section III details the evidence of the large-scale effects of the public housing neighbourhoods on privately built residential development. Section IV details the evidence of the market re-allocating high-amenity areas to higher income households. Section IV concludes the paper.

II. Conceptual framework

Figure 1 illustrates an idealised process of residential development over time in a monocentric city (featureless plain, radial transport, etc.). One quadrant of the central business district (CBD) appears in the southeast corner of the diagram. Residential development occurs outside the CBD and in 1940 is relatively compact due to high commuting costs, modest household incomes, and a relatively small population. In this simple situation there are two sources of neighbourhood disamenities: density and poverty. Poorer households live in smaller units in higher-density areas nearer the CBD. Household income rises and density falls with distance from the CBD.

To improve conditions for low-income households, the central government builds low-density subsidised rental housing, and the infrastructure to serve it, in the urban fringe, as shown in the figure.[1] Negative externalities associated with concentrations of low-income households extend through a buffer area around the public housing as shown in yellow. Sale prices and the characteristics of private housing in these areas respond to the proximity to low-income households who occupy the public housing.

Over time, private residential development expands into the urban fringe with reduction in commuting costs and increases in population and household incomes. Higher-income households prefer the newer houses and lower densities in the developing suburban areas. Older, more central housing tends to "filter" to lower-income households. Thus, the public housing (and the nearby private housing) diverts and to an extent displaces higher-income housing in the suburbs. The outer boundary in the figure depicts an idealised version of the situation around 1980 when these no-longer-remote areas essentially became built out.

Given this build out, each of the several alternatives for subsequent higher-income development suffers a disadvantage. New housing built farther into the urban fringe requires long commutes. New infill housing is on small lots and increases densities in the existing suburbs. In general, the effect on land supply of the public housing developments exacerbates these problems. An additional alternative presents itself: 'gentrification' of older private housing in central areas or of the public housing neighbourhoods themselves. In the present case, the low densities and high natural amenities in the vicinity of the public housing neighbourhoods may make this alternative attractive. The sales of state rentals to tenants and subsequent sales to households not associated with the state rental programme potentially reduce the concentration of especially low-income households.

[1] In the case of Dunedin, road connections to the CBD were improved, but commutes initially tended to be difficult due to limited access to private cars and public transit.

III. Effect of concentrated suburban public housing on the private housing market

This section details the empirical investigation of the impacts of the suburban public housing developments on the private residential housing market. The data analysed are cross-sectional: we observe sale prices and characteristics of houses that sold in calendar year 2005, and neighbourhood characteristics from the census taken in March of 2006. [2]

Based on the conceptual framework just described, we expect that the public housing neighbourhoods diverted higher-income housing to other areas. We provide several types of evidence. First, evidence that sale prices, incomes and house sizes correlate with natural amenities indicates exogenous siting of the public housing: these high-amenity areas would likely have been developed for higher-income housing had the public housing not been there. Second, variation in income and floor area distance gradients with direction toward or away from public housing provides more direct evidence of large-scale diversion of higher-income private housing in the suburbs. Finally, relatively high prices of older housing in a central area well endowed with natural amenities provides some evidence that the limited supply of suburban land encouraged maintenance and renovation of some older housing.

We start by describing the data, then the empirical methods, followed by presentation and discussion of results.

The year 2005 sales data set

The data come from the contiguously developed residential areas around the Dunedin CBD. Figure 2 shows the area from which the sales come, including topography and other natural features. Dunedin is a regional service centre with a port, a university, and a population of about 115,000. The relatively small ten-by-ten kilometre study area includes

[2] We cannot compare sales of nearby private housing before and after construction because there was little private housing nearby that pre-dated development. The earliest data available in a convenient electronic form is from the early 1980s, after most of the suburban areas had developed.

essentially all of the contiguously developed residential areas surrounding the Dunedin CBD. There are a variety of smaller residential areas developed at suburban densities within the municipal boundaries and longer commuting distance of the CBD. Sampling from this larger area, however, adds to cost and provides little additional useful variation.

The base data set from which the sample was taken consists of observations on all sales in 2005 of detached single-family houses within the study area.[3] We eliminated observations for several reasons. First, we eliminated observations with missing or implausible values. To avoid giving extra weight to a house that sold more than once in 2005, only the latest sale was retained. And we eliminated observations on sales in neighbourhoods near the University, the CBD and a commercial subcentre southwest of the CBD in which more than half of the housing consists of private rental houses.

We also excluded from the sample the relatively small number (154) of sales of houses built since 1980. Residential development patterns in the study area were established by 1980 as population growth of almost 30% since the end of WWII had essentially resulted in build out. Of interest is that requirements for minimum amounts of thermal insulation were implemented only in 1978. Very few of the houses built prior to 1980 were originally fitted or have since been retrofitted with wall or under-floor insulation.[4] As a result, exposure to the sun may be an influential natural amenity in this market as a source of heating and dehumidification in this market. As a practical matter, omitting this small number of observations on sales of relatively new houses has no impact on the results.

Table 1 provides summary statistics. The data set analysed contains 1584 observations. The median sale price is about $206,000, with a large range: from about $81,000 to over $1.4

[3] The data set was purchased from Quotable Value, Ltd. QV collects sales data from local units of government, and employs local "valuers" to inspect properties and record or update house and property characteristics. These data provide the basis for most of the property valuation in New Zealand for tax assessment.

[4] See Clark et al. (2005). The cut-off date is 1980 rather than 1978 because the data set includes only decade, rather than year, of construction.

million.[5] Almost 97% of the sales fall in the smaller range of $100k to $500k. Sales were spread fairly evenly over calendar year 2005, a year in which sale prices rose considerably.

Floor and land areas are generally modest. The median building lot consists of about 600 square meters (0.15 acres), and over 90% of the sample lots contain less than 1000 square meters (0.25 acres). Floor areas are also modest at a median of 117 square meters (1260 square feet), with over 90% of the sample houses having less than 200 square meters (2150 square feet) of floor space. Making up for their small size, most of these older houses are of generally good construction quality with a variety of 'character' features.

The median age of the houses in the sample is seven decades. The decade-built data indicate a steady pace of construction from 1900 through the 1970s, after which construction rates fell dramatically in this area due in part to build out, but also due to slow growth in population since the 1980s.[6]

We include a dummy variable indicating whether the house was built before 1920. The "villa" style dominates houses built before 1920. These houses and those of other early designs tend to be especially difficult to heat as they have high ceilings, are typically oriented toward the street rather than to the sun and are draughty by design to combat dampness. The villa style gives way to the "bungalow" in the 1920s, which differs from the earlier designs in each of these characteristics and dominates construction through the 1970s. We expect pre-1920 houses to sell for a discount. We also include a dummy variable for the 103 ex-state houses that sold in 2005, which we also expect to sell for a discount.

None of the sample houses is far in modern commuting terms from employment centres. Distances reported in Table 1 are straight-line distances in kilometres from the traditional centre of the CBD, with the exception of the houses directly across the harbor. To

[5] Sale prices are in New Zealand dollars.

[6] Most of the substantial growth in the New Zealand population since 1980 has been accommodated in urban areas that are larger and/or with warmer climates.

better reflect driving distances from these houses, two kilometres were added to straight-line distance from a point two kilometres directly south of the CBD. The most distant sample house is about 5.3 km (3.3 miles) from the city centre.

Median "mesh block" household income proxies for neighbourhood quality. A mesh block is the smallest unit of census geography, and consists in this area of usually 40 to 60 housing units. Mesh block income data come from the census taken in March of 2006. The minimum of $16,000 shown in Table 1 seems low, but is consistent with welfare and old-age support. The large range in median incomes indicates that essentially all income groups are represented in the sample.[7]

The remainder of Table 1 describes our measures of exogenous local amenities. Figure 3 superimposes all of the houses currently in the public rental housing program on a scatter plot of observed house sales. The five large public-housing developments are easy to identify. Natural amenities in these neighbourhoods compare favourably with those in other suburban areas: a median of 7.3 hours exposed to the mid-winter sun and 43% with a good view as defined below. There are also three small clusters of public housing and numerous isolated public rental houses that have no discernable effect on nearby sale prices.

