Impact of playgrounds on property prices: evidence from Australia

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Abstract

We examine the impact of proximity to a small playground on property prices in urban Australia. We match properties located near an undeveloped green space that could be developed into a playground with similar properties that are already near a playground. We control for other property characteristics and distance to a wide range of urban amenities and other open spaces. We find that the presence of a playground within 300 metres adds about AU$20,000 (just under five per cent) to the average property price. The effect of a playground is larger for houses. The effect of a playground falls with distance from the playground.

Keywords: Property price; Hedonic analysis; Playgrounds; Australia

JEL Codes: H41,R30,Q51

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1 Introduction

The motivation for this paper is to identify the impact on property prices of building a small playground on a previously undeveloped green space. This question is of interest to property owners, to local councils who might be considering investing in a playground and to owners of undeveloped green space.

We focus on two particular undeveloped green spaces located in Moreland City Council (MCC). MCC is part of the greater metropolitan region of Melbourne. Melbourne is Australia's second largest city, with a population just over 4 million. MCC has 163,488 residents (estimated as of 30 June 2015), twelve suburbs and contains 63,292 private dwellings (2011 Census) covering 51 square kilometers. MCC comprises the inner northern suburbs between 4 and 14 kilometres from the Melbourne city centre.[1]

The two green spaces are part of extensive landholdings of Melbourne Water which serve as flood ways and which connect various water amenities. The two potential playground locations are in the suburbs of Coburg North and Pascoe Vale. These two sites were chosen because they currently have no infrastructure. One of the spaces is currently fenced off and does not have public access. The other has public access but no infrastructure. They were chosen to show the value that could be produced by investment in limited-value assets. Both are viewed as currently providing little or no public amenity value.

Appendix A contains a map showing the two green spaces. Box Forest Retarding Basin is 3.34 hectares and is near the top of the map, marked in blue (lightly shaded). Merlynston Linear Park is 0.99 hectares and can be found in the middle of the map, marked in blue.

Our approach to addressing the question of the impact on property prices is to ask the following question: What would happen to the property price of properties near the empty green space were a playground to be built on that site? To answer this question, we compare those properties near the empty green space to a set of 'matched' properties that are near playgrounds which have already been built.

We categorise properties near the empty green space on the basis of two distances–distance to the empty green space and distance to the nearest playground. We also categorise all other properties on the basis of two distances–distance to the nearest playground and distance to

[1] For more information, see Moreland City Council website.

the second nearest playground.

The properties near the empty green spaces constitute a control group. We form a treatment group by matching exactly on the two distances. Were a playground to be built on the empty green space, the set of properties near the empty green space would now look like the matched properties in terms of distance to the two nearest playgrounds. The 'matched' properties near existing playgrounds thus form a treatment group (treatment being proximity to a playground). Comparison of treatment properties to control properties, after matching on the two distances and controlling for a wide variety of property-specific and spatial factors, provides an estimate of the impact of building a playground on an undeveloped green space.

We find effects of playgrounds that vary from about AU$15,000 to about AU$35,000 depending upon the distance from the playground and the type of property considered.[2] In general, we find that the impact falls as we move further away from the playground. We find that the impact is larger if we consider only houses instead of all properties.

If we consider properties within 300 metres (a distance where one can comfortably walk with small children or with a pram) of the nearest playground (or the empty green space) and 600 metres to the next closest playground, and we restrict possible matches to properties within Coburg North and Pascoe Vale, we find that the effect of a playground is about AU$20,000. If we further restrict to houses, we find that the effect is about AU$30,000.

In the next section, we provide some background to our study and review the relevant literature. In section three we present our data. In section four we discuss our matching approach in more detail and the hedonic and spatial regressions which we use. In section five, we discuss our results and in section six we conclude.

2 Background

Playgrounds constitute an essential part of urban livelihood in Australia.[3] A nearby playground allows young children to engage in healthy physical activities that are not otherwise available to them at home. Such activities and experiences contribute to the physical and

[2] All dollar values are in Australian dollars. At the end of our sample period, 2014, one AU$ was equivalent to US$0.82.

[3] Playgrounds in Australia are defined as small grounds with basic play facilities for young children. The responsibility of managing playgrounds is usually entrusted to city councils (Moreland City Council, 2008).

mental development of the participating children. In addition, playgrounds facilitate social interaction. Informal gatherings at the local playground are not limited to children but are also available to parents and other carers. Altogether, playgrounds contribute to improving the living standard of the neighboring residents. This is particularly true for parents with young children and limited access to financial resources (Moreland City Council, 2008).

Several approaches are particularly popular in empirical studies that aim to value urban amenities. First is the travel cost method in which the value of an amenity is calculated by observing individuals' behaviour, particularly the cost people incur in visiting the amenity. Second is the contingent valuation method in which people are asked about trade-offs of various options which allow a researcher to indirectly infer how much they are willing to spend for an amenity. Last is the hedonic pricing method which uses actual transaction data to reveal homeowners' preferences for nearby amenities (Morancho, 2003; Jim and Chen, 2010). The hedonic pricing model is a widely used valuation technique for environmental and non-environmental amenities and has been employed in a number of important studies (e.g Mahmoudi, MacDonald, Crossman, Summers and Van der Hoek, 2013; Panduro and Veie, 2013; Buck, Auffhammer and Sunding, 2014; Gibbons, 2015; Polyakov, Pannell, Pandit, Tapsuwan and Park, 2015; Zhang, Polyakov, Fogarty and Pannell, 2015). Spatial hedonic models, which assume that the price of properties in close proximity to each other may be correlated (e.g., Choumert and Cormier, 2011; Mahmoudi, MacDonald, Crossman, Summers and Van der Hoek, 2013; Efthymiou and Antoniou, 2013), are also popular. Gibbons and Overman (2012) provides a cautionary note about such models which often rely on ad hoc functional forms and arbitrary imposition of exclusion restrictions, or untested theories about which there is no consensus.

The explosion of quasi-experimental techniques in applied econometrics has also been felt in the literature which looks at pricing environmental amenities. Recent papers have used standard matching techniques to form a control group to evaluate the value of living near water (Abbott and Klaiber, 2013) and difference-in-difference methods to evaluate negative externalities of shale gas development on drinking water sources as reflected through property prices (Muehlenbachs et al., 2015). Parmeter and Pope (2013) provides an extensive review of the literature which combines hedonic price models with quasi-experimental techniques,

particularly difference-in-difference and regression discontinuity techniques.

Our paper is related to these strands of literature and combines the hedonic method with quasi-experimental techniques. We form a treatment group through exact matching of distance to nearest and second nearest playground. We use regression-adjusted matching which accounts for both hedonic features of properties but also for spatial characteristics.

While we are unaware of any study that focuses specifically on the valuation of nearby playgrounds (i.e., child play facility), comparable hedonic analysis focusing on open/green space, air quality or other amenities usually find a significant effect of the exposure variable on the prices and rents of urban properties (Morancho, 2003; Jim and Chen, 2010; Donovan and Butry, 2011). For example, in investigating the valuation of urban green areas, Morancho (2003) concluded that proximity to green spaces contributed to increasing property prices in Castellón, Spain. However, they found no significant effect of the view and the size of the nearest green space. Jim and Chen (2010) found that the prices of high-rise private residential units in Hong-Kong with a park within an 800 metre radius were higher compared to those with no park within the same radius. Using a hedonic model for property prices, Panduro and Veie (2013) found a positive and significant contribution for green spaces that are rated highly in terms of accessibility and maintenance. They argue that open spaces, such as parks, reserves, sports fields and civic urban spaces usually improve landscaping and provide recreational and leisure opportunities which improve the quality of urban life.

Studies on property price find the effect of environmental amenities differs with the type and quality of the facility (e.g., Mahmoudi et al., 2013; Pandit et al., 2013). Mahmoudi et al. (2013) examined the importance of amenities in metropolitan Adelaide, Australia. They controlled for area of and distances to reserves, national parks, other parks and water bodies. The study found that the effect of distances to and size of environmental amenities can be positive, negative or insignificant depending on their types. Pandit et al. (2013) included distance from each type of park separately and also found different effects for different types of parks in Perth, Australia. They found that proximity to parks with lakes and small neighbourhood reserves had positive and statistically significant impacts on the sale price. However, proximity to large parks and sport reserves had negative impacts. Also looking at Perth, (Pandit et al., 2014) find that bush reserves, lakes and golf courses had significant and

positive impacts on property prices. However they find no statistically significant effect of small open spaces and sports reserves on property prices. Our study specifically focusing on playgrounds adds to this stock of knowledge about the value of urban amenities.

There is broad consensus amongst government agencies in Australia that improving urban amenities, and in particular, ensuring adequate playground and open space in high property valuation ares is important. Most of Australia's major cities expect and plan for a huge growth of urban housing, implying that local bodies need to rapidly expand their services for amenities like playgrounds, parks and other open spaces (Victorian Government, 2008; Moreland City Council, 2008; NSW Government, 2014).

In the next section, we discuss the data we use in our study.

