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Capitalised non-market benefits of local council involvement in the planning of residential developments

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Contents

Abstract

Many established urban localities undergo densification of residential areas. Effective densification requires smart planning, including water sensitive urban design. In this study, we analyse whether higher levels of local council involvement in the early stages of planning residential infill projects result in projects that provide higher levels of amenity. In this instance, we identify higher levels of amenity via residents' willingness to pay for houses in these developments. We use three councils in South Australia as a case study and focus on homes built after 2000, following a subdivision. We classify developments by three levels of local council involvement in the planning and development process. The 'Limited' level of council involvement means the subdivision relied primarily on the policies outlined in the council's development plan. The 'Medium' level of involvement is related to high-level land division design and layout outcomes, such as connectivity to adjoining open space, road network, and stormwater infrastructure. The 'High' level of involvement from the council may, in addition, include rezoning to enable specific development policy to more explicitly guide development outcomes or design guidelines for dwellings design.

We estimate a hedonic pricing model with log sales price as a dependent variable, spatial and temporal fixed effects, house characteristics, and a categorical variable that indicates the involvement of the local council in the planning and development process. The analysis indicates the 'High' level of involvement from the council is associated with higher house prices compared with the subdivisions with 'Limited' or 'Preliminary' input by the council. These results demonstrate the value of councils' more active involvement with residential development.

1.0 Introduction

The population is growing at a rapid rate in Australia and is expected to double by 2061. More than three-quarters of the Australian population will live in cities and towns (Commonwealth of Australia 2015). The fast growing urban population increases pressure on city infrastructure and exacerbates the highly unaffordable housing markets, which are characterised by a gradual decline in homeownership, intensified housing stress, and increasing homelessness. Due to increased demand, the private rental market is becoming unfavourable to people from low socioeconomic groups leading to rising inequity in the housing market (Beer, Morris et al. 2018).

There are two main approaches to address the problem of increasing population pressure: development of greenfield at the periphery of the cities and redevelopment in established areas. Greenfield development is usually characterised by low- and medium-density housing, whereas infill development involves medium- to high-density residential development. Infill development within city boundaries helps preserve rural land for agriculture, environmental and other uses (Coleman 2017). Infill development could also be more cost-effective compared with greenfield development. For example, InfraPlan (2013) estimated that median infrastructure cost per lot is around $20,000, which is one-quarter of comparable greenfield development. More importantly, considering mortgage costs and transport, on average, the household cost is 15% higher in a greenfield development than a comparable infill development. However, this study did not differentiate between the costs of different types of infill development.

Given the limitation of greenfield development, infill development is gradually becoming more popular (Phelan, Hurley et al. 2018). Higher density infill housing is being used as the main instrument to achieve 'compact city' (Baker 2013) and many cities have already established infill development targets. For example, Sydney is expected to add 32,000 new dwellings annually, of which 60–70% will be supplied from infill development (Coleman 2017). Similar targets have been set for other cities. Melbourne is expected to add 41,000 new dwellings annually and has a target to source 61% from infill. Perth is adding 14,000 dwellings annually, with a target to source 47% from infill (Coleman 2017). Adelaide has a target to supply from infill 75% of 8,000 dwellings constructed annually (DPTI 2017), which is a higher target than Perth and Melbourne. However, without adequate planning, infill development could induce a loss of green infrastructure and waterways. This could have unintended consequences on urban heat impact, local ecology, biodiversity, people's wellbeing and social welfare (Coleman 2017, Phelan, Hurley et al. 2018). Therefore, infill development processes need to be managed in an integrated fashion involving various parties.

Local government is a centrepiece in managing multi-faceted and conflicting housing needs because they play an essential role in managing housing policies and programs at the local level (Beer, Morris et al. 2018). In Australia, local government is the lowest tier of government which is working closest to the people. As expected, housing is a prominent issue/concern for local governments. For example, in a survey of the chief executive officers of local councils in Australia, Beer, Morris et al. (2018) found that for around half of the councils, housing was a substantial or very substantial priority issue.

State and local governments directly influence the demand and supply of housing products. Their functions include identifying residential land, setting residential development controls and subdivision design, conducting environmental and social assessment of proposed residential development, collaborating with other housing providers, managing local housing stocks, identifying and monitoring housing needs, and coordinating and/or delivering appropriate support services (Gurran 2003). In most instances, housing matters were dealt with in the planning departments within councils and, in some instances, they were treated as part of the community development portfolio. As a result, the involvement of local councils in the infill development process is different in different locations.