About 55% of the observed sales of privately built houses are between the CBD and one of the large public housing neighbourhoods. We measure straight-line distance from each observed sale to the closest public rental house in the nearest of the five large public-housing neighbourhoods. As detailed in the results section, the proximity effects of the public housing neighbourhoods appear to extend to about 400 meters. About 28% of the sample sales are within 400 meters of one of the public-housing neighbourhoods. Most of the private housing near these neighbourhoods is of a vintage similar to the public housing as

[7] Census household income is reported in bands, with the highest recorded as $100,000 or greater.

private builders took advantage of improvements to streets and utilities built to serve the public housing.

We measure two locally varying exogenous environmental variables: the quality of the view and exposure to the mid-winter sun. Categorical measures of the "focal point" of the view (water or landscape) from the living room of each house and its "scope" (slight, moderate and wide) are included in the data set. About 60% of the houses in the sample are reported as having at least a "slight" view. Experimentation with view dummies indicates little sale price effect of a "slight" view, and the price effects of "moderate" and "wide" views are similar, so we combine them to create a new category called "good" view. The proportion of private houses with a "good" view is similar to that of public rental houses.

The amount of time a house is potentially exposed to the sun at mid-winter ranges from about 1.5 hours to over 8 hours, but over 98% of the houses are exposed to between 4.5 and 8.4 hours of sun.[8] Exposure to the sun varies due to the variation in topography shown in Figure 2. Exposure to the sun is important because winter days are cool but frequently sunny, and, as described earlier, the housing stock is poorly insulated.[9]

Proximity to the coast offers ocean views and quick access to beaches. However, proximity to the coast *per se* appears to have little effect on sale prices. One reason is that a significant portion of the coastline is rugged cliffs, which offer views, which we measure separately, but no direct access. The remainder of the coastline is beach, but very few houses are close to the beach because most beachfront land is in non-residential, usually public, uses: sports fields, a golf course, a large cemetery and a sewage treatment plant. Experimentation indicates negligible sale price effects of proximity to the beach in most of these areas. An exception is at the south end of the beach. This area provides direct access to the best beach

[8] The measurements of solar exposure are based on digital elevation data with which a computer program produces a map of the horizon as seen from any location. See Stewart (1998) for more detail.

[9] The sun shines brightly on Dunedin an average of about 100 hours per month in winter out of a potential total of about 250 hours.

and surfing area, and includes a small commercial development. Thus, the measure we include in our analyses is straight-line distance to this beach access.

Methods

We start by estimating a fairly standard hedonic price model. A general hedonic sale price function takes the form:

$$ln\ P = f\ (H,\ N,\ L) + \varepsilon \tag{1}$$

where P is sale price, H is a vector of house characteristics, N is a vector of neighbourhood characteristics, L measures accessibility to commercial centres and ε is a standard error term. Using the natural log of price as the dependent variable in the case of housing reduces heteroskedasticity and allows an easy percent-change interpretation of the estimated coefficients, which is plausible generally and is consistent with theory with respect to distance variables.

Importantly, the relationships of the explanatory variables to sale price can be non-linear. For example, the effect on sale prices of proximity to a public housing neighbourhood or to the coast may diminish quickly with distance, but what that distance is and how prices fall with distance is unknown a priori. And the irregular variation in topography may generate non-linear relationships of unknown form in other variables.

Exploring these relationships requires a flexible specification. We use the flexible Fourier expansion because it is very flexible, efficient, and easy to implement. Pagan and Ullah (1999) describe the general procedure and McMillen and Dombrow (2001) apply it to housing. The Fourier expansion derives its flexibility from the use of sine and cosine wave functions of varying frequencies. Following McMillen and Dombrow, the Fourier expansion is written as:

$$f(x) = \alpha_1 z + \alpha_2 z^2 + \sum_{q=1}^{Q} (\lambda_q \sin(qz) + \gamma_q \cos(qz)) \tag{2}$$

where $z = 2\pi x/\max(x)$, which transforms the independent variable, x, to range from 0 to 2π, and Q defines the number of terms in the expansion. A larger Q adds higher-frequency sine and cosine waves. As a practical matter, the number of terms rarely need be large, with Q equal to 1 or 2 when the form is applied to any one regressor.

Simply substituting equation (2) for any linear term in a continuous variable allows estimation of the flexible relationship by OLS. The results provide insight into the functional relationship of interest and often suggest a more parsimonious non-linear specification. The more flexible specification in addition treats spatial autocorrelation (McMillen, 2010).

Though many hedonic sale price studies have focused on estimating the price effects of urban amenities, relatively few have focused on exogenous amenities.[10] Examples include Benson (1998) and Bin et al. (2008) who estimate the house-price effects of variation in views, and Mahan, Polasky and Adams (2000) who estimate the price effects of amenities generated by wetlands of varying characteristics.[11] There also are studies of the house price effects of externalities from historical development, such as Kohlhase's (1991) study of toxic waste sites.

We take a similar approach to estimate the long term effects of accessibility and natural and historical amenities on development patterns: regressing the log of median block household income and the log of floor area on distance to the CBD and each of the amenity variables we measure. Each observation in the median income regression is a random draw of a house sale from each of the 498 census "mesh blocks" represented in the data.[12] We use the functional specification established in the sale price model.

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[10] See Palmquist (2005) for a recent survey.

[11] Numerous hedonic house price studies report estimates of the implicit market values of local amenities that are endogenous in the long run. For example, Chong, Phipps and Anselin (2003) report price effects of intra-urban variation in air quality and Tyrväinen and Miettinen (2000) report the price effects of forest reserves within an urban area. Boyle and Kiel (2001) provide a review.

[12] The results vary little across alternative random samples of one house from each mesh block.

We found few empirical studies of the effects of exogenous amenities on development patterns, i.e., house and neighbourhood characteristics, across a single urban area. Wu (2006) presents a theoretical analysis. Smith (1993) estimates the effect of proximity to the coast on residential densities. There are also papers that report the effects of variation in exogenous amenities across regions. Craig and Kahn (1999), Englin (1996), and Rappaport (2007), for example, explore the effects of variation across regions in exogenous environmental amenities, such as climate, on migration patterns, house prices, wages and quality of life.

We test differences in CBD distance gradients by adding a term that interacts distance to the CBD with a dummy for whether the observed sale is located in the direction of a public housing neighbourhood. The rationale comes from Brueckner et al. (1999) who introduce exogenous amenities to the standard Alonso-Muth-Mills monocentric-city model. In their model, historical development in the CBD generates positive amenities in some cities (e.g., Paris) and disamenities in others (e.g., Detroit). These amenities determine the sign on the income gradient in distance from the CBD. In Dunedin, in contrast, suburban amenities vary circumferentially in part due to low-income public housing. The testable hypothesis is that price, income and floor area gradients fall more quickly or rise more slowly in directions toward the public housing neighbourhoods, holding natural amenities constant. A significant coefficient on the interaction term indicates differences in distance gradients.

Results

The results from standard OLS regressions are reported in Table 2. The estimated effects of variation in house characteristics on sale prices reported in the first column appear reasonable. Sale prices rose by an average of about 0.9% per month in 2005 as Dunedin participated in the global appreciation in house prices. The coefficients on the floor area variables indicate that sale prices increase over the range of floor areas in the sample, but at a decreasing rate. The estimated market price of adding a metre of floor area to a house of

median size is about $1150, close to marginal construction cost at the time. The coefficient on land area appears small, but steep slopes and wet soils reduce the value of large yards.

Houses built before 1920, mostly of the villa style, sell for the expected significant discount relative to the predominantly bungalow-style houses built between 1920 and 1979. Not surprisingly, these older houses tend to be smaller. Decade dummies indicate little trend in sale price with age in these mostly bungalow-style houses. House prices are higher in areas with higher incomes and lower farther from the CBD, as expected. On average, incomes and house sizes both increase with distance from the CBD, even with controls for natural amenities.