3 Data

3.1 Property data and amenities

We use individual transaction data for properties sold between January 2005 and December 2014, collected by Australian Property Monitors (APM).[4] For each property, we know the date and price of sale. The data include location and detailed information on characteristics such as property type[5] and size and number of bedrooms, bathrooms and parking spaces. We also have property features such as separate study, dining or family room, courtyard, built-in-wardrobe, fireplace, air conditioning or alarm. Neighborhood information includes data on property views with respect to water, harbor, city, bay, park, river and mountain.

For each property, we know the exact geographical location of the property. Combining this with information on the exact geographical location of a variety of amenities, we generated the distance from the property to each important amenity including beach, river, road, outdoor shelter, schools, golf course, shops and rail station.[6] The list also includes features like waste transfer facilities and cemeteries which could have a negative effect on property

[4]The data were purchased from APM.

[5]Types are house, duplex, semi-detached house, studio apartment, terrace apartment, townhouse, unit (apartment), or villa (detached house in a common housing complex).

[6]Each property in the sales information contains a latitude and longitude. Map data was created by aggregating GIS data provided by Melbourne Water and publicly available data from the Open Street Map system.

prices.[7] Table 1 contains a list of all the amenities that we consider.

A distinct feature of our analysis is the use of detailed information on nearby playgrounds, parks and other open spaces. Because of the limited availability of such detailed information, we focus only on suburbs managed by the Moreland City Council (MCC), who generously provided us with the parks data and information about other types of public spaces (nature reserves, sports fields, cemeteries, etc.). There are fourteen suburbs in the MCC, namely Brunswick, Brunswick East, Brunswick West, Coburg, Coburg North, Fawkner, Fitzroy North, Glenroy, Gowanbrae, Hadfield, Oak Park, Pascoe Vale, Pascoe Vale South and Tullamarine. Our analysis uses playground, park and open space data provided by the MCC in combination with 33,521 property sales during the 2005-2014 period in these fourteen suburbs.

Table 1 contains summary statistics of structural features of the properties. It also contains the average distance to the various amenities that we include in our modeling. Table 2 contains the sample composition by property type with mean price by each property type.

[Tables 1 and 2 about here]

For property size, number of bedrooms and number of bathrooms there are some missing values as reflected in the last column of Table 1. For the number of parking spaces, there are some properties with zero and some with missing values and we can not distinguish between the two. In our regressions below, we include all observations and control for missingness with dummy variables.

Tables B.1 and B.2 in appendix B show the number of observations and median property price by year and quarter in our data. Prices in our data rose 70 per cent from 2005 to 2014, consistent with the large overall increase in property prices throughout Australia during this period. The post-Great Recession dip in property prices experienced in 2011-2012 throughout Australia is visible in our data as is the sharp post-2012 recovery in property prices.

Tables B.3 in appendix B shows the number of observations and median property price by suburb. Table B.4 shows the number of properties which have each type of property feature in our data and the median price of properties that have that feature. Heating is

[7] Onwards, our use of 'amenity' will refer all to amenities excluding playgrounds and open spaces.

the most common feature and tennis courts the least common.[8] Only 17 properties feature tennis courts and the average property price of those 17 properties is quite low as they are all small apartments in a complex with tennis courts. There are just over 1,000 properties with fireplaces and this feature is associated with the highest average property price–the median property price for properties with fireplaces is AU$715,000.

Table B.5 provides more detailed information on the distribution of distance between properties and amenity types. As the Moreland City Council is a relatively dense and small area, most properties are within 2 km of most amenities. Half the properties are within 1 km of a rail station, for example. This is one explanation for why Moreland City Council dwellers are more likely to use public transport than the average Melbournian.

3.2 Playground data and open space

The MCC provided detailed information on all of the 122 playgrounds in the selected suburbs including their size and type. Playgrounds are classified as four types–local, significant local, district and heritage. District are the largest playgrounds and provide for a wide variety of sporting activities and may even draw in tourists from nearby localities. Significant local playgrounds draw junior and senior users and have facilities such as toilets or barbecues. Local playgrounds (which make up the vast majority of playgrounds) are smaller sites primarily targeted at children aged three to seven. They generally have some modest infrastructure such as a swingset, climbing bars or other recreational equipment. Seven playgrounds are classified as heritage because of some historical significance.

District parks are quite large–over 1,000 square metres in size. Local playgrounds are very small with an average size of 269 m^2. Table 3 lists the types of playgrounds in MCC along with the number of households for which a specific type of playground is the closest playground. Local playgrounds are the closest type of playground for almost 72 per cent of properties. Table 3 also provides average distance to playgrounds and median property price by category. Those properties for which a local playground is the closest playground have median property price of $439,900; the same as for the overall sample. Details of the definition of playground type in MCC and the numbers and sizes of various types of playgrounds are

[8]Not all housing features are necessarily captured in our data. Houses may have a particular feature, but if it is not reported in the APM data then we do not have information on that feature.

provided in Appendix C and appendix Table B.1.

[Table 3 about here]

In our estimation, we focus on local playgrounds. We do this for two reasons. We wanted to examine the effect of incremental investment in infrastructure. Given that these two green spaces are empty, a step change improvement would be to build a local playground. We were also told that if a playground were to be built on one or both of these two green spaces, it would be a local playground. Secondly, local playgrounds are by far the most common playgrounds in the data. Most councils in Melbourne have an aspiration that every property should be within 500 metres of a local playground.[9]

All of the playgrounds are located within the council-owned and managed public open spaces with only three exceptions.[10] A large proportion of the 322 open spaces perform the function of Conservation (26%) followed by Playground (18%), Sport (18%) and Visual Amenity (12%). Other primary functions of the open spaces are Social Family Recreation, Accessway, Heritage, Utility/Drainage Floodway, Shared Trail, Utility, Civic Gathering/Forecourt, Community Horticulture and Memorial Park/Cemetery. A total of eight open spaces do not have any identified type of function.

Table 4 lists the types of open spaces along with the number of properties for which a specific type of open space is the closest one. The table demonstrates that the open space which performs the function of Playground is the closest open space for 19 per cent of households, followed by Sport (17%), Visual Amenity (13%) and Social Family Recreation (10%). A reasonable number of properties have nearest open spaces which perform the function of Conservation (9%), Heritage (9%), Shared Trail (7%), Utility (6%) and Accessway (6%). Only 4 per cent of the properties have the nearest open spaces of other types. The size of open spaces, although depending on the function, varies widely within each category.

[Table 4 about here]

[9] See Moreland City Council (2008), page 20.

[10] Open spaces in our data are defined as public land that has a leisure, sport, landscape value, habitat conservation, environmental or visual amenity function and/or is zoned or reserved for public parks or conservation purposes. It may include sports fields, conservation areas, playgrounds, recreation trails, as well as public land that may be provided for drainage or utility purposes or used or valued for leisure and environmental purposes (Moreland City Council, 2012). Details of the open spaces in MCC are provided at Appendix D.

Appendix B provides some additional descriptive data. Tables B.6 and B.7 provide finer detail on the distribution of distances from properties to playgrounds and open spaces, by type. Note from Table B.6 that approximately 70 per cent (23,648) properties have a local playground within the aspirational distance of 500 metres. Since playgrounds are co-located with open spaces, Table B.8 shows the distribution of distances between properties and all combinations of playground type and open space which appear in the data.

We next turn to our estimation strategy.

4 Estimation

4.1 Matching

Our main estimation approach is akin to a natural experiment. We identify 'treatment' and 'control' properties and compare the property prices of the two groups. 'Treatment' is defined as building a playground on an otherwise empty green space. Treatment houses are near a local playground. Control houses are near one of the empty green spaces.

We are interested in the question of how the value of a property changes if a playground is built on an empty green space. We thus want to compare properties which are near a playground to those who are near an empty green space where a playground could be built.

We have identified, with their help, two green spaces owned by Melbourne Water on which playgrounds could be built. For each property within 600 metres (about 2000 feet) of the green space we identify the nearest playground to that particular property in metres. Each control group property is thus classified by two distances: the distance to the empty green space and the distance to the nearest existing playground. In all cases, the nearest playground is further away from the property than the empty green space.

We build the treatment group from all of the other properties in the data excluding those properties within 600 metres of the two identified empty green spaces. For each of these properties, we again classify them by two distances: the distance to the nearest local playground and the distance to the second nearest playground. We consider a variety of possible compositions for treatment and control groups. In addition to using all properties, we also restrict the sample to using only properties in the same suburbs where the two empty

green spaces are located and we also consider building treatment and control groups from houses only instead of all properties.

We then use this data to create a range of treatment and control groups which are defined by the distance to the nearest local playground (for 'treatment') or the distance to one of the empty green spaces (for 'control') and the distance to the second nearest local playground (differentiating by type of playground).

For example, a treatment group could be defined as: houses within 300 metres of a local playground for which the second nearest playground is also a local playground and which is within 600 metres of the second nearest playground. The control group would then be defined as: houses within 300 metres of one of the empty green spaces and within 600 metres of the nearest playground where the nearest playground is a local playground.

If all houses were identical in all respects except distance to playgrounds, comparing the treatment houses to the control group houses would give an answer to the question: what would happen to house price if a local playground were built on the empty green space.