While state governments control development through planning policies, local councils administer the development assessment process and grant approvals. They can play a more prominent role in influencing the infill development process. Higher involvement in the process allows the local councils an opportunity to enhance the welfare of the residents by implementing better infill development designs which improves the condition of the local environment while reducing the negative impacts of infill development. To encourage planning systems that enable the councils to become more active in the infill development process, it is necessary to demonstrate the value of such interventions. However, there are not many studies that have examined this issue. Therefore, in this study, we employ a non-market valuation technique – hedonic pricing method – to estimate the non-market amenity benefit of higher involvement of councils in the infill development process.

The objective of the study is to investigate whether local governments' direct involvement in planning residential infill development improves social welfare. Such information will contribute to more effective implementation of infill projects through an optimal level of involvement by local governments. We focus on three local government areas from Adelaide that are experiencing rapid infill development.

2.0 Relevant literature

Implementing improved urban designs could provide many tangible and intangible benefits to the residents, which would influence how much people are willing to pay to buy or rent a property in that location. There are two main non-market valuation techniques economists have developed to estimate people's willingness to pay or accept: stated preference methods and revealed preference methods. In a stated preference method, surveys are used to understand people's preferences, whereas in a revealed preference method, market price information is used to calculate the implied non-market values of goods and services (Gunawardena, Zhang et al. 2017, Iftekhar, Gunawardena et al. 2019). Both revealed and stated preference methods have been used to estimate non-market values of water sensitive systems and practices. For a review of national and international non-market valuation studies on water sensitive urban systems and practices, see Gunawardena, Zhang et al. (2017). There is a rich literature that has used non-market valuation techniques to estimate people's preferences for different urban design features. The selected features include the value of neighbourhood (connectivity, accessibility, street layout, etc.); the value of zoning (as an aspect of planning); the value of densification (related to housing density); and the value of good planning. A brief summary of the literature is presented below.

Value of neighbourhood

Several hedonic pricing studies have investigated the impact of neighbourhood characteristics such as connectivity, land use and accessibility of services, distance to different local urban amenities, and street layout on property values (Matthews and Turnbull 2007, Glaesener and Caruso 2015, Li, Joh et al. 2015, Shen and Karimi 2017). For example, Song and Quercia (2008) used hedonic pricing analysis to understand the effect of neighbourhood design features such as neighbourhood development density, street network connectivity, pedestrian access to transit and commercial stores, and land use mixture as factors affecting housing price. The authors used a statistical approach to identify distinct neighbourhood types using data from Washington County, Oregon. Results showed design features such as higher street network connectivity, better pedestrian access to transit and commercial stores, neo-traditional neighbourhoods, and conventional neighbourhood features such as lower housing density and a higher degree of homogeneous land uses raise house price.

Using a mixed-scale hedonic model, Shen and Karimi (2017) evaluated the effect of the spatial layouts and land use system in terms of the street network on the values of the residential properties in central Shanghai, China. They found that the design of the neighbourhoods impacts house prices. Specifically, the properties located on the streets with higher accessibility to urban amenities are associated with higher house prices, however higher 'betweenness' or being situated between several urban amenities or amenities and other residential properties is associated with lower house prices.

Other empirical studies of the neighbourhood street layout yield mixed results. Matthews and Turnbull (2007) assessment of effects of street layout based on accessibility and land use mix on property values showed that more gridiron-like street pattern increases the price in pedestrian-oriented neighbourhoods whereas such connectivity decreases house value in auto-oriented developments. Li, Joh et al. (2015) investigated the impact of neighbourhood walkability (measured by street Smart Walk Score and sidewalk density) to single family property values in Austin, Texas. The results showed that improving walkability through increased access to amenities in car-dependent neighbourhoods does not increase property values, but additional sidewalks in these neighbourhoods may lead to a slight increase in property values. This suggests that the effect of neighbourhood street connectivity on property values is mixed and depends on neighbourhood composition.

Others studied the spatial distribution of residential land values in relation to neighbourhood green space diversity and neighbourhood services effects. Based on a multi-level approach of hedonic model analysis, Glaesener and Caruso (2015) found that the presence of a mix of neighbourhood services (proximity) and green space have no direct impact on housing prices whereas the presence of diverse land uses in walking distance but not in the immediate proximity tend to have a positive effect.