Of interest are the effects of variation in amenities. The ex-state houses in the sample sell for a significant 9% discount, after controlling for their small size. Private houses close to public housing sell for a somewhat smaller discount of 6%, which suggests that most of the discount on ex-state houses is due to disamenity rather than to architectural style. The Fourier expansion in distance from the nearest state-house development, though not shown in the table, indicates that sale prices remain steady, on average, to a distance of about 400 meters, then rise quickly. The estimated discount of 6% is close to the 7% discount in Philadelphia reported in Lee et al. (1999), but the 400 meter distance band is a about twice as large as the one-eighth mile band in Philadelphia. Adding a dummy for houses between 400 and 800 meters produces a tiny and insignificant coefficient. Both incomes and floor areas are smaller near the public housing indicating substantial long term proximity effects. Note that 400 meters is a rather large band of influence in this context.

Natural amenities also have both short and long-term effects. An additional hour of sun commands a price premium of about 3.5%, or about $7000 on a median-priced house

(about $50 per month on a typical mortgage).[13] This seems large, but plausible given the lack of insulation and the cool, damp climate. The Fourier expansion in hours of sun is a bit wild at values less than 4½ hours, but appears roughly linear above 4½ hours. Restricting the sample to houses exposed to at least 4½ hours of sun has little effect on the estimated coefficient. Exposure to the sun surprisingly has no effect on incomes, perhaps due to good exposure to the sun in areas near public housing, but a positive effect on floor areas, perhaps because good solar exposure reduces the cost to heat a larger house.

The estimated coefficients on the view variables in the sale price regression have the expected positive sign but are surprisingly small and at best weakly significant. The long-run effects of views on incomes are, however, strong: incomes in areas with a good water view average 25% higher and with a good landscape view 18% higher than areas without a view. Views affect development patterns, and including those effects as controls in the sale price regression essentially eliminates the direct effect of a view on price. Note that good views are common in the public housing neighbourhoods.

Proximity to the beach access strongly influences sale prices, incomes, and house sizes. The Fourier expansion indicates a steep linear drop in prices to about one kilometre from the beach access and then no further effect. The estimated magnitude of the price gradient over the first kilometre is about 55%, which in this area seems plausible.

Diagnostic tests support the results reported above. Omitting potentially influential outliers has minor effects on the results. Restricting the sample to the 1509 observations with residuals of less than two standard deviations in magnitude has essentially no effects. Restricting the sample to the 1541 observations with sale prices between $100k and $500k results in small decreases in the coefficients on distance to the CBD and median household

[13] A mortgage rate of 7.5% with a term of 25 years was common in 2005. Mortgage interest payments are not tax deductible in New Zealand.

income. Eliminating the observations on sales of ex-state houses has no effect. Restricting the sample to observations either above or below the median household income of $45k has surprisingly small effects. Replacing the logged dependent variables with levels produces broadly consistent estimates.

Taken together, these results have implications for the effects of the public housing developments on private development. First, the results indicate significant proximity effects: sale prices, house sizes and household incomes are lower in private housing proximate to public housing. At least as important are the long-term effects of natural amenities on household income and floor areas. Table 4 reveals that houses in the state rental programme are as well endowed with the natural amenities that we measure – views and exposure to the sun – as are the houses in the private sales sample. Had the public housing not been built, the areas they occupy likely would have developed in higher-income suburban housing similar to that which occupies other suburban areas.

Table 3 provides more direct evidence of the diversion of private development. The coefficient on CBD distance in the sale price regression has the expected negative sign and a sensible magnitude. As expected, the distance gradient is significantly steeper in directions toward public housing. Income and floor area gradients differ more starkly. The income gradient in directions away from the public housing is positive and large; higher-income households build larger houses in high-amenity suburban areas. In contrast, the income gradient in directions toward the public housing neighbourhoods has the opposite sign.

There is one additional coefficient worthy of note in each of Tables 2 and 3. In Table 2 the variable is called ‘within close-in ridge neighbourhood’. This variable was motivated by the flexible Fourier expansion in CBD distance, which indicated a steep drop in sale price in the first two kilometres, beyond which prices fall more slowly. Almost all of the sales in this distance range are on a ridge that runs close to and to the north and west of the CBD. In

Table 3 the variable is the dummy for between CBD and public housing. These dummies are not exactly the same, but are closely correlated. The estimated coefficients on these variables in the sale price, income and floor area regressions are positive and significant, consistent with an exclusive but older and close-in neighbourhood.

Exclusive close-in neighbourhoods were common before the era of low-cost transportation. These neighbourhoods have lost their exclusivity in many cities, however, as the relatively wealthy have taken advantage of low transportation costs to move to newer houses in high-income neighbourhoods in the suburbs. Though impossible to test with the data at hand, it seems plausible that through its limiting effect on land supply the suburban public housing may have played a role in preserving this neighbourhood. Some higher-income households may have chosen to remain in and maintain the high quality housing in this older neighbourhood.

III. Effect of privatising state rentals on public housing neighbourhoods

Dunedin experienced essentially no growth in population between 1981 and 2001. Commuting costs fell over that time period, however, with improvements in the road network and especially with the easing of trade restrictions to allow import from Japan of fuel-efficient and reliable second-hand cars. Lower commute costs and smaller households encouraged some additional new development in the urban fringe and development of 'lifestyle' properties in exurban areas. Not surprisingly, there was little trend in real house prices over this period, despite steady reductions in mortgage interest rates.

Population growth resumed in the early 2000s, with roughly 4% growth, or roughly 2000 households, from the 2001 to 2006 censuses.[14] Also during this time period New Zealand generally and Dunedin specifically took part in the global housing price boom. We

[14] The 2011 census has been delayed as a result of the recent earthquakes in the Christchurch area.

expect that population growth, limited supply of developable land within easy commuting distance of the CBD, rising house prices, and a general trend toward smaller household sizes lead to interest among *relatively* high-income households in the high natural-amenity areas occupied by the public housing neighbourhoods.

Some of this demand could have been supplied by privatised state rentals. When in power, the centre-right National Party has offered state rental houses for sale to tenants under favourable terms. Tenants in the 1950s were offered mortgage terms of 5% down, 3% interest, and 40 years to pay. In the 1960s, the National government advanced families with children £1,000 with which to buy their first home. Down-payment requirements were again cut in the 1980s. And in the 1990s the National government "levelled the playing field" by charging market rents for state rentals and providing income assistance through a cash "accommodation supplement" which could be used toward rent or mortgage payments. Sales of state rentals consequently surged during parts of the 1950s, 60s, 80s, and 90s. The centre-left Labour government formed at the end of 1999 put a moratorium on state-house sales which lasted for nine years.[15]

We purchased information about the characteristics of all current state rentals and all ex-state rentals in Dunedin's five large state-house neighbourhoods. We also purchased information on all sales of ex-state rentals since 1980. Figures 4 and 5 show the current pattern of private versus state ownership in the two largest neighbourhoods (patterns are similar in the smaller neighbourhoods). The houses built by the state are shaded blue if they remain as state rentals and red if they are privately owned. The houses not shaded are privately-built, most contemporaneous with nearby state housing. These houses differ

[15] Information sourced from "State Housing in New Zealand," New Zealand History online, http://www.nzhistory.net.nz/culture/state-housing-in-nz.

markedly from state houses in architectural style and tend to sell for a discount of about two-thirds that on ex-state houses.

Home ownership rates in these areas are, not surprisingly, lower than the New Zealand average of about 70%. For example, the owner-occupancy rate from the most recent (2006) census in the area depicted in Figure 4 (Brockville) is 57.4%. However, census block data indicate that on average about 80% of the privately built houses in these areas are owner-occupied. We sampled 100 ex-state rental houses and compared the address of the owner in city council records to that of the house and found that the rate of owner-occupancy in ex-state houses is similar to that of the privately built housing in the area (about 80%).