We would then have an estimator for the effect of a local playground on house prices (ϕ) from comparing average house prices ($\overline{p}$) of treatment to control group houses:

$$\widehat{\phi} = \overline{p}_{\text{treatment}} - \overline{p}_{\text{control}} \tag{1}$$

Of course, properties differ in many respects beyond their proximity to the two nearest playgrounds. To control for this, we estimate a hedonic model of property price where we control for property size, number of bedrooms, number of bathrooms, presence of a garage, dummies for type of property (stand alone house, duplex, etc.), dummies for postcode, and a large set of variables to control for distance to public and private amenities and other types of open spaces (other than playgrounds).

Let the hedonic regression model be specified as (detail is provided in section 4.3 below):

$$p_i = \mathbf{Z}_i\boldsymbol{\theta} + v_i \tag{2}$$

where p_i is the property price, $\mathbf{Z}_i$ is a vector of characteristics about the property, and v_i captures unobservable influences on property price.

We can estimate this model and generate predicted values as

$$\widehat{p}_i = \mathbf{Z}_i \widehat{\boldsymbol{\theta}} \tag{3}$$

If playground has no effect on price, then the average difference between the actual price and the predicted price should be equal for treatment and control groups. That is to say that there should be no systematic differences between the residuals from the estimated regression for treatment and control group properties.

If there is a systematic difference between prices and actual values for treatment and control group properties, then we will attribute that difference to the presence of the playground.

The effect of a local playground can then be estimated from

$$\widehat{\phi} = \overline{\widehat{v}}_{\text{treatment}} - \overline{\widehat{v}}_{\text{control}} \tag{4}$$

where $\widehat{v}$ are the residuals from equation (2). Note that we estimate one model for property prices where we combine all treatment and control group properties to generate the estimates of θ but we separately average the residuals for treatment and control group properties.

By varying the distances from the nearest playground /empty green space and the second nearest playground/nearest playground for treatment/control group properties, we generate a series of estimates for ϕ that will vary with distance. In what follows, we will check how the estimate changes with distance.

4.2 Identification and assumptions

The two key assumptions involved in any matching estimator are "conditional independence" (or "selection on observables") and common support.

In our approach, "conditional independence" is equivalent to saying that all factors which influence price except for proximity to the local playground have been controlled for in the hedonic regression. If there are other unobservable differences between the two sets of properties, then we will be mistakenly attributing these differences to the playground. This would invalidate our estimation strategy.

To check common support, we look at whether there is a reasonable overlap in the char-

acteristics of the properties that we compare in treatment and control groups. We provide this comparison in Tables B.10 and B.11 in the appendix for our preferred sub-sample of properties and houses in the two suburbs where the empty green spaces are located (Coburg North and Pascoe Vale). The main difference of importance is that the property sizes of the houses in the treatment group (that is the matched houses that are not near the Melbourne Water sites) are larger than in the control group. There are some very small significant differences in number of parking spaces and number of bedrooms. Note that we do not need exact overlap since the regression model is correcting for systematic observable differences between treatment and control properties. However, if those differences are extreme (which they are not in our case), then a heavy reliance would be placed on the parametric model to create an equivalence across very different property features and this would be undesirable.

Our examination of the data and our physical examination of the properties and neighborhoods (from driving through the neighborhood) reassure us that we have captured all of the important attributes that affect property prices and that the properties in the control group are not substantively different than those in the treatment group in the same suburbs. Angrist and Krueger (2001) and Parmeter and Pope (2013) both stress the importance of this type of 'shoe leather' research when it comes to using natural experiment methods.

There are two alternatives to our approach. The first would be to simply include a dummy variable for treatment properties in the hedonic model and then look at the resulting coefficient as an estimate of the impact of building a local playground. The main advantage of a matching estimator over this approach is that it allows for heterogeneous treatment effects.

A second approach would be to control for distance to local playground by using a fine set of distance variables that allow for non-linear effects of distance to local playgrounds. This is our approach to controlling for distance to amenities and other open spaces as described in section 4.3 below. The problem with this approach is that it does not answer the question of interest. It tells us the marginal effect of proximity to a local playground relative to having the nearest local playground far away. But it doesn't tell us the effect of building a playground on a green space where there was no playground previously. It is also difficult to turn such estimates into an average impact estimator since there is a need to aggregate over

the number of properties within each distance category which is quite cumbersome. It also fails to allow for heterogeneous treatment effects.

We now turn to discussion of the hedonic model and present results from the baseline hedonic model.

4.3 Specification of the hedonic model

Our hedonic regression model for property prices will be

$$p_i = \mathbf{X}_i\boldsymbol{\beta} + \mathbf{A}_i\boldsymbol{\alpha} + \mathbf{O}_i\boldsymbol{\omega} + u_i \tag{5}$$

where $\mathbf{X}$ contains

- Time (quarter $\times$ year interaction dummies)
- Decile dummies for lot size including a dummy if lot size is missing
- Dummies for number of bedrooms, including a dummy variable if information on bedrooms is missing
- Dummies for number of bathrooms, including a dummy variable if information on bathrooms is missing
- Dummies for number of parking places, including a dummy variable if information on parking places is missing
- Dummies for property type (see Table 2)
- Dummies for presence of household features from Table B.4
- Dummies for suburb

Our variable inclusion set is similar to other papers that estimate hedonic models (e.g., Jim and Chen, 2010; Mahmoudi et al., 2013; Efthymiou and Antoniou, 2013; Klimova and Lee, 2014). By using indicator variables for different deciles and categories, we allow for a much more flexible functional form that does not impose linear restrictions between, for example, the number of bedrooms and price or lot size and price.

A and **O** contain controls for distance to amenities and distance to open spaces. For both amenities and open spaces, we experimented with a linear functional form, a quadratic functional form and a set of dummies based upon the deciles of distance between properties and amenities (or open spaces).

u controls for all other unobserved factors which affect property prices. One important factor will be demographic information about the individuals and families actually living in the property. So, for example, proximity to a playground is more valuable if you have young children in the household. We do not have any information about the actual owners and residents of the properties for which we have price data.

We estimate baseline models with and without controls for distance from amenities and distance from open spaces. We varied the controls for geographic location and used postcode, suburb and socio-economic area indicators. We experimented with using lot size data in continuous form (both level and natural log) and in categorical form. We experimented with property price, the dependent variable, in level and in natural log form. We experimented with a variety of ways for controlling for year and quarter effects.

From the above, we conclude the following which we incorporate in what follows.

1. Using the dependent variable in log form is superior to using it in level form.

2. Quarter and year dummies alone are not sufficient to control for seasonal effects. This is probably due to the Great Recession (Global Financial Crisis) which falls in the middle of our data set. In all models, we thus use a complete set of quarter $\times$ year interactions.[11]

3. Controlling for socio-economic status of neighborhoods adds no additional information once we control for either postcode or suburb so we do not include this variable in any models.

4. The effect of lot size on property price is complicated and non-linear.[12] A set of categorical variables is superior to controlling for either the lot size or the log of lot size even if we use a quartic in the continuous set of controls. Thus we incorporate the categories in all models.

[11] Kuminoff et al. (2010) also suggest this as the most appropriate form.
[12] See Table B.9 in Appendix B.

Table 5 summarises the results by presenting marginal effects from the baseline hedonic regressions.[13] In the first column of Table 5 we present a model with no controls for amenities or open spaces (we set $\alpha = \omega = 0$). In column 2 we control only for amenities and in column 3 we control only for open spaces. In column 4 we control for both simultaneously.

[Table 5 about here]

Without any controls for amenities or open spaces, we explain about 67 per cent of the variation in property prices. This is large compared to some other Australian studies (e..g, Tapsuwan and Polyakov (2016), who explain less than 50 per cent of property prices). Adding amenities and/or open spaces adds very little additional explanatory power to the regressions, nor does it change the marginal effects on the property characteristics or the location dummy variables. The marginal effects conform to our prior expectations and seem reasonable.

For all of the models where we include amenities and open spaces we generate twenty quantiles of distance from properties to amenities/open spaces. We then include a dummy variable for the first 10 quantiles, using further away than median distance as the omitted category. This allows for complicated non-linear relationships between property price and distance to amenity/open space.[14] Rather than present marginal effects for each included quantile, we summarise the marginal effects as distance grows between the property and the indicated amenity/open space. "0" indicates no statistically significant marginal effect. "+" means the effect is always positive. "-,0" means the effect is negative at first, but becomes statistically insignificant at further distances. So proximity to a beach always has a positive effect whereas proximity to a public toilet is negative but becomes statistically insignificant at further distances. More detailed results are available from the authors.

In general, care should be taken in interpreting the marginal effects for the amenities and open spaces since many of these are co-located. The focus in the paper is on the effect of playgrounds so our inability to separately identify the individual effect of any particular open space or amenity is not important for our conclusions.

[13] Detailed regression output is available from the authors.

[14] There is a lack of consensus about the most appropriate form of distance variables. Some papers include levels or log of distance and may or may not include a quadratic term (e.g., Morancho, 2003; Mahmoudi et al., 2013). Interactions with other characteristics (e.g., lot size) have also considered (e.g., Mahmoudi et al., 2013). Distance dummies seem to be the most common format in hedonic models for property price (e.g., Jim and Chen, 2010; Klimova and Lee, 2014).