Empirical valuation studies also examined people's preferences for different types of neighbourhood developments. For example, Levine and Frank (2007) analysed land use preferences and residents' neighbourhood choices for neighbourhood types with low-density and auto-oriented environments or for compact, walkable and transit-oriented neighbourhoods. Analysis of the contingent valuation survey (a stated preference method) data suggested that compact and walkable environment are the preferred attributes by residents in the Atlanta region in the United States. These preferences were found to be associated with ethnicity. Native Americans, Latinos and Asian/Pacific Islanders favour alternative developments more than White Americans and African Americans. Another study by Liao, Farber et al. (2015) also employed stated preference methods and advanced empirical analysis of latent class modelling to understand the heterogeneity of residential preferences. Using a stated preference survey of residents in the metropolitan area of Utah in the United States, they quantified the demand for compact development. The result showed the presence of two preference classes: one class with strong preferences for compact development among households with fewer school age children, low-income and renter-occupied households, and those who appreciate social heterogeneity and have less desire for privacy. The second class were proponents of low accessibility who are more likely to be households with more children.

Some studies have also looked at the value of proximity and diversity of the neighbourhood. For example, Matthews and Turnbull (2007) found that the effect of proximity to retail sites on house prices depends on the neighbourhood characteristics. In pedestrian-oriented neighbourhoods with traditional gridiron street pattern, proximity to retail sites has a significant effect on house prices. However, in automobile-oriented neighbourhoods with curvilinear and cul-de-sac subdivision development patterns, in general, there was no price effect.

Some studies have examined consumers' preferences for conservation and development. In the United States, maintaining conserved and/or open space within urbanising landscapes has positive effects on housing prices (Bowman, Thompson et al. 2009, Hannum, Laposa et al. 2012). Bowman, Thompson et al. (2009) compared the economic values of two subdivision designs in Cedar Rapids, Iowa: conservation subdivision with conserved open space and standard subdivision. They used both hedonic analysis and the contingent valuation method. They found that residents had positive demand and willingness to pay for conservation subdivision design. Overall, 66% of all respondents indicated a willingness to pay for additional open space/conservation features, with an average willingness to pay of US$4343.

Other empirical studies focus on the principle of new urbanism related to increased density, mixed land uses, street connectivity and their effect on property values (Tu and Eppli 1999, Park, Huang et al. 2016). A recent meta-analysis of the design components of new urbanism on housing prices indicated that a lower density, decreased street connectivity, and closer proximity to a transit stop can contribute to increased housing premiums, while mixed land uses do not always affect house prices (Park, Huang et al. 2016).

Tu and Eppli (1999) compared the prices of single family home prices in new urbanist and suburban neighbourhoods in Kentlands, Maryland using the hedonic pricing technique. They found that consumers were willing to pay a 12% (approximately US$25,000) premium for houses in a new urbanist neighbourhood compared with houses in conventional subdivisions. In contrast, home buyers in Tucson, Arizona, valued the vintage development (pre-World War II) than conventionally designed post-war subdivisions (Bitter 2014). Conversely, modern subdivision designs with enhancements made to the auto-oriented subdivision designs were also found to be attractive to home buyers. Modern highly planned subdivisions with more internal facilities attract higher prices (Bitter 2014).

Value of zoning

Some studies provide evidence of the relationship between zoning policies and housing premiums (Kendall and Tulip 2018). Ahmed, Sangari et al. (2019) studied the effect of zoning on residential property values in selected districts in Abuja, Nigeria and found that zoning is negatively correlated with residential values. Lindenthal (2017) also conducted a comparative study of the architectural zoning in the city of Rotterdam, which looked at shape homogeneity among neighbouring homes but showed a different result. Drawing on large-scale shape and transaction data, Lindenthal found that architectural homogeneity was positively valued in residential property markets. Further, rowhouses surrounded by other buildings of the same shape carry a 4% premium compared with comparable buildings in heterogeneous rows of houses.

A recent study by Kendall and Tulip (2018) quantified the importance of zoning regulations. They use the marginal costs of supply at different points in time in four cities in Australia. Relative to estimates of the costs, as of 2016, they found that zoning raised detached house prices 73% above marginal costs in Sydney, 69% in Melbourne, 42% in Brisbane and 54% in Perth. In Brisbane, the values due to zoning restrictions increased the prices of house and apartment by AU$159,000 and AU$110,000 respectively.

Densification on housing premiums

Studies also showed that the style of urban planning affects house values. For example, amenity or disamenity of proximity to retail centres depends on street connectivity (Matthews and Turnbull 2007). Using hedonic pricing models, Dunse, Thanos et al. (2013) analysed the effects of government planning policies and market pressures on the housing price in England in the period 2000–08. The authors claim that planning policies for increasing densities in urban centres, as a crucial factor of good design, have played a key role in shaping the built environment of UK cities at the turn of the millennium. The study also showed that consumers prefer houses over flats, and detached properties over semi-detached and terraced (i.e. lower density suburban areas). However, both low-density, detached-dominant areas and high-density, flat-dominant areas attracted a premium over medium-density areas, and the relative size of these price differences vary between different housing market areas.