Tables 4 and 5 show characteristics of state and ex-state rentals, respectively. Relatively few characteristics of houses that remain in the state rental programme are available, but comparison of Tables 4 and 5 indicate that they are similar to the ex-state rentals. The typical state rental is small at about 100 square meters (1075 square feet) on lots typically of about 750 square meters (a fifth of an acre), essentially the same as that in other private suburban developments in Dunedin. The only major difference between state and ex-state rentals is that a higher proportion of ex-state rentals is recorded as having an appreciable view. Indeed, in a logit regression of whether a house is ex-state or state rental, only view is significant. Other structural and neighbourhood characteristics seem self-explanatory.

Figure 6 shows the number of sales of ex-state rentals each year since 1980. An unknown proportion of these sales consist of the original sale from the state to the tenant. Unfortunately, the date of first sale to the tenant is not searchable electronically, and the cost of having it done by hand prevents our obtaining it at this stage. Most of the sales, however, are most likely subsequent to the first sale either to former tenants of other state houses or, more likely, to households not involved with the state housing programme.

Figure 7 shows the trend in sale prices obtained by including year-of-sale dummies in a standard hedonic house price regression (described more fully below). Real sale prices rose after the recession of the early 1980s, remained remarkably steady for most of twenty years, then rose quickly beginning in 2004, essentially doubling in three years. This trend follows that of the larger housing market in Dunedin. Our hypothesis is that higher house prices generally encouraged some relatively high-income households to look at and seriously consider buying in the historically low-income, but high natural amenity state house neighbourhoods.

The 2001 and 2006 censuses offer direct, but weak, evidence in support of this hypothesis. The census reports median income at the block level. The data we have also allow us to measure the proportion of housing in private ownership, approximately 80% of which is rented at market rates. Relative growth in incomes in areas of relatively high private ownership rates would provide additional support for the hypothesis. And, indeed, the correlation between the percentage change in median block income between 2001 and 2006 with ownership rate is positive, equal to 0.054, and marginally significant ($t = 1.47$).

Less direct evidence, gleaned from analysis of sales of ex-state rentals, provides additional support. We expect that relatively high-income purchasers of ex-state houses would view proximity to concentrations of state rentals as a disamenity. Thus, a relatively recent increase in the sale price premium on ex-state rentals in areas of relatively high ownership rates would support our hypothesis.

We constructed four measures of rates of private ownership or of owner-occupancy, none of which is perfect. These are shown beginning in the third row of Table 5. The first two measures use census data to calculate the numbers of households renting (either in subsidised public rentals or in private houses) and owner-occupying in each census block in each of the 5-yearly censuses since 1981. So, for each observed sale of an ex-state house, we

assign a block owner-occupier rate from the census closest in time. For example, the owner-occupier rate assigned to a sale in 1987 is that of the block in the 1986 census. That rate varies across the sample from 0.1 to 1.0. A concern with census blocks is that block boundaries follow streets; houses across the street are in a different block. We treat this by combining several blocks to form a block group and assign the average owner-occupancy rate from the nearest census to each sale. This rate varies from 0.33 to 0.76.

It may be that home buyers are more concerned about the occupants of houses near them on their street than about those in their entire block or in the larger block group. To the extent that we know which houses are in the state rental program at the time of each sale, we can accurately measure the proportion of nearby houses in private ownership, though approximately 20% of these are occupied by market-rate renters, on average. The "street ownership rate" measures the proportion of non-state rentals in the twelve houses closest to each observed sale on both sides of the street, and "neighbour ownership rate" that of the six closest houses. Because we do not know when a house converted from state to ex-state, we calculate these rates only from year 2000, the year when the Labour government ceased sales of state rentals (the current ex-state houses have been ex-state since at least year 2000).

Table 6 reports the results of a series of standard regressions. The dependent variable is the natural log of real sale price (adjusted by the annual CPI). The estimated coefficients on the structural and neighbourhood controls for the most part seem plausible. The coefficients on the floor area variables are significant and of plausible magnitudes. The coefficient on land area indicates that houses on larger lots tend to sell for less, all else the same, which seems counter-intuitive. However, lots tend to be larger where slopes are steeper, presumably due to constraints on building roads and structures. Houses on steeper slopes sell for a significant discount. Views, which are insignificant, are also correlated with

steep slopes. Older houses sell for less, houses with brick facades sell for a significant premium (about 6%), and houses with better parking sell for more.

Neighbourhood characteristics also matter. Sale prices vary with local variation in racial composition and householder age, but appear not to vary with median income, holding these other two variables constant. However, all of these variables are positively correlated: the correlation between median age and median income, for example, is 0.26. There is also some, relatively small, variation in the coefficients on the neighbourhood dummies, which pick up the effects of variation in accessibility and other relatively large-scale unobserved characteristics. The relatively large R-squareds mostly reflect the influence of the year dummies.

The coefficients on the first variable in Table 6 provide evidence of the effect of proximity to local concentrations of state rentals. Note first that all four of the coefficients on the ownership/owner-occupier rates are positive: ex-state houses tend to sell for more in areas of higher concentrations of privately-owned or owner-occupied homes. Though this is consistent with findings reported in the literature, it could not be considered a foregone conclusion.[16] Low income home owners, though they have long-run financial incentives to maintain their house and contribute to their neighbourhoods, may nevertheless sensibly choose to spend their limited income on goods or services other than home maintenance. It would seem plausible, a priori, that maintenance levels provided by the state could exceed those provided by low-income home buyers. The results suggest that this is not the case, though the premium may have as much to do with the characteristics of state rental households as with house characteristics (though controls include racial mix and income). The coefficient on ownership rate interacted with % European descent is negative, as might be expected, but relatively small and insignificant.

[16]See Haurin et al. (2003) for a review of the effects of home ownership.

The magnitudes of the coefficients on the ownership/owner-occupier rates are of interest. The coefficient in the first column, though only marginally significant, indicates that on average over almost three decades ex-state sale prices rise by about 4% as the block group owner-occupier rate increases over its range of roughly 0.3 to 0.8. This is smaller than the 2.5% increase in house prices with each ten percentage point increase in homeownership rate reported by Glaeser and Shapiro (2003). The effect of the block-group owner-occupier rate appears smaller during the 2000s, for unknown reasons. The estimated effect of a higher rate of nearby private ownership shown in the third column is similar, though a bit higher – consistent with a greater concern for conditions relatively nearby – but still insignificant.

Of most interest is that the sale price effect of higher rates of private ownership nearly doubles after the big gain in sale prices after 2004. None of these sales was from the state to state-rental tenants due to the moratorium on sales to tenants imposed in 2000. The households paying much higher prices for ex-state rentals in the later 2000s appear clearly more sensitive to proximity to concentrations of state rentals than did their counterparts purchasing at lower prices in the early part of the decade. The buyers of these now higher-priced houses likely have higher incomes and are attracted to the area by the relatively high natural amenities, but remain concerned about disamenities associated with concentrations of low-income rental households.

The basic results are robust to standard diagnostics. Omitting all but the most recent sale of each house, observations with large residuals, and observations in each neighbourhood one neighbourhood at a time do not affect the results. The two other measures of state rental concentration provide no additional insight.

IV. Summary and conclusions

This paper sheds light on the effects on the private, single-family housing market of the development four to seven decades ago of five large public housing neighbourhoods in

parts of the urban fringe well endowed with natural amenities. We report estimates of proximity effects on both sale prices and in the longer term on house and neighbourhood characteristics. We also report evidence of large-scale effects, namely diversion of higher-income development to other suburban areas and possibly maintenance and renovation of older housing in central areas. Finally, we provide evidence that relatively high-income households are purchasing ex-state houses, presumably attracted to the natural amenities.

Given these findings, it's tempting to try to evaluate after half a century the original policy of building relatively large tracts of low-density public housing in the urban fringe. Doing that is difficult in the absence of the counter-factual: what would have happened had this policy not been implemented? Still, it's tempting to speculate.