If we add quantiles for distance to local playgrounds to these baseline models we find a negative effect of being too close to a local playground (less than 100 metres) but a positive effect of being 250 - 400 metres away. These are both relative to being more than 500 metres away. This is not surprising because local playgrounds can sometimes be locations for drinking or hanging out by adolescents and occasionally suffer from vandalism subsequently. This argues further for our matching approach and allowing for heterogeneous effects.

We present the matching results in the next section.

5 Results

5.1 Main results

We find a statistically significant and positive effect on property prices of the presence of a local playground relative to an empty green space. That is, we find that the treatment properties (those near a local playground) have a higher price than the control properties (those near the undeveloped green space) even after we control for all other characteristics.

Tables 6 through 8 present our impact estimates for a variety of distances and a variety of subsamples. In Table 6, we consider properties that are within 300 metres (m) of the empty green space and within 600 m of the nearest local playground. These are the 'control' properties. The treatment properties are within 300 m of a local playground and within 600 m of the second nearest local playground. Were a playground to be built on the empty green space, the two sets of properties would look identical in terms of their proximity to the two nearest local playgrounds.

The first column of Table 6 compares mean values for the treatment and control properties. The second column compares residuals after controlling for the hedonic model with locational (suburb) effects but no controls for distances to amenities and open spaces. The third column uses the hedonic model including distances to local amenities. The fourth column includes both distances to amenities and distances to non-playground open spaces. Standard errors for all estimates are calculated via the bootstrap.

The first row uses all the properties in our data set as potential treatment properties. The second row uses only houses. It may be difficult to capture the hedonic characteristics of

non-house properties using the variables that are available to us in the data set. By using only houses, we may improve the ability of our hedonic model to control for all of the important characteristics–i.e., selection on observables should be more likely to hold. Houses are also a more homogeneous group of properties so common support is more likely to be met. Finally, it may be that local playgrounds are more valuable to owners and residents of houses as these households are more likely to have young children.

Rows three through eight further restrict the sample to the two suburbs where the empty green spaces are located–Coburg North and Pascoe Vale. We consider them together and separately. Again, restricting to the same suburb makes selection on observables more likely to hold as we remove other sources of unobserved heterogeneity that differ by suburb.

Looking at Table 6, we can draw the following conclusions.

- The impact estimator falls when we control for property characteristics.

  Properties near the empty green spaces are of lower quality (as captured by the hedonic model) than those in the chosen treatment groups because once we control for property characteristics, the impact estimator generally falls.

  The exception is in Pascoe Vale where properties near the empty green space are not statistically different from those in the treatment group in raw price but there is a large difference in expected price once we control for hedonic characteristics.

- The impact estimators drop substantially when we add controls for distance to amenities.

- There is not much difference in the impact estimators when we control for amenities only or distance to amenities combined with distance to open spaces.

- We find a larger impact for houses than all properties.

  This is consistent with local playgrounds being more valuable for residents and owners of houses than for other types of properties. This could be picking up demographic characteristics such as the presence of children in the household.

- Although the difference in prices between control and treatment groups is quite different for Coburg North and Pascoe Vale, the final impact estimates once we control for distance to amenities (or to amenities and open spaces) are quite similar.

Our preferred estimates are the two estimates framed in Table 6. By restricting possible treatment properties (houses) to the suburbs where the control group properties (houses) are located, we eliminate some possible sources of endogeneity. However, we note that the difference in impact estimate between using all properties (houses) and only those in Coburg North and Pascoe Vale is never statistically significant.

The estimates from Table 6 imply that building a local playground will increase the average value of houses that are within a 300 m radius of the playground by AU$32,073. It will increase the average value of all properties (including houses) by AU$20,218.

The estimates in Table 7 are similar to those in Table 6 except we now change the radius of impact. The estimates from Table 7 imply that building a local playground will increase the average value of houses that are within a 500 m radius of the playground by AU$21,861. It will increase the average value of all properties (including houses) by AU$14,226. It is intuitively appealing that as we move the radius of impact out, the average impact falls. Properties within 300 m will see a larger benefit that those in the 300 m - 500 m range so adding properties in this latter group should cause the average impact to fall.

The estimates in Table 8 restrict the impact to a 200 m radius where the second nearest local playground is within 500 m. The estimates from Table 8 imply that building a local playground will increase the average value of houses that are within a 200 m radius of the playground by AU$36,087. It will increase the average value of all properties (including houses) by AU$25,561.

The overall pattern across the three tables is similar and confirms the main conclusions listed above.

5.2 Caveats

Should we believe these estimates? As we have pointed out before, our estimated impacts rely upon the assumption that there are no unobserved differences between 'treatment' and 'control' properties once the hedonic models have been estimated. If the residuals from those models reflect systematic differences in property prices that are driven by something other than the presence of the local playground, then our estimates will be biased. Note that the bias could be positive or negative.

As indicated above we have done everything possible within our data to control for observables. We have looked at the neighborhoods and properties in person. We are also reassured by the similarity of the separate impact estimates for Coburg North and Pascoe Vale. This despite the very different initial property price differences without any controls.

Our preferred estimates may be too low. There is a high degree of correlation between distance to local playground and distance to various natural and urban amenities. This is partially a feature of co-location of amenities and playgrounds and partly a feature of suburb layout where a variety of amenities might be 500 - 600 m from a set of properties that are grouped together. (Amenities and properties are not randomly allocated in space.) Because we use the hedonic regression to partial out all of the effect of amenities before we use the residuals to estimate the impact of playgrounds, some of the effect of playgrounds will be attributed to amenities because of the correlation in distance between these two. Since the effect of most amenities is positive, this may lead to an under-estimate of the impact of local playgrounds.

This would be an argument to prefer the second column of Tables 6 through 8 where we only correct the property prices for the basic hedonic model with suburb effects. However, these estimates seem intuitively too large. A positive impact of over 10 per cent on property prices to be an additional 300 m closer to the nearest playground seems excessive.

On most characteristics, treatment and control group houses are similar. The one big difference is that treatment group houses have larger lot sizes. The hedonic model upon which our estimates are based uses a set of ten dummy variables to capture a flexible relationship between lot size and house price. If, however, the hedonic model is not completely capturing the effect of lot size on price, then these estimates might be biased upwards in the sense that they may partly be capturing the effect of lot size in addition to the effect of playgrounds. This would lead to the conclusion that our preferred estimates should be treated as upper bounds for the value of playgrounds.

In addition to the various checks and tests we mention above, we undertook a wide range of robustness checks of the model and of our results. We discuss the most important of these in the next sub-section.

5.3 Robustness checking

We undertook a large variety of robustness checks. All the results discussed below are available from the authors upon request.

We estimated the impact for all combinations of distance to nearest and second nearest playground between 100 m and 800 m. We find statistically significant impacts out to 600 m but which then taper off. Previous papers used larger distances such as 800 m (Jim and Chen, 2010; Gedikli and Özbilen, 2004) but we think this is too far for the type of local playground that we are studying. 300 m is a distance which families with young children can easily cross on foot or with a pram. Intuitively, this seems like the right distance.

We estimated the model on data excluding the Great Recession (Global Financial Crises) and the results were basically the same. We also checked that the coefficients on the property characteristics in the hedonic model are temporally stable. We check that the same hedonic model applies equally well to treatment and control group properties and a statistical test indicates that the pooled model is preferred to separate models for these two groups.

We re-estimated all models using any playground type rather than just local playgrounds. (We also estimated the models keeping the nearest playground as a local playground and the second nearest playground as any type of playground.) The results are very similar. This is not surprising given that for over 70 per cent of households a local playground is the closest playground.

6 Conclusion

We estimate the effect of building a local playground by focusing on a set of properties in the urban area of Melbourne, Australia. The properties are near two empty green spaces that are considered suitable for building a small local playground. A local playground is one with simple facilities targeted at children aged three to seven.

We match these properties to a synthetic treatment group who are the identical distance to a local playground. Properties are matched on their distance to the green space/nearest local playground and nearest local playground/second nearest local playground. If a playground were to be built on the empty green spaces, the two sets of properties would now look identical

in their proximity to the two nearest local playgrounds.

We use the treatment group properties to predict what would happen to property prices in the properties near the empty green spaces were a local playground to be built on that green space. We control for observable property characteristics using a hedonic model. We augment that model with controls for location and distance to various amenities and other types of open spaces.

We focus on properties within 300 metres of the nearest local playground (or the empty green space) which have a second playground located within 600 metres. Our estimate is that the presence of the local playground adds AU$20,218 to the average property price. If we restrict our estimation sample to houses, we find the presence of the local playground adds AU$32,073 to the average house price.

As discussed in section 5.2, our approach may over-estimate the effect of playgrounds if we are partially picking up the house price effect of larger lot sizes in the treatment group. However, the effect of lot size on house prices is controlled for in the hedonic model in a flexible, non-parametric way, so any over-estimation should be slight.

The impact of a local playground on property price increases as we consider properties in a smaller radius around the playground and decreases as the distance increases. We find that it is important to control for other characteristics that affect house prices. We always find that house prices respond more than other property prices to the presence of a local playground. If families with small children are more likely to live in houses and they value playgrounds more than families without children, this result is not surprising.