Kupke, Rossini et al. (2012) used principal components factor analysis to identify the impact of medium-density development on housing investment and social structure on several neighbourhoods in the Adelaide Statistical Division, Australia. They found that densification has had a significant impact on neighbourhood built form but not necessarily on neighbourhood structure or housing market performance.

Good planning and housing prices

Urban planning is an important aspect of determining the preferences for housing and property values. A study in Nigeria, Africa showed a significant difference in residential property values between well-planned and unplanned residential neighbourhoods of Lagos Metropolis (Ajibola, Olaniyan-Adekola et al. 2012).

Some subdivision infrastructure design features intended to reduce stormwater runoff may impose costs on developers by reducing residential property values. For instance, Boatwright, Stephenson et al. (2013) used a hedonic pricing approach in Hanover County, Virginia to examine the impact of different infrastructure design features, in addition to a variety of property and location characteristics, which affect stormwater runoff on residential property sale prices. Results of this study suggested that prohibiting curb-and-gutters and cul-de-sacs could impose an opportunity cost on the developer. Buyers are willing to pay a 1.3% property price premium for a home located on the street with a cul-de-sac and a 7.8% premium for a home located on the street with curb-and-gutters. On the other hand, constructing narrower streets would provide benefit to developers because people would pay approximately 3.5% more for these properties.

There are studies on people's preferences for alternative neighbourhood designs which have less of an environmental impact. For example, Bowman, Tyndall et al. (2012) studied US consumers' preferences and willingness to pay for low-impact development (LID) practice, which is a design to help control stormwater runoff and reduce extensive storm sewer systems in residential neighbourhoods, standard subdivision designs (SSD) and conservation subdivision designs (CSD). Analysis of spatial hedonic price models and contingent valuation methods consistently showed that residents valued both CSD and LID features. Neighbourhood features such as the presence of neighbourhood association-owned forest, water features, and proximity to urban parks positively affect housing prices. People have a positive willingness to pay for tax-funded conservation land purchases, and a property tax of around US$50 would be the maximum people would be willing to pay.

Kim and Larsen (2017) examined new urbanism implementation in Orlando, Florida, focusing on social sustainability using housing affordability and socioeconomic diversity as indicators of sustainability. The authors compared the impact of new urbanism infill development in Parramore, an economically distressed inner city neighbourhood, and Baldwin Park, a brownfield inner ring suburb, with control neighbourhoods in Orlando, Florida. In Parramore, active new urbanism implementation involved Partnership for Sustainable Communities, through increased socioeconomic diversity, whereas the Baldwin Park plan incorporated new urbanist best practices. The findings are based on analysis of community indicators which show that infill development in these two distinct cases of the new urbanism does not necessarily bring about social sustainability.

In summary, research on the values of housing has focused on several neighbourhood features. These include the built environmental characteristics such as the density of amenities, proximity to destinations, street connectivity and sidewalk density. Several studies have attempted to understand residents' preferences by using property values or house prices and their responses to surveys. Findings of these empirical studies, in some cases, have mixed results. It appears that people value lower density, separation from different land uses, and isolated space with less connected streets over most new urbanism, as well as living close to transit stations with appropriate zoning policies and well-planned designs. However, most of these findings are from international case studies and do not focus on Australian infill development. In this paper, we contribute to this gap.

3.0 Case study area

The study area includes three local government areas (LGAs) in the Adelaide Metropolitan Area: Salisbury, Port Adelaide and Onkaparinga (see Figure 1). These LGAs were selected because they are located on the outskirts of the Adelaide Metropolitan Area and experience densification and revitalisation.

The time trend of selected socioeconomic profiles of these LGAs are in Table 1. For easier comparison, the same information for Greater Adelaide has been provided. The median income in the selected LGAs is slightly lower than in Greater Adelaide. On average, the household size and the average number of persons per bedroom is similar across the LGAs. However, population density is much higher in Port Adelaide and Salisbury than Greater Adelaide. More importantly, in all three LGAs population is growing rapidly. For example, in Port Adelaide, population density increased by 18% between 2006 and 2016, which is much higher than the population growth rate in Greater Adelaide (12%). Salisbury LGA also has a higher population growth rate (17%) than Greater Adelaide whereas Onkaparinga LGA has a similar growth rate as Greater Adelaide. Another indicator of infill is the changing housing type composition. The share of separate houses has dropped in all three LGAs. On the other hand, the proportion of semi-detached, row or terrace house has increased.