The public housing at the time of construction was aimed at families living on the modest wages earned by unskilled labourers. These households likely had poor access to financial markets in the aftermath of the Great Depression. This suggests that government financed public housing increased the supply of housing in the market serving low-skilled workers. The workers who opted for the public housing enjoyed better quality housing at the cost of significantly longer commutes. Their departure from the private market reduced demand, probably reducing private rents for other low-wage workers. And the larger supply of housing would have pushed housing prices down to some extent generally. It's hard to say how this would have compared to a demand-side policy of housing vouchers or the current "accommodation supplement" that subsidizes either rent or mortgage payments.

Now shift to the present. It seems likely that had the public housing not been built in high-amenity suburban areas, reductions in transportation costs would by this time have encouraged higher-income development. The increased supply of relatively close-in suburban land would have attracted development away from the farther-flung alternatives that have developed, resulting in shorter commuting costs and lower land prices. It seems

likely that the location of the public housing has in the long term imposed a net cost on higher income households as a group, at least those attracted to newer housing in suburban areas.

Where would the current occupants of the public housing have gone? Typically, older housing in central areas filters to lower-income households. As noted earlier, some of the more high-quality older housing has remained occupied by high-income households. This may not have happened to the same extent if public housing areas had been available for higher-income development. It seems likely that low-income households, even if given financial support, would be living in older houses mostly in lower-amenity areas. The households who remain in state rentals probably benefit (as long waiting lists suggest).

It seems worth noting that by discouraging flight to the suburbs, the public housing may have provided a long-term and large-scale benefit. Many small and medium-sized cities have experienced commercial decay in the traditional CBD. Dunedin has experienced less of this decay than might otherwise be expected, likely in part due to the high income neighbourhood nearby.

Of interest is the long-term effect of state rental sales to tenants. We provide evidence that relatively high-income households are attracted to affordable housing in areas with good natural amenities. Some of the tenants who bought their state house under favourable terms and sold during the recent boom benefitted financially. In recent decades, policy toward public housing in New Zealand, as in other countries, has shifted away from large-scale development and toward purchase of existing houses in private neighbourhoods to avoid concentrations of low-income households. Whether intentional or not, it appears that sales of public housing in the large developments may have a similar effect in the long term.

References

Benson, E. D. (1998), "Pricing residential amenities: The value of a view," *Journal of Real Estate Finance and Economics*, 16(1): 55-73.

Bin, O., T.W. Crawford, J.B. Kruse and C.E. Landry (2008), "Viewscapes and flood hazard: Coastal housing market response to amenities and risk," *Land Economics*, 84 (3): 434-448.

Boyle, M. A. and K. A. Kiel (2001), "A survey of house price hedonic studies of the impact of environmental externalities," *Journal of Real Estate Literature*, 9(2): 117-144.

Brueckner, J. K., J. F. Thisse and Y. Zenou (1999), Why is central Paris rich and downtown Detroit poor: An amenity-based theory," *European Economic Review*, 43: 91-107.

Chong W. K., T. T. Phipps and L. Anselin (2003), "Measuring the benefits of air quality improvement: A spatial hedonic approach," *Journal of Environmental Economics and Management*, 45(1), 24-39.

Clark, S. J., M. Jones and I. C. Page (2005), "New Zealand 2005 house condition survey," BRANZ, Ltd., http://www.branz.co.nz/.

Craig, M. I. and M. E. Kahn (1999), "Climate consumption and climate pricing from 1940 to 1990," *Regional Science and Urban Economics*, 29: 519-539.

Englin, J. (1996), "Estimating the amenity value of rainfall," *The Annals of Regional Science*," 30: 273-283.

Glaeser, E. L, and J. M Shapiro (2003), "The benefits of the home mortgage interest deduction," *Tax Policy and the Economy*, Chicago: University of Chicago Press: 37-82.

Haurin, D. R, R. D. Dietz and B. A. Weinberg (2003), "The impact of neighborhood homeownership rates: A review of the theoretical and empirical literature," *Journal of Housing Research* 13(2): 119-151.

Kohlhase, J. E. (1991), "The impact of toxic waste sites on housing values," *Journal of Urban Economics,* 30(1): 1–26.

Lee, C.-M., D. P. Culhane, and S. M. Wachter (1999), "The differential impacts of federally assisted housing programs on nearby property values: A Philadelphia case study," *Housing Policy Debate*, 10(2): 75-93.

Mahan, B. L., S. Polasky and R. M. Adams (2000), "Valuing urban wetlands: A property price approach," *Land Economics*, 76(1): 100-113.

McMillen, D. P. and J. Dombrow (2001) "A flexible Fourier approach to repeat sales price indexes," *Real Estate Economics*, 29(2): 207-225.

McMillen, D. P. (2010) "Issues in spatial data analysis," *Journal of Regional Science*, 50(1): 119-141.

Munneke, H. J. and V. C. Slawson, Jr. (1999), "A housing price model with endogenous externality location: A study of mobile home parks," *Journal of Real Estate Finance and Economics*, 19(2): 113-131.

Pagan, A. and A. Ullah (1999), *Nonparametric Econometrics*, Cambridge: Cambridge University Press.

Palmquist, R. B. (2005), "Property value models," in K. Mäler and J. R. Vincent (eds.) *Handbook of Environmental Economics, Vol. 2: Valuing Environmental Changes*, Amsterdam: Elsevier North Holland, pp. 763-819.

Rappaport, J. (2007), "Moving to nice weather," *Regional Science and Urban Economics* 37: 375–398.

Schwartz, A. E., I. G. Ellen, I. Voicu, and M. H. Schill (2006), The external effects of place-based subsidized housing," *Regional Science and Urban Economics*, 36: 679-707.

Smith, B.H. (1993), "The effect of ocean and lake coast amenities on cities," *Journal of Urban Economics*, 33: 115–123.

Stewart, A. J. (1998), "Fast horizon computation at all points of a terrain with visibility and shading applications," *IEEE Trans. Visualizat. Comput. Graph*., 4(1):82-93.

Tyrväinen, L. and A. Miettinen (2002), "Property prices and urban forest amenities," *Journal of Environmental Economics and Management*, 39: 205–223.

Wu, J. (2006), "Environmental amenities, urban sprawl, and community characteristics," *Journal of Environmental Economics and Management*, 52: 527-547.

Table 1. Characteristics of the city-wide sales sample

	Median	Mean	Std. Dev.	Min	Max
Sale price (1584 obs.)	205,750	225,477	97,526	81,000	1,417,000
Sale date in months	6.18	6.06	3.41	0.10	11.93
House/neighbourhood chars.					
Floor area (sq metres)	117	126	42.9	50	494
Land area (sq metres)	599	640	265	142	3898
Age (decades)	7	7.01	2.35	3	13
Built before 1920	30.0%				
Ex-public rental house	6.5%				
Median HH income ($,000s)	45.0	47.9	15.6	16.7	100.0
Driving dist. from CBD (km)	3.29	3.23	0.93	0.92	5.34
Amenity variables					
Between the CBD and public housing	55.2%				
< 400m from public housing	28.1%				
Hours of winter sun	7.17	6.98	0.82	1.45	8.38
Good water view	7.39%				
Good landscape view	35.7%				
< 1 km from beach access	6.3%				

Table 2. Estimates of local amenity effects

Dependent variable	ln price	ln income	ln floor area
Sale date (months)	.00865 (5.71)		
Floor area (10 sq metres)	.0655 (14.9)		
Floor area squared	-.000663 (5.47)		
Land area (100 sq metres)	.00942 (4.36)		
Built pre-1920	-.0873 (6.96)		-.0434 (2.62)
Ex-public rental	-.0894 (3.75)		-.236 (7.55)
Within 400 m of public housing neighbourhood	-.0638 (4.93)	-.0912 (2.99)	-.0566 (3.26)
Median household income ($10,000s)	.0360 (8.91)		
Distance from CBD (kilometres)	-.0247 (3.26)	.0706 (3.76)	.0372 (3.65)
Hours of sun	.0372 (5.36)	-.0130 (0.74)	.0410 (4.43)
Good water view	.0266 (1.19)	.229 (4.44)	.0852 (2.84)
Good landscape view	.0230 (1.93)	.167 (5.58)	.0808 (5.11)
Distance from beach access to 1 km (kilometres)	-.528 (9.42)	-.505 (3.78)	-.453 (6.09)
Within close-in ridge neighbourhood	.176 (7.57)	.430 (7.79)	.182 (6.27)
Constant	11.6 (130.3)	1.77 (7.79)	2.32 (23.6)
# of observations	1584	498	1584
R-squared	0.655	0.229	0.134

t-statistics appear in parentheses.