Tables and Figures

Table 1: Summary statistics of structural and locational characteristics

Characteristics	Mean	SD	Minimum	Maximum	Obs.
Structural features					
Property size (m^2)	1,001	2,595	10	204,943	32,757
Number of bedrooms	2.61	0.79	1	6	26,458
Number of bathrooms	1.26	0.49	1	3	23,205
Number of parking	1.52	0.77	1	4	19,744
Locational features: distance from nearest amenity (in km)					
Beach	5.14	2.60	0.75	16.53	33,521
River	2.88	1.51	0.03	10.69	33,521
Freeway (onramp)	1.72	0.96	0.00	4.57	33,521
Road (freeway)	1.72	0.99	0.02	4.58	33,521
Road (trunk)	2.10	1.47	0.00	6.82	33,521
Bench	0.70	0.44	0.01	5.07	33,521
Public toilets	0.67	0.45	0.01	3.81	33,521
Drink fountain	0.89	0.74	0.01	5.93	33,521
Outdoor shelter	1.77	0.81	0.01	5.29	33,521
School	0.37	0.22	0.00	1.76	33,521
Waste transfer facility	4.01	2.15	0.01	13.91	33,521
Stadium	2.24	1.18	0.02	11.87	33,521
Golf course	1.99	0.99	0.01	4.78	33,521
Cemetery	1.97	0.99	0.01	7.74	33,521
Shops	0.43	0.28	0.00	1.92	33,521
Rail station	1.09	0.69	0.02	5.66	33,521

Table 2: Sample sizes and median prices by property type

Property type	Observations	Property price ($1,000)
Duplex	74	450.5
House	19,570	499.0
Semi-detached	2	435.5
Studio	3	510.0
Terrace	400	568.3
Townhouse	2,540	416.1
Unit	10,861	370.0
Villa	71	360.5
Total	33,521	439.9

Table 3: Distance to closest playground and median property price ($1,000)

Playground type	Number of households[a]	Distance (km)		Property price
		Mean	Median	
District	444	0.28	0.27	520.38
Heritage	3,484	0.30	0.29	470.00
Local Significant	3,691	0.31	0.29	420.00
Local	24,065	0.41	0.29	439.90
Undefined	1,837	0.32	0.31	399.00

[a] Number of households for whom this type is the closest playground.

Table 4: Distance to closest open space and median property price ($1,000)

Open space type	Number of households[a]	Distance (km)		Property price
		Mean	Median	
Accessway	1,838	0.60	0.18	375.00
Civic Gathering/Forecourt	109	0.18	0.18	418.00
Community Horticulture	111	0.10	0.08	591.00
Conservation	3,005	0.22	0.10	446.00
Heritage	2,987	0.21	0.20	470.00
Memorial Park/Cemetery	360	0.15	0.14	395.00
No Identified Function	331	0.16	0.12	488.00
Play	6,539	0.18	0.15	451.50
Shared Trail	2,249	0.61	0.51	548.50
Social Family Recreation	3,420	0.17	0.16	482.75
Sport	5,892	0.18	0.16	432.45
Utility	1,909	0.14	0.10	405.00
Utility/Drainage Floodway	504	0.16	0.13	420.00
Visual Amenity	4,267	0.36	0.19	390.00

[a] Number of households for whom this type is the closest open space.

Table 5

Hedonic regression model of house prices

(Table entries are average marginal effects expressed as percentage price changes.)

	Categorical distance to			
	None	amenities only	open space only	amenities & open space
Year of house sale: 2005 is omitted category				
2006	4.1*** (0.6)	4.0*** (0.6)	3.9*** (0.6)	4.0*** (0.6)
2007	20.4*** (0.6)	20.6*** (0.6)	20.2*** (0.6)	20.4*** (0.6)
2008	28.3*** (0.6)	28.6*** (0.6)	28.4*** (0.6)	28.6*** (0.6)
2009	36.7*** (0.6)	37.1*** (0.6)	36.5*** (0.6)	37.1*** (0.6)
2010	50.5*** (0.6)	50.8*** (0.6)	50.6*** (0.6)	50.8*** (0.6)
2011	47.2*** (0.6)	47.2*** (0.6)	46.8*** (0.6)	47.1*** (0.6)
2012	41.8*** (0.6)	42.2*** (0.6)	41.5*** (0.6)	42.1*** (0.6)
2013	46.0*** (0.6)	46.0*** (0.6)	45.7*** (0.6)	45.9*** (0.6)
2014	53.1*** (0.6)	53.1*** (0.6)	52.8*** (0.6)	53.0*** (0.6)
Quarter of year in which house is sold: First quarter is omitted category				
2nd quarter	2.1*** (0.4)	2.0*** (0.4)	2.0*** (0.4)	1.9*** (0.4)
3rd quarter	2.8*** (0.4)	2.8*** (0.4)	2.7*** (0.4)	2.7*** (0.4)
4th quarter	4.6*** (0.4)	4.5*** (0.4)	4.5*** (0.4)	4.4*** (0.4)
Lotsize: $\leq 150m^2$ is omitted category				
$>150m^2$ & $\leq 200m^2$	4.3*** (0.6)	3.6*** (0.6)	4.0*** (0.6)	3.7*** (0.6)
$>200m^2$ & $\leq 300m^2$	6.1*** (0.6)	5.8*** (0.6)	5.8*** (0.6)	5.9*** (0.6)
$>300m^2$ & $\leq 400m^2$	4.7*** (0.6)	4.9*** (0.6)	5.0*** (0.6)	5.1*** (0.6)
$>400m^2$ & $\leq 500m^2$	5.5*** (0.6)	5.7*** (0.6)	5.9*** (0.6)	6.1*** (0.6)
$>500m^2$ & $\leq 600m^2$	1.4** (0.6)	2.4*** (0.6)	1.8*** (0.6)	2.7*** (0.6)
$>600m^2$ & $\leq 700m^2$	3.0*** (0.6)	3.6*** (0.6)	3.1*** (0.6)	3.8*** (0.6)
$>700m^2$ & $\leq 900m^2$	5.6*** (0.6)	5.9*** (0.6)	6.1*** (0.6)	6.2*** (0.6)
$>900m^2$&$\leq 2000m^2$	1.7*** (0.6)	1.4*** (0.6)	1.5*** (0.6)	1.7*** (0.6)
$>2000m^2$	−3.6*** (0.7)	−2.2*** (0.7)	−3.4*** (0.7)	−2.0*** (0.7)
lot size missing	−2.5*** (1.0)	−1.2 (1.0)	−2.6*** (1.0)	−1.0*** (1.0)

***, ** and * represent significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

Table 5 (continued)
Hedonic regression model of house prices
(Table entries are average marginal effects expressed as percentage price changes.)

	Categorical distance to			
	None	amenities only	open space only	amenities & open space
Number of bedrooms: One bedroom is omitted category				
2 bedrooms	35.2*** (0.7)	35.3*** (0.7)	35.2*** (0.7)	35.2*** (0.7)
3 bedrooms	46.7*** (0.7)	46.7*** (0.7)	46.8*** (0.7)	46.7*** (0.7)
4 bedrooms	55.8*** (0.9)	55.4*** (0.9)	55.7*** (0.9)	55.1*** (0.9)
5 bedrooms	62.5*** (1.6)	62.2*** (1.5)	62.4*** (1.5)	61.9*** (1.5)
6 or more	69.4*** (2.6)	69.1*** (2.6)	69.4*** (2.6)	68.8*** (2.6)
missing	38.7*** (0.8)	38.8*** (0.8)	38.8*** (0.8)	38.6*** (0.8)
Number of baths: One bath is omitted category				
2 baths	10.6*** (0.5)	10.1*** (0.5)	10.5*** (0.5)	9.9*** (0.5)
3 or more	22.3*** (1.2)	22.1*** (1.2)	22.1*** (1.2)	22.9*** (1.2)
missing	4.1*** (0.6)	4.0*** (0.6)	4.2*** (0.6)	4.0*** (0.6)
Property type: House is omitted category				
Duplex	−11.7*** (2.7)	−12.3*** (2.7)	−11.4*** (2.7)	−11.7*** (2.7)
Semi-detached	−3.8 (16.6)	−4.0 (16.2)	−7.4 (16.4)	−2.1 (16.1)
Studio	−8.0 (13.5)	−8.3 (13.2)	−9.7 (13.3)	−8.0 (13.1)
Terrace	−0.0 (1.2)	−0.5 (1.2)	−0.9 (1.2)	−0.7 (1.2)
Townhouse	−14.7*** (0.5)	−14.7*** (0.5)	−14.5*** (0.5)	−14.8*** (0.5)
Unit	−25.2*** (0.4)	−24.8*** (0.4)	−24.9*** (0.4)	−24.7*** (0.4)
Villa	−21.6*** (2.8)	−21.6*** (2.7)	−21.8*** (2.8)	−22.1*** (2.7)
Number of parking places: One car park is omitted category				
2 cars	5.3*** (0.4)	5.0*** (0.4)	5.1*** (0.4)	5.0*** (0.4)
3 cars	6.2*** (0.8)	6.1*** (0.8)	6.2*** (0.8)	6.3*** (0.8)
4 or more	10.0*** (0.9)	9.8*** (0.9)	9.9*** (0.9)	9.8*** (0.9)
missing	1.3*** (0.5)	1.1** (0.5)	1.1** (0.5)	1.0** (0.5)

Table 5 (continued)
Hedonic regression model of house prices
(Table entries are average marginal effects expressed as percentage price changes.)