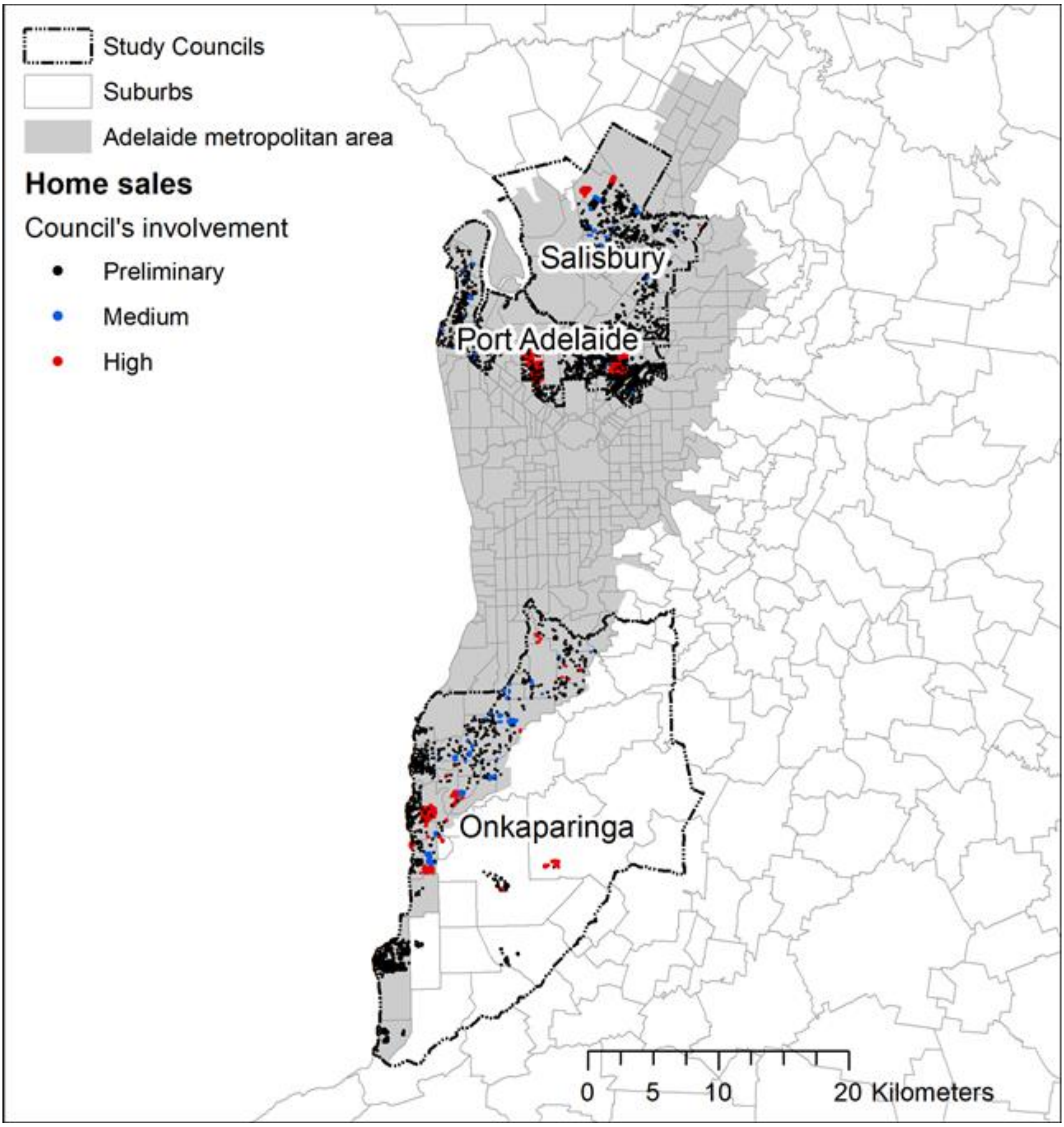

Figure 1. Locations of study local councils and property transactions in infill developments

