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Article

Public Greenspace and Life Satisfaction in Urban Australia

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Abstract

This paper examines the influence of public greenspace on the life satisfaction of residents of Australia's capital cities. A positive relationship is found between the percentage of public greenspace in a resident's local area and their self-reported life satisfaction, on average corresponding to an implicit willingness-to-pay of $1172 in annual household income for a 1 per cent (143 square metres) increase in public greenspace. Additional results suggest that the value of greenspace increases with population density and that lone parents and the less educated benefit to a greater extent from the provision of public greenspace than the general population. In all, these results support existing evidence that public greenspace is welfare enhancing for urban residents and adequate allowance should be made for its provision when planning urban areas.

1. Introduction

It is estimated that over 50 per cent of the world's population now reside in urban areas. Moreover, the United Nations (2010) projects that the world's urban areas will absorb all of the global population growth over the next four decades, as well as continue to draw some of the rural population. Policy-makers and urban planners therefore face a significant challenge to design urban areas in such a way as to accommodate this growth, while maintaining residents' well-being.

One means of managing population growth is urban consolidation (that is, increase the density of existing built environments). Advocates of this approach (see Alexander and Tomalty, 2002; Bambrick *et al.*, 2011) cite more efficient use of established infrastructure and services (such as water and energy), greater accessibility of services for a variety of people, reduced traffic congestion and pollution, as well as the mitigation of health and well-being risks associated with obesity and sedentary lifestyles. In contrast, opponents (see Forster, 2006; Randolph, 2006) observe the loss of

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precious public open space to urban infill, increased noise, gentrification, poorly matched preferences, concentrated social disadvantage and potentially undermined social cohesion. These criticisms of urban consolidation are particularly strident when policy-makers have not appropriately preserved the public domain and residential amenity (Bryne and Sipe, 2010).

The compensating hypothesis argues that urban consolidation should be accompanied by increases in public greenspace, as residents will seek to substitute public for private areas (Maat and de Vries, 2006). One of the key simplifications, and potential shortcomings, of the compensating hypothesis is that people living in high densities are assumed to be homogeneous in regards to their need for greenspace. In this paper, using data from residents of Australian capital cities, we investigate the heterogeneity of preferences for greenspace across people depending on their characteristics or circumstances. This is consistent with the idea of taking a needs-based approach to the provision of greenspace, as advocated by Bryne *et al.* (2010).

The paper proceeds as follows. The remainder of section 1 examines existing evidence on the welfare effects of public greenspace, as well as the place of life satisfaction research in economics. Method and data form the subject of section 2. Results are presented in section 3 and discussed in section 4.

1.1 Greenspace and Well-being

A substantial body of evidence demonstrates the positive effect of greenspace on well-being. For example, in metropolitan centres in Italy and the United Kingdom, frequent visits to greenspace are found to generate significant improvements in the well-being of users during periods of heat stress (Lafortezza *et al.*, 2009). In Stockholm and Göteborg, greenspace is found to mitigate the negative effect of road traffic noise on well-being (Gidlof-Gunnarsson and Ohrstrom, 2007). In the South Australian capital city of Adelaide, respondents who perceive their neighbourhood to be 'highly green' are more likely to report better physical and mental health (Sugiyama *et al.*, 2008). Similarly, Maas *et al.* (2006) in the Netherlands and Mitchell and Popham (2007) in England find greenspace to enhance perceived general health; the former finding the relationship to be stronger for lower socioeconomic groups, with some residents such as the elderly, youth and those with low levels of education benefitting more from greenspace than the general population. For a review of the literature see Bell *et al.* (2008), Croucher *et al.* (2008, 2007) and Newton (2007).

The case for a positive relationship between greenspace and well-being is also made in the contingent valuation and hedonic property pricing literature (Brander and Koetse, 2011; Crompton, 2001, 2005, 2007). For example, Jim and Chen (2010) find that residents of Hong Kong are willing to pay a substantial premium (USD76,274)[1] for having a park nearby, and a further USD9962 for having a view of a park. In 15 cities across New Zealand, households are found to be willing to pay approximately NZD184 per annum to avoid a 20 per cent reduction in the urban tree estate (Vesely, 2007). Further, there is some evidence to suggest that greenspace provides benefits indirectly through increasing social cohesion and inclusion (see Kazmierczak and James (2007) for a review).