Table 3. Estimated differential in CBD distance gradients

Dependent variable	ln price	ln income	ln floor area
Distance from CBD (kilometres)	-.0322 (2.30)	.269 (8.46)	.0784 (4.50)
Distance from CBD x between CBD & public housing	-.0661 (3.97)	-.388 (10.3)	-.147 (7.34)
Between CBD and public housing dummy	0.148 (2.48)	1.36 (10.0)	.421 (5.84)

t-statistics in parentheses. Coefficients on control variables not shown.

Table 4. Current characteristics of current state rentals

	Mean	SD	Minimum	Maximum
House Characteristics				
Floor area (metres^2)	98.6	16.3	56	250
Land area (metres^2)	740	180	280	2100
Brick construction	0.32		0	1
Neighbourhood characteristics				
Good view	61%			
Hours of winter sun	7.24	0.65	5.43	8.38
European descent	73.8%	8.58%	53.1%	100%
Median age (years)	31.6	5.05	18	62.5
Block ownership rate	40.9%	11.7%	19.7%	70.4%
Real median household income	$35,767	$8,552	$16,700	$61,400
Proportion of total rentals by neighbourhood				
Wakari/Balmacewen	6.01%			
Brockville	30.1%			
Halfway Bush	10.8%			
Corstorphine	39.7%			
Pine Hill	13.2%			

Table 5. Current characteristics of ex-state rentals

	Mean	SD	Minimum	Maximum
Real Sale Price (1728 obs.)	$108,697	$44,005	$26,936	$289,487
Number of sales per property	2.07	1.24	1	7
Block group ownership rate	49.6%	10.3%	32.6%	76.1%
Block ownership rate	47.6%	15.1%	10.0%	100%
Street ownership rate (post 1999, 929 obs.)	82.2%	14.3%	25.05	100%
Neighbour ownership rate (post 1999, 929 obs.)	81.4%	18.8%	0%	100%
Structural Controls				
Floor area (metres^2)	98.90	17.65	56	250
Bedrooms	2.72	0.574	1	5
Land area (metres^2)	756	176	280	2020
Year built (estimated)	1954		1930	1978
Brick construction	30.3%			
Driveway	36.6%			
Attached garage	16.7%			
Detached garage	32.4%			
Moderate slope	53.0%			
Steep slope	18.2%			
Neighbourhood Controls				
Good view	32.3%			
% European descent	78.7%	11.0%	48.6%	100%
Median age	29.9	5.04	17	54
Real Median Income	$34,351	$8,587	$16,349	$67,714
Proportion of sample sales by neighbourhood				
Wakari/Balmacewen	4.2%			
Brockville	22.5%			
Halfway Bush	12.2%			
Corstorphine	53.6%			
Pine Hill	7.35%			

Table 6. Effect of state rentals on ex-state sales

	Block group 1980 - 2010	Block group post 1999	Street rate Post 1999	Street rate Post 2004
Block group occupier rate/ Street ownership rate	0.0809 (1.59)	0.0454 (0.57)	0.0669 (1.27)	0.146 (2.41)
Floor area (10 m^2)	0.0106 (6.212)	0.012 (4.69)	0.0122 (4.75)	0.0119 (4.32)
Floor area^2	-3E-05 (-3.945)	-4E-05 (-3.23)	-4E-05 (-3.31)	-4E-05 (-3.04)
Land area (100 m^2)	-.0115 (-4.213)	-.0129 (-2.92)	-.0135 (-3.05)	-0.0017 (-0.29)
Decade built	0.00454 (6.626)	0.00257 (2.18)	0.00309 (2.51)	0.00344 (2.45)
Brick	0.0605 (6.425)	0.0655 (4.30)	0.0663 (4.35)	0.0596 (3.39)
Driveway	0.0501 (4.769)	0.0452 (2.70)	0.0459 (2.74)	0.0185 (0.94)
Detached garage	0.0602 (6.220)	0.0697 (5.39)	0.0714 (5.51)	0.0731 (4.86)
Attached garage	0.0618 (5.858)	0.119 (3.69)	0.123 (3.87)	0.11 (2.80)
Steep slope	-0.0814 (-5.208)	-0.0777 (-3.20)	-0.0794 (-3.28)	-0.0783 (-2.77)
Appreciable view	-0.0017 (-0.160)	-0.0109 (-0.66)	-0.0091 (-0.55)	0.00049 (0.025)
% European descent	0.165 (3.214)	0.218 (2.67)	0.219 (2.69)	0.0497 (0.52)
Median Income ($,000s)	-1E-07 (-0.230)	5.2E-07 (0.59)	5.6E-07 (0.65)	1.5E-06 (1.42)
Median age (decades)	0.00411 (3.596)	0.00737 (4.09)	0.00746 (4.20)	0.0107 (5.51)
Constant	1.604 (1.199)	4.925 (2.17)	3.861 (1.61)	3.814 (1.39)
R squared	0.838	0.826	0.826	0.536
Number of observations	1381	749	749	389

Dependent variable is the natural log of real sale price. T-statistics shown in parentheses. Neighbourhood and year of sale dummies are included in the regressions, but coefficients not shown.