Table 1: Socioeconomic profile of the LGAs

	Port Adelaide			Salisbury			Onkaparinga			Greater Adelaide		
	2006	2011	2016	2006	2011	2016	2006	2011	2016	2006	2011	2016
Area (km^2)	91.8	91.8	91.8	159.8	159.8	159.8	518.1	518.1	518.1	3259.8	3259.8	3259.8
Median total household income ($/weekly)	726	950	1,139	873	1,019	1,140	919	1,078	1,191	929	1,105	1,262
Average number of persons per bedroom	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Average household size	2.3	2.4	2.4	2.6	2.6	2.6	2.6	2.5	2.5	2.4	2.4	2.5
Population density (person/ km^2)	1,121	1,229	1,321	741	808	863	289	308	322	355	376	397
Distribution of households by type (%)												
Separate house	73	73	69	85	84	83	90	90	89	77	77	74
Semi-detached, row or terrace house	14	15	23	9	9	12	5	6	8	12	12	17
Flat, unit or apartment	13	11	8	5	6	5	4	4	2	11	11	8
Other dwelling	0	0	0	0	0	0	1	1	1	0	0	0
Dwelling structure not stated	0	0	0	1	0	0	0	0	0	0	0	0

Source: ABS Community Profile (2016). https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/4GADE?opendocument.

4.0 Method

To investigate the impact of local government intervention in planning residential developments, we look at the extent to which homebuyers benefit as a result of the improved planning and design of the infill development capitalising into the value of homes and residential units. To evaluate the impact of the improved planning and design on the home values, we use the hedonic pricing method (HPM) (Rosen 1974). This method allows for retrieving implicit prices of the house attributes from the observed house sale prices.

4.1 Hedonic analysis

The hedonic pricing method has been widely used in economic analysis of sustainable or water sensitive urban infrastructure to estimate the value of proximity to green infrastructure (Pandit, Polyakov et al. 2013, Netusil, Levin et al. 2014), green technologies (Ma, Polyakov et al. 2015, Zhang, Polyakov et al. 2015), new urbanism features (Tu and Eppli 1999), and complete street policies (Vandegrift and Zanoni 2018). Empirically, the sales price of a house can be expressed as $p = F(\mathbf{x}, \boldsymbol{\beta})$, where $\mathbf{x}$ is a vector of the house underlying attributes and $\boldsymbol{\beta}$ is a vector of parameters to be estimated. The underlying attributes include house-specific characteristics such as lot size; number of bedrooms, bathrooms and parking spaces; proximity to amenities; zoning; and a set of dummy variables for the extent of local government intervention in planning and development. The coefficients on the extent of local government intervention dummies provide measures of the value of these interventions, controlling for all other relevant factors.

Estimating implicit prices using the HPM with data based on the sales prices of dwellings requires overcoming several estimation challenges. First, the value of homes, as well as the factors determining these values, are characterised by spatial heterogeneity and spatial dependencies (Anselin 1988). Spatial heterogeneity means that prices and other characteristics of dwellings vary from location to location. Spatial dependence implies that the prices of homes may depend on the prices of nearby homes. Ignoring these dependencies may result in biased and/or inconsistent parameter estimates. In this application, to control for spatial heterogeneity and spatial dependencies, and hence mitigate the omitted variables problem, we use a spatial fixed effects model. Specifically, we use Australian state suburbs as the spatial fixed effects, and this is the same approach used in Mahmoudi, Hatton MacDonald et al. (2013) in the Adelaide metropolitan area.

The second estimation issue is that residential properties within each infill development project have similar unobservable characteristics. As a result, residuals within each infill development are likely to be correlated, and ordinary least squares (OLS) estimates of standard errors are incorrect. Therefore, we estimate robust standard errors clustered at the infill project level (Abbott and Klaiber 2011, Pope and Pope 2015).

General modelling issues that apply regardless of the use of the home sales data relate to controlling for the dynamics of property prices and model functional form. To control for the dynamics of the real estate market, we use year temporal fixed effects. To select the appropriate transformation of the dependent variable, we use the Box-Cox method. Using this method, we find that log-likelihood is flat around a lambda value of zero, indicating that a model with log price as the dependent variable is appropriate. Considering distributions of the explanatory variables, we also applied log transformation to continuous explanatory variables. Formally the HPM we estimate can be written as:

$$p_{ijkt} = \alpha + h_j\eta + m_j\mu + \mathbf{x}_i'\boldsymbol{\beta} + \mathbf{y}_j'\boldsymbol{\gamma} + \mathbf{z}_j'\boldsymbol{\delta} + \kappa_k + \tau_t + \varepsilon_{ijkt}, \qquad (1)$$

where p_{ijkt} is the log sale price of home *i*, in an infill *j*, suburb *k*, in year *t*; h_j is a dummy variable indicating whether infill development *j* had high local council involvement; m_j is a dummy variable indicating whether infill development *j* had a moderate local council involvement ; $\mathbf{x}_i$ is a vector of unit-specific attributes; $\mathbf{y}_j$ is a vector of the infill development specific characteristics; $\mathbf{z}_i$ is a vector of location-specific characteristics; κ_k are spatial (suburb) fixed effects; τ_t are temporal (year) fixed effects; ε_{ijkt} is a zero-mean observation-specific random error term clustered at the infill level; α is an intercept; and η, μ, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\delta}$ are parameters and vectors of parameters to be estimated.