	Categorical distance to			
	None	amenities only	open space only	amenities & open space
Other features:				
study	6.0*** (0.4)	5.9*** (0.4)	5.9*** (0.4)	5.9*** (0.4)
separate dining	0.1 (0.9)	−0.4 (0.9)	−0.1 (0.9)	−0.5 (0.9)
family room	1.3 (1.4)	1.5 (1.4)	1.7 (1.4)	1.6 (1.4)
sun room	2.2*** (0.9)	1.7** (0.9)	2.1** (0.9)	1.8** (0.9)
rumpus room	−1.6 (1.0)	−1.4 (1.0)	−1.3 (1.0)	−1.1 (1.0)
fireplace	10.5*** (0.8)	9.9*** (0.7)	10.2*** (0.7)	9.7*** (0.7)
walk-in wardrobe	1.8** (0.7)	1.6** (0.7)	1.8** (0.7)	1.5** (0.7)
courtyard	−2.3*** (0.4)	−2.2*** (0.4)	−2.2*** (0.4)	−2.3*** (0.4)
internal laundry	−5.6*** (1.0)	−5.3*** (1.0)	−5.5*** (1.0)	−5.2*** (1.0)
heating	2.1*** (0.4)	2.0*** (0.4)	2.1*** (0.4)	2.1*** (0.4)
air conditioning	−0.8** (0.4)	−0.6 (0.4)	−0.8* (0.4)	−0.6 (0.4)
balcony	0.0 (0.6)	0.1 (0.6)	0.1 (0.6)	0.0 (0.6)
barbeque	1.6 (1.2)	2.2* (1.1)	2.2* (1.1)	2.5** (1.1)
polished timber floor	1.5*** (0.4)	1.6*** (0.4)	1.4*** (0.4)	1.6*** (0.4)
ensuite	−2.1*** (0.6)	−1.9*** (0.6)	−1.9*** (0.6)	−1.7*** (0.6)
spa	−1.0** (0.5)	−1.0** (0.4)	−0.9** (0.4)	−1.0** (0.4)
locked garage	1.3*** (0.4)	1.1*** (0.4)	1.1*** (0.4)	1.1*** (0.4)
tennis court	−6.7 (5.7)	−1.6 (5.6)	−6.9 (5.6)	−1.6 (5.6)
alarm	4.3*** (0.6)	3.9*** (0.6)	4.1*** (0.6)	4.0*** (0.5)

Table 5 (continued)
Hedonic regression model of house prices
(Table entries are average marginal effects expressed as percentage price changes.)

	Categorical distance to			
	None	amenities only	open space only	amenities & open space
Suburb: Brunswick is omitted				
Brunswick East	2.1^{***} (0.6)	0.3 (1.2)	1.6^{*} (0.9)	0.8 (1.4)
Brunswick West	-9.9^{***} (0.6)	-5.3^{***} (1.1)	-8.1^{***} (0.9)	-8.7^{***} (1.3)
Coburg	-12.6^{***} (0.5)	2.9^{**} (1.4)	-2.4^{**} (1.0)	4.5^{***} (1.5)
Coburng North	-29.1^{***} (0.8)	-3.6^{*} (1.9)	-11.0^{***} (1.4)	-4.4^{**} (2.2)
Fawkner	-47.4^{***} (0.7)	-19.0^{***} (2.0)	-33.6^{***} (1.5)	-19.1^{***} (2.5)
Fitzroy North	24.6^{***} (0.6)	27.2^{***} (1.5)	25.3^{***} (1.0)	29.2^{***} (2.1)
Glenroy	-40.4^{***} (0.5)	-18.0^{***} (2.0)	-28.0^{***} (1.5)	-17.9^{***} (2.5)
Gowanbrae	-41.3^{***} (1.2)	-10.1^{***} (2.4)	-31.9^{***} (2.0)	-11.4^{***} (3.0)
Hadfield	-41.6^{***} (0.9)	-19.1^{***} (2.2)	-26.7^{***} (1.8)	-17.1^{***} (2.6)
Oak Park	-22.2^{***} (0.7)	-4.8^{**} (2.1)	-16.4^{***} (1.4)	-5.8^{**} (2.4)
Pascoe Vale	-19.8^{***} (0.5)	-0.4 (2.0)	-6.6^{***} (1.4)	-0.4 (2.2)
Pascoe Vale South	-12.5^{***} (0.7)	3.4^{**} (1.7)	-5.3^{***} (1.2)	-0.4 (1.9)
Tullamarine	-46.6^{***} (0.7)	-10.2^{***} (2.4)	-46.0^{***} (1.3)	-7.3^{**} (3.3)

Table 5 (continued) *Hedonic regression model of house prices*
(Table entries are average marginal effects expressed as percentage price changes.)

Amenity	Categorical distance to None	amenities only	open space only	amenities & open space
beach		+		+
river		+		+, −
freeway onramp		+, 0		+, 0
road (freeway)		−, +		−, 0
road (trunk)		+		+
bench		+, 0		+, 0
public toilets		−, 0		0, −, 0
drink fountain		+, 0		0, −
outdoor shelter		+, 0		0, +, 0
school		+, 0		0, +, 0
waste transfer		−		−
stadium		−		0, −
golf course		+		+, 0, +
cemetary		−		−, 0, −
shops		+, −		mixed
rail station		0, +		−, 0

Note that a positive value means that house prices are higher if the amenity is closer.

Table 5 (continued) *Hedonic regression model of house prices*
(Table entries are average marginal effects expressed as percentage price changes.)

Amenity	Distance to None	amenities only	open space only	amenities & open space
Accessway			−	−
Civic Gathering/ Forecourt			−	−
Community Horticulture			+	+
Conservation			−, 0, +	0
Heritage			+, 0, −	+, 0, −
Memorial Park/ Cemetery			−	+, 0, −
Unidentified Function			−	−, 0
Shared Trail			+	+, 0
Social Family Recreation			0, −	mixed
Sport			−	mixed
Utility			0	+
Utility/Drainage Floodway			−	+
Visual Amenity			0	+
Year and quarter interactions	yes	yes	yes	yes
R-squared	67.1%	68.9%	68.2%	69.5%
N	33,521	33,521	33,521	33,521

We summarise the marginal effects as distance grows between the property and the indicated amenity/open space. "0" indicates no statistically significant marginal effect. "+" means the effect is always positive. "-,0" means the effect is negative at first, but becomes statistically insignificant at further distances, etc.. Note that a positive value means that house prices are higher if the open space is closer.

Table 6: Matching estimators

Effect of building a playground within 300 m of a property when the nearest playground is between 300 and 600 m

Sample	Controls: None	Controls: Hedonic model	Controls: Hedonic model plus distance to: amenities	Controls: Hedonic model plus distance to: amenities and open spaces	Sample sizes: Treatment	Sample sizes: Control
All	$\$50,702^{***}$ (7,232)	$\$43,639^{***}$ (4,770)	$\$25,921^{***}$ (4,334)	$\$24,019^{***}$ (4,850)	8,386	316
Houses only (all)	$\$92,558^{***}$ (8,765)	$\$54,519^{***}$ (5,725)	$\$36,725^{***}$ (5,943)	$\$34,701^{***}$ (5,188)	4,774	236
Coburg North and Pascoe Vale	$\$18,203^{**}$ (8,338)	$\$38,678^{***}$ (5,328)	$\$20,621^{***}$ (5,327)	$\$20,218^{***}$ (5,120)	1,020	316
Houses only (Coburg North and Pascoe Vale)	$\$62,566^{***}$ (10,493)	$\$51,464^{***}$ (6,996)	$\$31,812^{***}$ (7,083)	$\$32,073^{***}$ (6,927)	562	236
Coburg North	$\$41,898^{***}$ (11,575)	$\$24,860^{***}$ (8,535)	$\$22,942^{***}$ (8,597)	$\$22,570^{***}$ (8,344)	323	154
Houses only (Coburg North)	$\$46,417^{***}$ (14,324)	$\$31,661^{***}$ (9,711)	$\$29,216^{***}$ (9,746)	$\$30,856^{***}$ (9,322)	260	113
Pascoe Vale	$-\$6,738$ (10,277)	$\$49,418^{***}$ (6,946)	$\$18,693^{***}$ (7,178)	$\$20,137^{***}$ (6,647)	697	162
Houses only (Pascoe Vale)	$\$74,902^{***}$ (14,162)	$\$69,184^{***}$ (10,360)	$\$34,055^{***}$ (9,742)	$\$33,366^{***}$ (9,237)	302	123

Control group houses are less than 300m from empty green space and less than 600m away from closest playground

Treatment group houses are less than 300m away from nearest local playground and less than 600m away from second nearest local playground