Figure 1. Conceptual framework

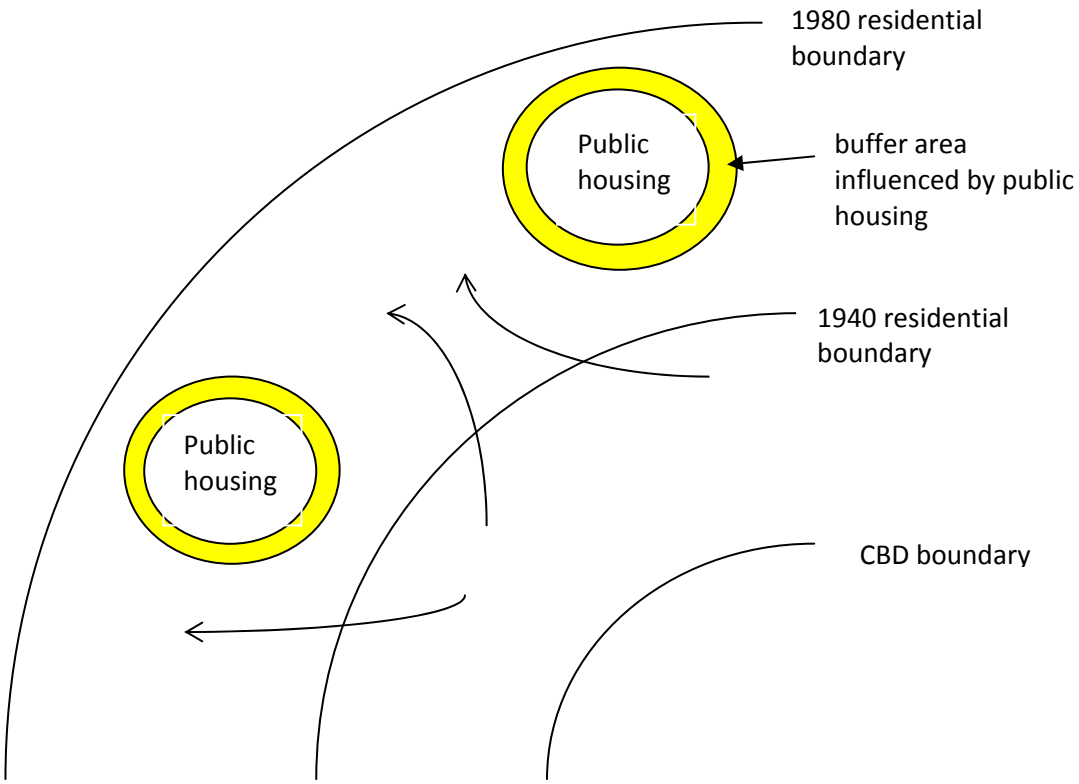


Figure 2. Study area

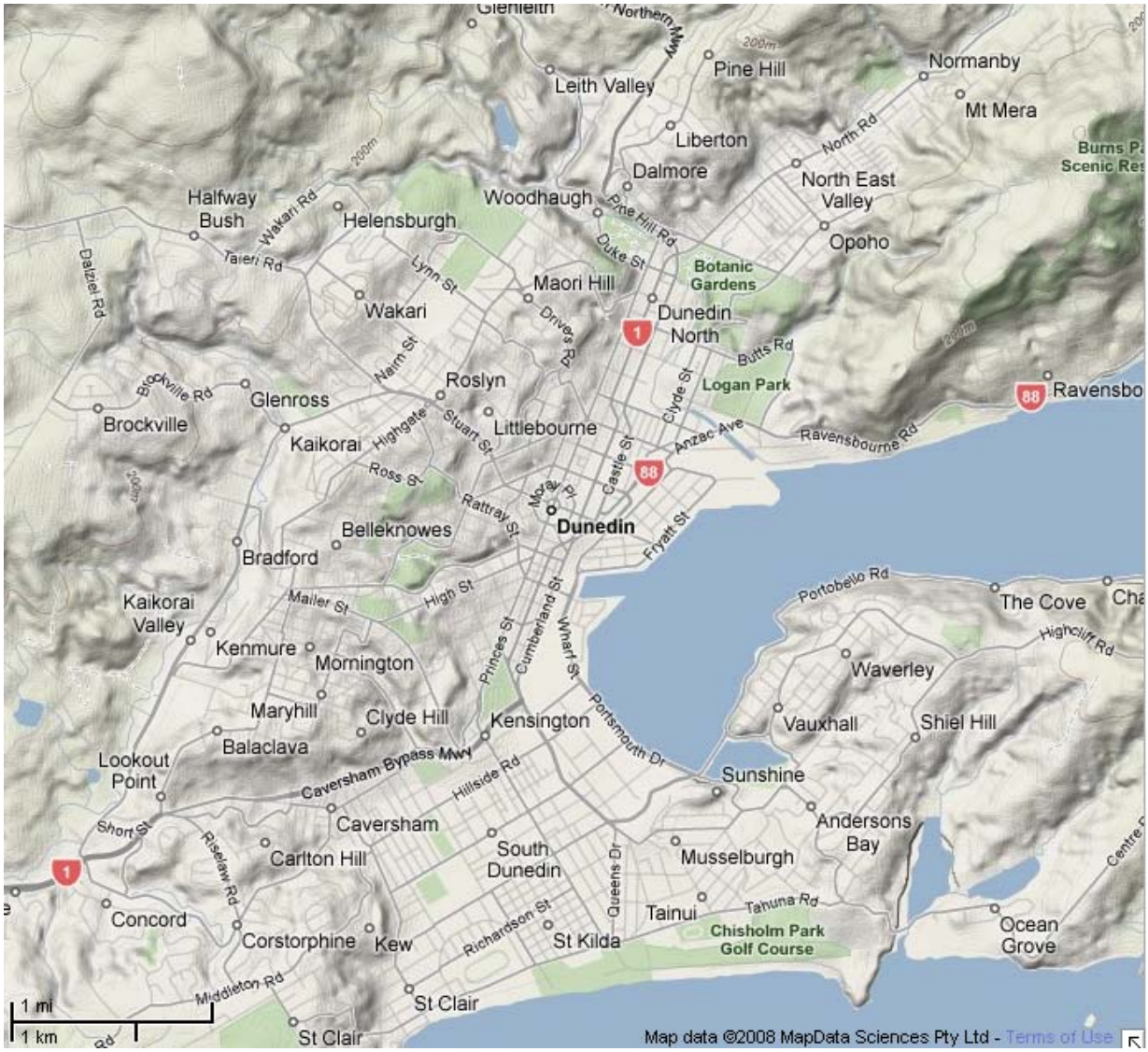
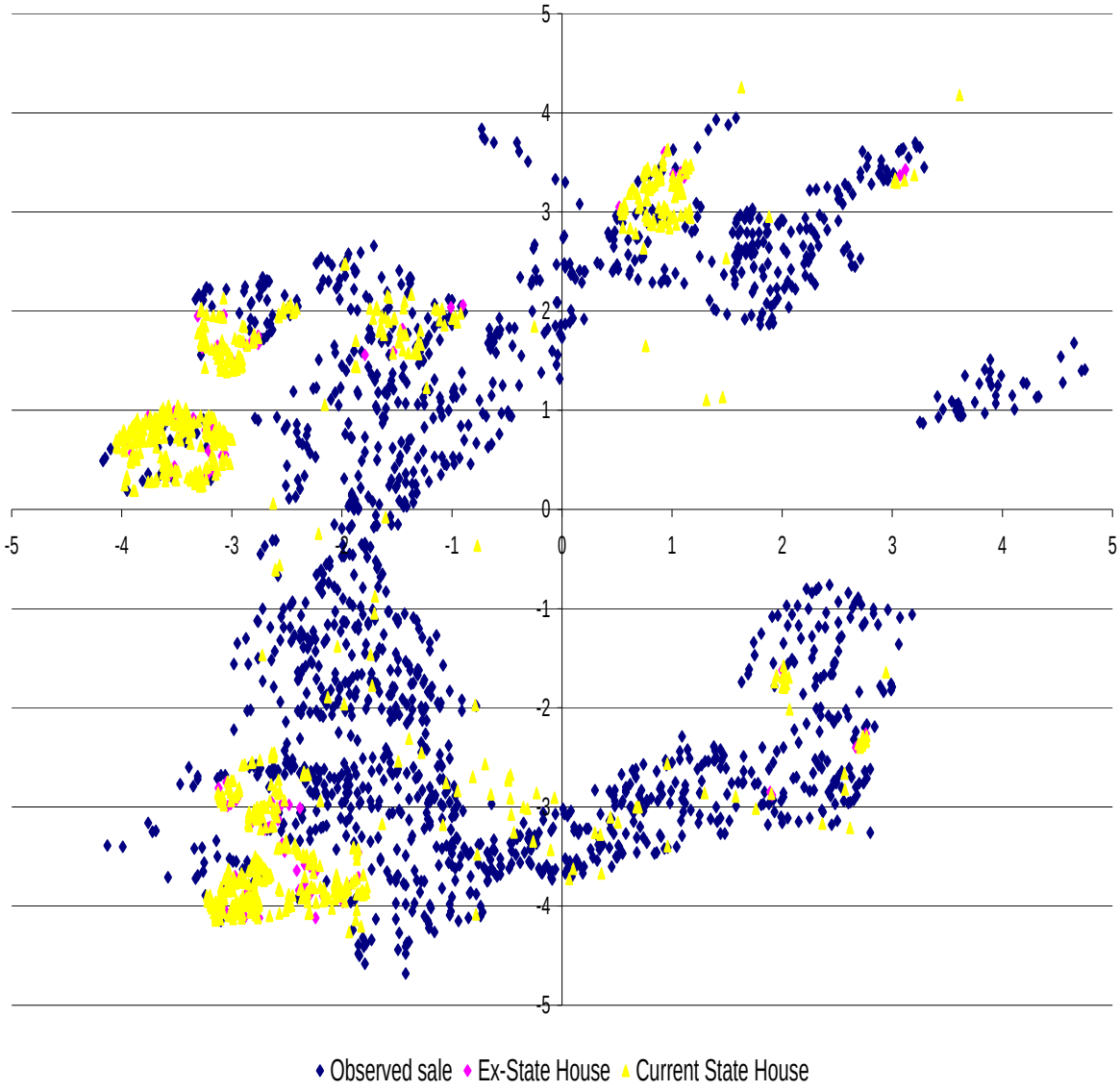


Figure 3. Observed house sales and public housing neighbourhoods



The x and y axes show distance north and east from the centre of the CBD in kilometres, respectively.