4.2 Data

We obtained property sales data for the study area from the Pricefinder database. Pricefinder is a subscription-based online dataset containing detailed information on real estate transactions in Australia. The transaction database contains data on residential, commercial and industrial property transactions. The database includes details such as the address of the property, cadastral number, type of sale, land use, lot size, sale price, and the date of transaction. For this analysis, we use sales of residential properties within the Salisbury, Port Adelaide, and Onkaparinga LGAs that were sold between January 2000 and December 2019. Residential properties include houses, which are detached single family homes, and units, which include semi-detached units or flats. To georeference sold properties, we use a cadastral spatial dataset from the AURIN database. Sales records were matched to property locations using cadastral codes. The matching resulted in 127,313 observations.

To identify infill development, we used the Land Division Applications dataset from data.sa.gov.au. It contains information about the applications and approvals of subdivisions in South Australia. We selected approved residential subdivisions and spatially matched them with the cadastral dataset for the three selected LGAs. In the case of several overlapping subdivisions, we selected the most recent. In the Residential Zoning of three LGAs, we identified 3,133 infill developments (subdivisions).

The Residential Code was introduced in South Australia in 2009 to allow for simpler, faster and cheaper planning and building approvals for home construction and renovation. It sets out performance criteria related to physical aspects of the development, such as location, height, boundary setbacks and site coverage. These criteria allow councils and private certifiers to quickly process applications that comply with the code. We assume that developments in the location where the Residential Code applies may have different characteristics and amenity value than the developments where the Residential Code does not apply. We identified relevant properties using the spatial dataset at the South Australian Government Data Directory: https://data.sa.gov.au/data/dataset/residential-code.

One spatial factor that may influence property prices and may be correlated with the explanatory variables of interest is access to public open space (POS). We used the classification of 2016 Census mesh blocks to identify POS. We then calculated distance from every property to the nearest POS, which we used as a measure of access to POS.

The City of Salisbury, City of Onkaparinga and City of Port Adelaide Enfield provided information about the council's involvement in the planning and development of the identified infill development. We categorised the level of involvement of local councils with land division applications as follows:

- low-level involvement (default scenario). This is most common for smaller land division proposals of 1 into 2 or 3 allotments:
  - Typically it is in accordance with the requirements of Residential Code/Development Regulations and council's development plan and approved without significant alteration.
- medium-level involvement:
  - We based this on preliminary advice provided regarding desired development outcomes (e.g. provision and location of open space/connections to adjoining or nearby open space areas, stormwater infrastructure, road network, density/allotment size, dwelling design/typology outcomes).
- high-level involvement. This typically takes place for larger land division proposals and/or where there are significant issues to overcome. In addition to the advice provided in the medium-level involvement, it may include:
  - land rezoned and policies specific to the area that guide land division layout and/or dwelling design incorporated into council's development plan
  - council acting as the developer or partner in a joint venture
  - design guidelines/encumbrances developed (typically by the developer, not council).

We identified 102 infill developments with medium-level involvement and 147 infill developments with high-level involvement of the local council (Figure 1). We calculated the sizes of the subdivisions as numbers of properties (the cadastral parcels) in each subdivision. We then spatially matched the georeferenced property sales data to the subdivision dataset and selected single family houses and units constructed after the approval of respective subdivisions. We removed outliers (1st and 99th sale price percentiles of the data). We also excluded the Mawson Lakes suburb in Salisbury because Mawson Lakes is a large-scale, mixed-use development that is not comparable with regular infill. Finally, we excluded duplicate sales by retaining the latest sale for the properties that were sold multiple times. The final sample has 11,504 observations. The information on the key characteristics of the sales data selected for the analysis is presented in Table 2. Table 3 presents the distribution of infill development projects and sales in our sample by the level of local council involvement in the infill development and by their location inside or outside of Residential Code.