1.2 Life Satisfaction in Economics

Research into life satisfaction is increasingly the subject of a great deal of interest to economists (see Bruni and Porta, 2005; Frey, 2008). At an individual level, a great deal of effort has been devoted to better understanding the determinants of life satisfaction, with a number of stylised 'facts' becoming apparent. For example, a common finding is that men are less happy than women and that age is U-shaped, with happiness reaching a minimum in a person's 30s and 40s (see Blanchflower and Oswald, 2004). Estimating the degree to which income positively affects life satisfaction has been the subject of substantial research effort, with the relationship complicated by the fact that both absolute and relative income matter (Clark *et al.*, 2008).

Marriage is associated with greater life satisfaction (see Evans and Kelley, 2004; Stutzer and Frey, 2006); however, Blanchflower and Oswald (2004) find second and subsequent marriages to be less happy than first marriages. Evidence on the effect of children is complex, although life satisfaction appears to decrease as the number of dependent children increases (see Margolis and Myrskyla, 2010; Shields and Wooden, 2003).

Poor health and unemployment invariably lower life satisfaction (see Frijters *et al.*, 2004; Powdthavee and van Praag, 2011), whereas the influence of education is not straightforward (most authors find education in developed countries to have a negative or statistically insignificant influence on life satisfaction (see Shields *et al.*, 2009; Veenhoven, 1996)). MacKerron (2012) provides a recent review of the literature.

The environment and life satisfaction. In the environmental and ecological economics literature, life satisfaction data have been used to infer implicit monetary valuations of environmental amenities and disamenties. For example, Welsch (2002) uses cross-section data on reported well-being for 54 countries to value urban air pollution. The author finds that, on average, an individual needs to be given USD70 per annum compensation in order to accept a 1-kiloton per capita increase in urban nitrogen dioxide load. While the valuation of air quality has dominated the literature (see Ferreira and Moro, 2010; Luechinger, 2009, 2010; MacKerron and Mourato, 2009; Menz, 2011), other non-market environmental goods valued via the life satisfaction approach include airport noise (see van Praag and Baarsma, 2005), climate (see Ferreira and Moro, 2010; Frijters and van Praag, 1998; Maddison and Rehdanz, 2011), ecosystem diversity (see Ambrey and Fleming, in press), scenic amenity (see Ambrey and Fleming, 2011), floods (see Luechinger and Raschky, 2009) and drought (see Carroll *et al.*, 2009).

Few studies have investigated greenspace and life satisfaction within the life satisfaction framework, with mixed results. MacKerron (2010) finds the accessibility of greenspace to have an insignificant impact on the life satisfaction of London residents, although we suggest that this may illustrate a shortcoming of the greenspace data employed. Smyth *et al.* (2008, 2011) in contrast, find green area per capita in urban China to be positive and statistically significant for happiness. Our paper contributes to this body of literature in the context of urban Australia.

1.3 Public Greenspace and Urban Australia

Despite a large land mass and comparatively small population, Australia is heavily urbanised, with 89 per cent of the population living in towns and cities. Moreover, most future population growth is expected to be concentrated in existing urban centres (Commonwealth of Australia, 2010b). Within this context, a standards approach to the provision of public greenspace has been employed since the 1940s, with the standard set at a level of 7 acres (3 ha) per 1000 residents (Bryne *et al.*, 2010). However, there are many instances where this standard has not been met. For example, in Sydney (Australia's largest city) the inner and middle suburbs have local open space per 1000 residents ranging from 0.56 to 2.41 ha (Searle, 2011).

Somewhat surprisingly, given the wealth of evidence supporting the well-being benefits of greenspace, the provision of greenspace in urban environments does not appear to be high on the policy agenda. For example, the *State of Australian cities 2010* report (Commonwealth of Australia, 2010b) barely mentions greenspace and the 2010 intergenerational report (Commonwealth of Australia, 2010a) all but ignores the issue (Bryne *et al.*, 2010). Furthermore, policies of urban consolidation have concentrated medium- to high-density residential development in inner-ring suburbs where greenspace is comparatively scarce. Exacerbating this scarcity are zoning and development regulations that allow a reduction of greenspace for higher density development (Bryne, 2012). This provides reason to doubt the adequacy of local open space planning to cope with intensified urban consolidation across Australian cities (Searle, 2011).

2. Method and Data

Our first step is to estimate a model where life satisfaction is a function of socioeconomic and demographic characteristics, spatial variables and the extent of public greenspace. The model takes the form of an indirect utility function for resident r in location k as follows

$$\begin{aligned} U_{r,k} = \beta_0 + \beta_1 \ln(y_{r,k}) + \beta_2' x_{r,k} \\ + \beta_3 a_k + \beta_4' \delta_{r,k} + \varepsilon_{r,k} \\ r = 1 \ldots R, \; k = 1 \ldots K \end{aligned} \quad (1)$$

where, $y_{r,k}$ is household income, x is a vector of socioeconomic and demographic characteristics including age, marital status, employment status, education and so forth, a_k is the percentage of public greenspace in the resident's local area and $\delta_{r,k}$ is a vector of spatial controls, similar to those employed by Shields *et al.* (2009).