Figure 4. State and ex-state houses in the Brockville neighbourhood

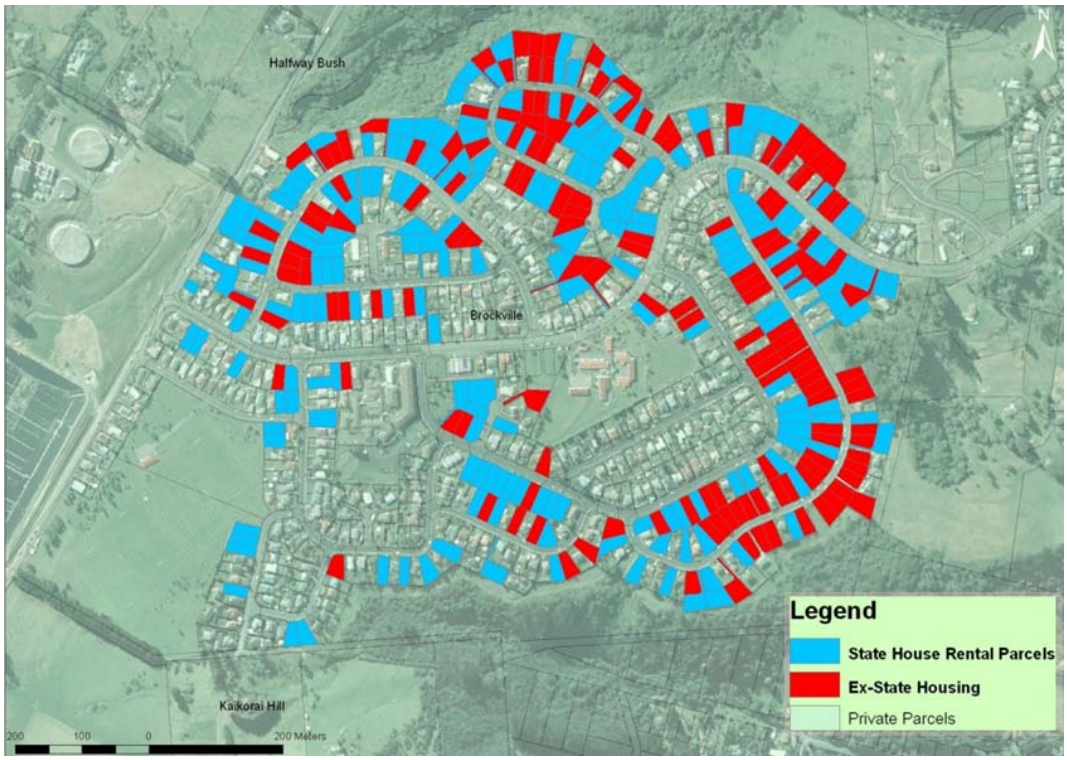


Figure 5. State and ex-state houses in the Corstorphine neighbourhood

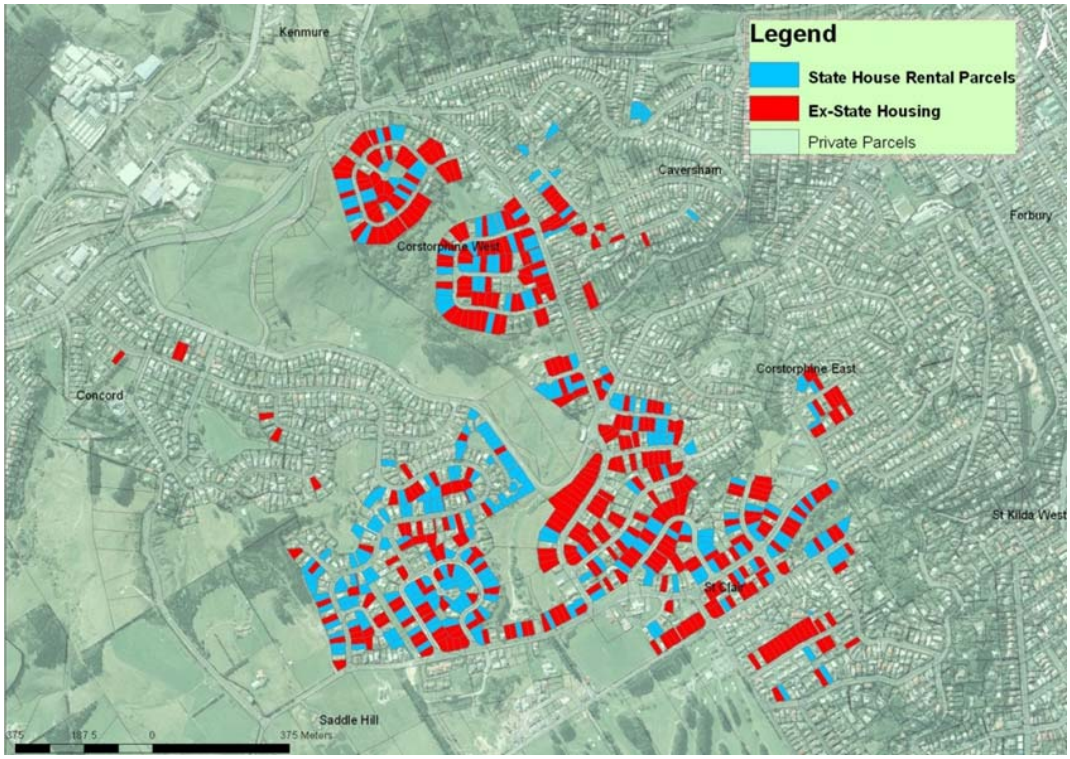


Figure 6. Number of ex-state sales by year

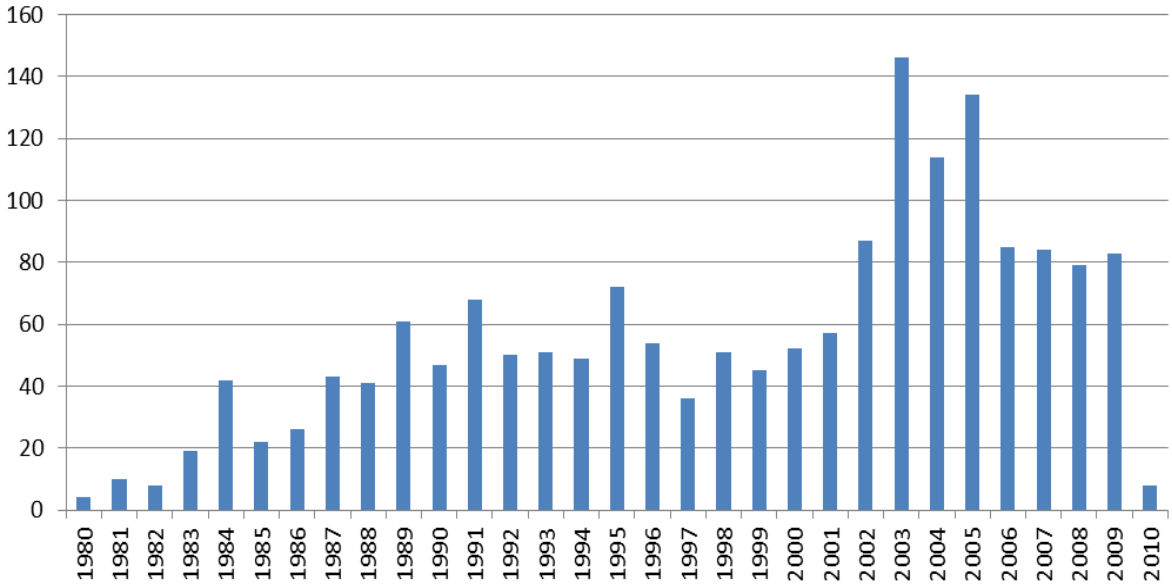


Figure 7. Percent change since 1980 in the real sale price of ex-state houses