Table 2: Descriptive statistics of the dependent and explanatory variables (n=11,504)

Variable	Mean	St. dev.	Min	Max
Sale price, 2019 AU$	426,855	101,568	100,673	798,760
Lot area, m^2	403	150.647	12	1,000
House age, years	6.245	3.919	1	19
Bedrooms, number	3.234	0.629	1	5
Bathrooms, number	1.758	0.464	1	3
Car parks, number	1.709	0.776	0	5
Size of the development (number of lots)	79	117	2	476
Distance to the nearest park, m	263	337	0	4,458
Multistorey (1/0)	0.133	0.339	0	1
Unit (‘1’ unit, ‘0’ house)	0.128	0.334	0	1
Brick wall (1/0)	0.516	0.500	0	1
Tile roof (1/0)	0.398	0.489	0	1
Residential code (1/0)	0.873	0.333	0	1
Medium-level involvement (1/0)	0.099	0.298	0	1
High-level involvement (1/0)	0.242	0.428	0	1

Table 3: Numbers of infill developments and sales in locations with and without Residential Code and with different levels of the local council's involvement in infill development

Local council's involvement	Outside Residential Code		Within Residential Code	
	Number of infill developments	Number of sales	Number of infill developments	Number of sales
Limited	453	1,041	2,469	6,545
Preliminary	30	200	86	936
High	35	217	126	2,565

5.0 Results

We present the model (equation 1) estimates in Table 4. The model has a log-log functional form. Therefore, the coefficients of continuous variables can be interpreted as elasticities and the coefficients of binary variables as the percentage change in the dependent variable when the explanatory variable changes from 0 to 1.

We calculate robust subdivision-clustered standard errors allowing for the residuals of the observations within each development to be correlated. The coefficient of determination (R2) suggests that the explanatory variables included in the model explain 80% of the variation in the dependent variable (log of the sale price). The coefficients on the explanatory variables that describe home characteristics are consistent with the expectations. As lot area, floor area, the number of bedrooms, the number of bathrooms and parking spaces increase, the value of a home increases. Homes with brick walls and tile roofs are valued less. Multi-storey buildings have higher values. The units have values lower than the houses. Proximity to the parks is considered as an amenity. While the coefficients on the log distance to the nearest park are negative, indicating higher property values close to the parks, these coefficients are not statistically significant. Finally, homes located within the Residential Code areas have values higher than homes located outside. This suggests that a uniform and consistent statewide set of requirements may result in higher amenity of the infill developments, which is reflected in higher home prices.

Our main variable of interest is the level of council involvement. It can be seen from the table that the coefficient for the medium-level involvement is not significant (95% confidence interval -0.86–2.66%). In other words, a medium level of involvement of councils in infill development is not associated with any additional uplift in property price (non-market benefit) compared with having low-level involvement. However, high-level involvement of the local council in the planning and development of the infill development is associated with higher property values, by approximately 2.7% (95% confidence interval 0.4–5.0%).

Table 4: Regression results. Dependent variable log (sale price).

Parameter	Coefficient estimate	Standard error
Log (lot area)	0.078***	(0.023)
Log (Building area)	0.347***	(0.026)
Log (House age)	-0.021***	(0.004)
Multi-storey	0.043***	(0.013)
Unit	–0.017**	(0.008)
Number of bedrooms	0.037***	(0.004)
Number of bathrooms	0.035***	(0.005)
Number of car parks	0.015***	(0.002)
Brick wall	–0.024***	(0.003)
Tile roof	–0.006*	(0.003)
Log (distance to the park)	–0.003	(0.002)
Residential Code	0.021***	(0.008)
Log (size of the infill/development)	0.003	(0.003)
Medium-level involvement	0.009	(0.009)
High-level involvement	0.027**	(0.012)
Year fixed effects (19)	Yes	
Suburb fixed effects (95)	Yes	
Number of observations	11,504	
Number of groups (clusters)	3,133	
R^2	0.798	

Note: Significance level: *** 1%; ** 5%; * 10%.

There are 2,782 properties in the sample in the developments with a high level of local council involvement in planning infill development. The median home price in our sample is $418,000 in 2019 dollars. Assuming that higher property prices are the result of high-level involvement of local councils in infill development, the capitalised value of the local council involvement can be estimated at $31 million ($4 million–$58 million) in 2019 dollars.

6.0 Concluding remarks

The value of residential homes is affected by a variety of factors beyond the characteristics of homes. The contributions of public open space, access to facilities, and housing density were well studied in the literature. There were few studies that looked at the impact of government interventions such as zoning (Kendall and Tulip 2018) or planning (Ajibola, Olaniyan-Adekola et al. 2012) on the price of a house. Consistent with Kendall and Tulip (2018) but contrary to Ahmed, Sangari et al. (2019), we found that Residential Code (a version of zoning regulation) is associated with a higher value of residential homes. To our knowledge, no study looked at the involvement of local councils in the process of planning residential subdivision or infill development. Our results suggest that a high level of involvement of local councils in the infill development is associated with higher prices of residential homes. This may be due to a greater amenity value of neighbourhoods where local councils were involved in the infill development.

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