In the micro-econometric life satisfaction function, the resident's true utility is unobservable; hence self-reported life satisfaction is used as a proxy. Due to the use of this proxy, the standard errors of our estimated coefficients are larger than if a more precise measure of utility were available. Table 1 provides a description of all variables employed.

As shown by Ferreira and Moro (2010), it is possible to estimate the implicit willingness to pay (denoted WTP) for a marginal change in public greenspace by taking the partial derivative of public greenspace and the partial derivative of household income, as follows

$$WTP = \frac{\frac{\partial U_{r,k}}{\partial a_k}}{\frac{\partial U_{r,k}}{\partial y_{r,k}}} = \frac{\partial y_{r,k}}{\partial a_k} = \bar{y}\frac{\widehat{\beta_3}}{\widehat{\beta_1}} \quad (2)$$

where, $\bar{y}$ is the mean value of household income.

If discrete changes are to be valued, the Hicksian welfare measures of compensating and equivalent surplus can be employed. In this case, the compensating surplus is the amount of household income a resident would need to receive (pay) following a decrease (increase) in the level of public greenspace in his or her local area, in order to remain at his or her initial level of utility. Compensating surplus (denoted CS) can be calculated as follows

$$CS = -\exp\left[\overline{\ln(y)} + \frac{\widehat{\beta_3}}{\widehat{\beta_1}}(a^1 - a^2)\right] + \bar{y} \quad (3)$$

where, a^1 is the initial, and a^2 the new level of greenspace.

Table 1. Model variables

Variable name	*Definition*
Age	Respondent is between 15 and 19 years of age; between 20 and 29; between 40 and 49; between 50 and 59; and 60 years of age or greater
Male	Respondent is male
ATSI	Respondent is of Aboriginal and/or Torres Strait Islander origin
Immigrant English	Respondent is born in a main English-speaking country (main English-speaking countries are: United Kingdom; New Zealand; Canada; USA; Ireland; and South Africa)
Immigrant non-English	Respondent is not born in Australia or a main English-speaking country
Poor English	Respondent speaks English either not well or not at all
Children	Respondent has children aged between 0 and 4; respondent has children aged between 5 and 14; respondent has children aged between 15 and 24; respondent has children aged 25 years and over
Married	Respondent is legally married
Defacto	Respondent is in a defacto relationship
Separated	Respondent is separated
Divorced	Respondent is divorced
Widow	Respondent is a widow
Lone parent	Respondent is a lone parent
Mild health condition	Respondent has a long-term health condition, that is a condition that has lasted or is likely to last for more than six months and this condition does not limit the type or amount of work the respondent can do
Moderate health condition	Respondent has a long-term health condition limiting the amount or type of work that the respondent can do
Severe health condition	Respondent has a long-term health condition and cannot work
Year 12 or below	Respondent's highest level of education is Year 12 or below
Employed part-time	Respondent is employed and works less than 35 hours per week
Self-employed	Respondent is self-employed
Unemployed	Respondent is not employed but is looking for work
Retired	Respondent is retired
Home duties	Respondent performs home duties
Student	Respondent is a non-working student
Non-participant	Respondent falls into the other non-participant category including individuals less than 15 years old at the end of the last financial year
Disposable income (ln)	Natural log of disposable household income
Hours worked	Respondent's hours worked are in the relevant quartile; 1st quartile hours worked greater than 0 and less than or equal to 26; 2nd quartile greater than 26 and less than or equal to 38.25; 3rd quartile greater than 38.25 and less than or equal to 45; 4th quartile greater than 45
Commute time	Number of hours spent travelling to and from paid employment per week by respondent
Extraversion	Degree of extraversion (scale 1 to 7)
Agreeableness	Degree of agreeableness (scale 1 to 7)
Conscientiousness	Degree of conscientiousness (scale 1 to 7)
Emotional stability	Degree of emotional stability (scale 1 to 7)
Openness to experience	Degree of openness to experience (scale 1 to 7)

(continued)

Table 1. (Continued)