***, ** and * represent significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

Table 7: Matching estimators

Effect of building a playground within 500 m of a property when the nearest playground is between 500 and 600 m

Sample	Controls: None	Controls: Hedonic model	Controls: Hedonic model plus distance to: amenities	Controls: Hedonic model plus distance to: amenities and open spaces	Sample sizes: Treatment	Sample sizes: Control
All	$\$46,580^{***}$ (6,188)	$\$34,808^{***}$ (4,267)	$\$18,778^{***}$ (4,168)	$\$16,376^{***}$ (4,435)	12,268	439
Houses only (all)	$\$82,435^{***}$ (7,582)	$\$43,144^{***}$ (5,498)	$\$26,766^{***}$ (5,169)	$\$23,635^{***}$ (5,414)	7,096	314
Coburg North and Pascoe Vale	$\$24,574^{***}$ (6,998)	$\$33,687^{***}$ (5,358)	$\$17,981^{***}$ (4,949)	$\$14,226^{***}$ (5,034)	1,552	421
Houses only (Coburg North and Pascoe Vale)	$\$61,289^{***}$ (9,632)	$\$44,002^{***}$ (7,032)	$\$26,670^{***}$ (6,879)	$\$21,861^{***}$ (6,761)	865	298
Coburg North	$\$48,191^{***}$ (11,55)	$\$22,993^{***}$ (7,428)	$\$20,214^{***}$ (7,684)	$\$13,146^{*}$ (7,342)	408	189
Houses only (Coburg North)	$\$42,191^{***}$ (12,588)	$\$26,899^{***}$ (8,793)	$\$22,621^{***}$ (8,616)	$\$16,392^{**}$ (8,521)	331	135
Pascoe Vale	$\$1,751$ (9,812)	$\$39,575^{***}$ (6,864)	$\$14,354^{***}$ (6,917)	$\$14,138^{**}$ (6,866)	1,144	232
Houses only (Pascoe Vale)	$\$67,027^{***}$ (12,757)	$\$56,015^{***}$ (10,225)	$\$28,342^{***}$ (9,835)	$\$25,533^{***}$ (9,842)	534	163

Control group houses are less than 500m from empty green space and less than 600m away from closest playground

Treatment group houses are less than 500m away from nearest local playground and less than 600m away from second nearest local playground

***, ** and * represent significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

Table 8: Matching estimators

Effect of building a playground within 200 m of a property when the nearest playground is between 200 and 500 m

Sample	Controls: None	Controls: Hedonic model	Controls: Hedonic model plus distance to: amenities	Controls: Hedonic model plus distance to: amenities and open spaces	Sample sizes: Treatment	Sample sizes: Control
All	$\$50,927^{***}$ (9,266)	$\$42,372^{***}$ (5,743)	$\$26,866^{***}$ (5,861)	$\$24,268^{***}$ (5,681)	4,554	203
Houses only (all)	$\$96,482^{***}$ (10,448)	$\$51,875^{***}$ (6,514)	$\$37,084^{***}$ (5,912)	$\$32,794^{***}$ (6,441)	2,295	155
Coburg North and Pascoe Vale	$\$20,475^{**}$ (10,773)	$\$39,387^{***}$ (7,282)	$\$24,588^{***}$ (7,474)	$\$25,561^{***}$ (7,475)	465	203
Houses only (Coburg North and Pascoe Vale)	$\$52,137^{***}$ (13,127)	$\$49,935^{***}$ (8,954)	$\$35,237^{***}$ (8,278)	$\$36,087^{***}$ (8,437)	283	155
Coburg North	$\$44,449^{***}$ (14,553)	$\$14,788$ (10,030)	$\$18,452^{*}$ (10,662)	$\$20,863^{**}$ (10,588)	181	108
Houses only (Coburg North)	$\$51,328^{***}$ (16,489)	$\$30,760^{***}$ (11,090)	$\$35,952^{***}$ (10,769)	$\$37,269^{**}$ (10,842)	161	79
Pascoe Vale	$-\$9,319$ (14,465)	$\$60,534^{***}$ (9,654)	$\$27,068^{***}$ (9,159)	$\$29,218^{***}$ (9,294)	284	95
Houses only (Pascoe Vale)	$\$62,717^{***}$ (19,556)	$\$72,758^{***}$ (13,963)	$\$36,118^{***}$ (13,016)	$\$34,909^{***}$ (13,758)	122	76

Control group houses are less than 200m from empty green space and less than 500m away from closest playground

Treatment group houses are less than 200m away from nearest local playground and less than 500m away from second nearest local playground

***, ** and * represent significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

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Appendix A

Map: contact authors for the map. File limits forced us to delete the map from this version of the working paper.

Appendix B Descriptive Statistics

Table B.1: Observations by year and quarter

	Quarter				
Year	1	2	3	4	Total
2005	649	814	720	858	3,041
2006	602	787	796	821	3,006
2007	909	1,081	1,099	1,079	4,168
2008	736	864	808	854	3,262
2009	692	985	1,172	1,113	3,962
2010	767	876	797	814	3,254
2011	718	810	729	803	3,060
2012	727	782	766	854	3,129
2013	644	916	880	1,022	3,462
2014	696	954	785	742	3,177
Total	7,140	8,869	8,552	8,973	33,521

Table B.2: Median property price (in $1000s) by year and quarter

	Quarter				
Year	1	2	3	4	Total
2005	310.0	320.0	302.0	327.6	318.0
2006	324.5	337.5	335.5	345.0	335.8
2007	350.0	362.0	385.0	415.0	380.0
2008	410.0	420.0	400.0	400.0	408.0
2009	410.0	432.0	450.0	484.0	447.0
2010	487.5	527.7	510.0	520.0	515.2
2011	515.5	510.0	490.0	495.0	500.0
2012	480.0	470.0	485.0	499.0	485.0
2013	485.0	490.0	499.0	527.3	500.0
2014	515.0	556.3	550.0	553.5	543.3
Total	425.0	439.9	435.0	452.0	**439.9**

Table B.3: Sample sizes and median property prices ($1,000) by Suburb

Suburb	Observations	Property price
Brunswick	5,178	481.4
Brunswick East	2,663	485.0
Brunswick West	2,903	420.0
Coburg	4,335	484.0
Coburg North	1,188	440.0
Fawkner	1,824	365.0
Fitzroy North	2,220	637.5
Glenroy	4,153	380.0
Gowanbrae	466	440.0
Hadfield	852	385.0
Oak Park	1,288	445.0
Pascoe Vale	3,565	435.0
Pascoe Vale South	1,449	525.0
Tullamarine	1,437	322.0
Total	33,521	439.9

Table B.4: Sample sizes and median prices ($1,000) by property feature

Property has feature	Observations	Property price
Study	4,027	550.0
Separate dining	685	532.5
Family room	291	500.0
Sun room	774	526.5
Rumpus room	573	547.0
Fireplace	1,085	715.0
Walk-in wardrobe	1,437	530.0
Courtyard	4,466	436.4
Internal laundry	563	429.0
Heating	9,500	495.0
Air conditioning	4,383	475.0
Balcony	2,161	469.0
Barbeque	426	541.0
Polished timber floor	3,617	518.0
Ensuite	3,295	525.0
Spa	4,111	450.0
Locked garage	4,443	433.0
Tennis court	17	310.0
Alarm	2,152	560.0
Total	33,521	439.9

Table B.5: Distance to amenities

Amenity	Distance (km)		Number of observations (33,521 total)			
	Mean	Median	$< 250m$	$< 500m$	$< 1km$	$< 2km$
Beach	5.14	5.08	0	0	353	3,163
River	2.88	2.77	758	1,593	3,265	10,243
Freeway onramp	1.72	1.62	1,134	3,378	8,663	20,917
Road (freeway)	1.72	1.62	1,587	4,160	9,216	20,827
Road (trunk)	2.10	1.81	2,347	4,551	8,299	18,582
Bench	0.70	0.64	5,022	13,094	25,629	33,244
Public toilets	0.67	0.56	3,730	14,564	28,463	32,691
Drink fountain	0.89	0.60	5,270	14,607	22,188	29,757
Outdoor shelter	1.77	1.69	347	1,481	6,165	21,415
School	0.37	0.34	11,471	24,958	33,090	33,521
Waste transfer	4.01	3.83	96	419	2,984	7,798
Stadium	2.24	1.91	146	749	3,688	18,171
Golf course	1.99	1.93	798	2,100	6,090	17,476
Cemetary	1.97	1.89	716	1,903	5,872	18,222
Shops	0.43	0.38	9,347	22,063	32,153	33,521
Rail station	1.09	1.03	1,520	5,478	16,182	31,870

Table B.6: Distance to playground

Playground type	Distance (km)		Number of observations (33,521 total)			
	Mean	Median	$< 250m$	$< 500m$	$< 1km$	$< 2km$
District	2.53	2.22	291	1,373	4,596	15,054
Heritage	2.56	1.86	1,465	4,983	11,915	17,269
Local Significant	1.07	0.96	1,707	6,645	17,678	31,155
Local	0.45	0.36	10,109	23,648	31,393	33,223
Unidentified	2.39	1.94	684	2,720	7,379	17,098

Table B.7: Distance to open spaces

Open space type	Distance (km)		Number of observations (33,521 total)			
	Mean	Median	$< 250m$	$< 500m$	$< 1km$	$< 2km$
Accessway	0.95	0.88	3,003	7,574	19,480	31,778
Civic Gathering/ Forecourt	3.18	2.74	244	994	3,880	10,858
Community Horticulture	3.21	2.47	315	1,102	3,866	13,355
Conservation	0.88	0.84	5,247	10,346	20,350	32,737
Heritage	1.29	0.94	2,890	8,591	17,461	25,774
Memorial Park/ Cemetery	3.68	3.43	583	1,793	4,069	8,447
Unidentified Function	2.09	1.84	900	2,578	8,102	18,330
Playground	0.53	0.45	7,838	19,313	30,456	33,260
Shared Trail	1.58	1.53	1,002	3,181	9,047	23,075
Social, Family, Recreation	0.95	0.79	4,859	10,630	20,298	30,050
Sport	0.61	0.42	8,598	20,141	29,527	32,016
Utility	1.69	1.55	2,498	5,333	10,706	22,133
Utility/Drainage Floodway	1.84	1.62	889	2,887	8,752	21,651
Visual Amenity	0.83	0.66	4,946	12,133	24,175	31,048

Table B.8: Distance to closest playground or open space and combinations

Playground (PG)/ open space type	Number of households[a]	Distance (metres)		Median property price ($1,000)
		Mean	Median	
Accessway/ Local PG	368	149	119	446.3
Accessway/ No PG	1,470	715	190	360.0
Civic Gathering/ Forecourt (no PG)	109	182	183	418.0
Community Horticulture (no PG)	111	99	82	591.0
Conservation/ Local significant	220	102	80	430.0
Conservation/ Local	111	100	76	445.0
Conservation/ Uniden. type PG	2,674	231	103	449.5
Heritage/ district PG	29	78	77	481.3
Heritage/ heritage PG	2,640	218	202	478.0
Heritage/ Uniden. type PG	138	200	252	324.0
Heritage/ no PG	180	170	162	492.5
Memorial Park/ Cemetery/no PG	360	155	145	395.0
Uniden. Function/ no PG	331	160	117	488.0
Playground/ Local significant PG	576	195	178	532.5
Playground/ Local PG	4,581	170	142	450.0
Playground/ Uniden. type PG	705	206	185	389.0
Playground/ No PG	677	167	175	495.0
Shared Trail/ Local PG	1,860	699	640	580.0
Shared Trail/ no PG	389	163	127	429.0
Social Family Recreation/ district PG	340	191	191	544.4
Social Family Recreation/ local sig PG	79	74	32	399.0
Social Family Recreation/ local PG	2,989	168	154	481.0
Social Family Rec / Unide type PG	3	8	8	297.5
Social Family Recreation/ no PG	9	745	37	275.0
Sport/ Local significant PG	1,556	180	153	400.5
Sport/ Local PG	2,044	170	156	450.0
Sport/ no PG	2,292	198	173	440.0
Utility/ Local PG	283	265	249	530.0
Utility/ no PG	1,626	115	85	398.5
Utility/ Drainage Floodway/ no PG	504	161	132	420.0
Visual Amenity/ local PG	710	177	138	365.0
Visual Amenity/ no PG	3,557	399	196	395.8

[a] Number of households for whom this park/open space combination type is the closest playground/open space.

Table B.9: Sample sizes and median prices by lot area

Area size	Observations	House price ($1,000)
$\leq$150m^2	3,011	425.0
$>$150m^2 & $\leq$200m^2	3,137	437.0
$>$200m^2 & $\leq$300m^2	3,629	440.0
$>$300m^2 & $\leq$400m^2	2,892	500.0
$>$400m^2 & $\leq$500m^2	3,168	531.0
$>$500m^2 & $\leq$600m^2	3,992	445.0
$>$600m^2 & $\leq$700m^2	3,716	425.0
$>$700m^2 & $\leq$900m^2	2,834	440.0
$>$900m^2 & $\leq$2000m^2	3,762	404.0
$>$2000m^2	2,616	399.0
lot size missing	764	420.0
Total	33,521	439.9

Table B.10: Property characteristics of treatment and control groups

Characteristics	Control	Treatment	Difference
Property size (m^2)	508.03	607.85	99.82**
	(260.56)	(696.49)	(40.05)
	[316]	[992]	[1,308]
Number of bedrooms	2.79	2.62	-0.17***
	(0.61)	(0.68)	(0.05)
	[236]	[805]	[1,041]
Number of bathrooms	1.23	1.24	0.01
	(0.45)	(0.47)	(0.04)
	[210]	[717]	[927]
Number of parking	1.60	1.59	-0.01
	(0.85)	(0.77)	(0.07)
	[182]	[654]	[836]
Proportion of house	0.75	0.55	-0.20***
	(0.44)	(0.50)	(0.03)
	[316]	[1,020]	[1,336]
Control: distance to MW green space Treatment: distance to nearest local PG	147.28	186.65	39.37***
	(82.47)	(72.14)	(4.81)
	[316]	[1,020]	[1,336]
Control: distance to nearest local PG Treatment: distance to 2nd nearest local PG	385.58	387.51	1.93
	(93.30)	(108.91)	(6.79)
	[316]	[1,020]	[1,336]

Notes: SD in parentheses for means; SEs for differences in means. Number of observations (without missing values) in square brackets.

***, ** and * represent significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

Table B.11: House characteristics of treatment and control groups

Characteristics	Control	Treatment	Difference
Property size (m^2)	517.52	555.66	38.14*
	(171.38)	(305.82)	(21.23)
	[236]	[543]	[779]
Number of bedrooms	2.82	2.82	0.00
	(0.63)	(0.69)	(0.06)
	[202]	[489]	[691]
Number of bathrooms	1.22	1.25	0.03
	(0.43)	(0.49)	(0.04)
	[187]	[434]	[621]
Number of parking	1.63	1.79	0.17**
	(0.87)	(0.85)	(0.08)
	[160]	[393]	[553]
Control: distance to MW green space Treatment: distance to nearest local PG	143.27	180.50	37.22***
	(77.72)	(73.55)	(5.80)
	[236]	[562]	[798]
Control: distance to nearest local PG Treatment: distance to 2nd nearest local PG	384.81	381.16	-3.65
	(95.78)	(110.00)	(8.22)
	[236]	[562]	[798]

Notes: SD in parentheses for means; SEs for differences in means. Number of observations (without missing values) in square brackets.

***, ** and * represent significance at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

Appendix C Playgrounds in the MCC

Moreland City Council (2008) provides details of the playground types in the council area. It lists three types of playgrounds – District, Significant Local and Local. Eight playgrounds are listed as 'Heritage'.

District Playgrounds are large facilities designed to cater for a wide range of visitors from local communities along with a capacity to draw a tourist element from the nearby localities. Generally District playgrounds are custom designed for a site and provides a wide variety of play. Currently there are 3 District parks under the control of the MCC.

Significant Local Playgrounds are generally large and may serve both junior and senior users. Such playgrounds are either located in a commercial/community hub or located in a site of high amenity that draw users from a greater catchment area than Local Playgrounds and attract family/social groups on weekends. Significant Local Playgrounds often contain greater amenities (such as toilets and barbecues) to facilitate these gatherings. The MCC currently has a total of 21 Significant Local Playgrounds.

Local Playgrounds are smaller sites and primarily targeted at 3-7 years aged children. Such playgrounds are generally located in small pocket parks or open space areas that are remote and have a limited use. A total of 83 (out of 122) playgrounds in the MCC are defined as Local Playgrounds.

Heritage playgrounds are parks labeled as 'Heritage' in the Moreland City Council Data. There are 8 such parks. While details are not available in the Moreland City Council documents, our data shows that such playgrounds are in between District and Significant Local playgrounds in size. They are presumably heritage listed for some historical reason.

Not categorised A total of 7 playgrounds in our data do not have a label of hierarchy.

Table C.1: Playground type, frequency and mean size (m^2)

Playground type	Frequency	Size
District	3	1,344
Heritage	8	571
Local Significant	83	269
Local	21	467
Type not labeled	7	421
Total	122	358

Appendix D Open spaces in the MCC

Open space is defined as public land that has a leisure, sport, landscape value, habitat conservation, environmental or visual amenity function and/or is zoned or reserved for public parks or conservation purposes. MCC classifies open spaces with their primary function types and currently identifies eleven open space function types (Moreland City Council, 2012). However, we use data that is slightly more disaggregated about the types of open space which we employ in our analysis. Frequencies of the open spaces in our data are presented below.

Table D.1: Openspace type, frequency and mean size(sqm)

Open space type	Frequency	Size
Accessway	21	10,042
Civic Gathering/Forecourt	2	2,058
Community Horticulture	2	18,860
Conservation	83	22,655
Heritage	10	19,996
Memorial Park/Cemetery	1	2,038,685
No Identified Function	8	23,970
Play	58	6,589
Shared Trail	7	8,018
Social Family Recreation	22	16,018
Sport	57	35,087
Utility	4	45,544
Utility/Drainage Floodway	8	57,629
Visual Amenity	39	9,451
Total	322	25,981