Variable name	*Definition*
Others present	Someone other than the respondent was present during the interview
Renter	Respondent is renting the home or is involved in a rent to buy scheme
Rent free	Respondent resides in the home rent free
Medium rise	Respondent resides in a townhouse, or one- to three-storey apartment
High rise	Respondent resides in a four- or more storey apartment
Other dwelling	Respondent resides in other dwelling, for instance, a non-private dwelling, a caravan or a houseboat
Years at current address	Number of years the respondent has lived at current address
Inner regional	Respondent resides in inner regional Australia
Outer regional or remote	Respondent resides in outer regional or remote Australia
Population density	Number of individuals per square kilometre in the CD
SEIFA index	The Australian Bureau of Statistics' (ABS) Socio-Economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage measured in deciles for the CD, where a higher decile is relatively less disadvantaged and conversely a lower decile is relatively more disadvantaged
Public greenspace	Percentage of public greenspace in the CD
Proximity to coastline	Respondent resides within 3 km; between 3 km and 5 km; between 5 km and 10 km of a coastline
Proximity to river	Respondent resides within 3 km; between 3 km and 5 km; between 5 km and 10 km of a river
Proximity to lake	Respondent resides within 3 km; between 3 km and 5 km; between 5 km and 10 km of a lake
Proximity to creek	Respondent resides within 3 km; between 3 km and 5 km; between 5 km and 10 km of a creek
Proximity to airport	Respondent resides within 3 km; between 3 km and 5 km; between 5 km and 10 km of an airport
Proximity to railway	Respondent resides within 3 km; between 3 km and 5 km; between 5 km and 10 km of a railway station
Proximity to major road	Respondent resides within 1 km and between 1 km and 3 km of a major road
Melbourne	Respondent resides in Melbourne
Brisbane	Respondent resides in Brisbane
Adelaide	Respondent resides in Adelaide
Perth	Respondent resides in Perth
Hobart	Respondent resides in Hobart
Darwin	Respondent resides in Darwin
Canberra	Respondent resides in Canberra

Notes: Omitted cases are: Age (30–39); Female; Not of indigenous origin; Country of birth Australia; Speaks English well or very well; Does not have children; Never married and not defacto; Not a lone parent; Does not have a long-term health condition; Beyond year 12; Not self-employed; Employed working 35 hours or more per week; Zero hours worked; No others present during the interview or don't know—telephone interview; Owns/paying off mortgage on home; Separate house; Major city; Greater than 10 km from the coastline; Greater than 10 km from a river; Greater than 10 km from a lake; Greater than 10 km from a creek; Greater than 10 km from an airport; Greater than 10 km from a railway station; Greater than 3 km from a major road; Sydney.

Similarly, the equivalent surplus is the amount of household income a resident would need to receive or pay in order to obtain the level of utility following a change, *if the change did not take place*. Equivalent surplus (denoted ES) can be calculated as follows

$$ES = -\exp\left[\overline{\ln(y)} + \frac{\widehat{\beta_3}}{\widehat{\beta_1}}(a^2 - a^1)\right] - \bar{y} \quad (4)$$

The next step is to augment the model estimated in equation (1) with interaction terms in order to assess whether different residents in different situations, on average, have different implicit preferences for public greenspace. The augmented life satisfaction model takes the form of an indirect utility function for resident r in location k as follows

$$\begin{aligned} U_{r,k} = {} & \beta_0 + \beta_1 \ln(y_{r,k}) + \beta_2' x_{r,k} \\ & + \beta_3 a_k + \beta_4' a_k \lambda_{r,k} + \beta_5' \delta_{r,k} + \varepsilon_{r,k} \end{aligned} \quad (5)$$

where, $\lambda_{r,k}$ is one of many possible characteristics unique to the resident or the resident's situation and all other variables are as previously defined.

From equation (5) we can proceed to derive the average implicit willingness to pay, as shown in equation (6)

$$WTP = \frac{\frac{\partial U_{r,k}}{\partial a_k}}{\frac{\partial U_{r,k}}{\partial y_{r,k}}} = \frac{\partial y_{r,k}}{\partial a_k} = \bar{y}\,\frac{\widehat{\beta_3} + \widehat{\beta_4}\lambda}{\widehat{\beta_1}} \quad (6)$$

where, λ takes the value of the variable interacted with public greenspace. For instance, if the resident is a lone parent λ equals 1.

2.1 Estimation Strategy

For ease of interpretation and to facilitate comparison with other studies we employ ordinary least squares (OLS) and ordered logit models. Many authors (see Ferrer-i-Carbonell and Frijters, 2004) have shown that estimates of the determinants of life satisfaction are virtually unchanged whether one models the ordinal nature of the variable (as implied by the use of ordered logit) or treats the responses as cardinal (implied by the use of OLS); contingent on individual heterogeneity being addressed appropriately. To satisfy this condition, we include Saucier's (1994) 'big five' personality trait controls (extraversion, agreeableness, conscientiousness, emotional stability and openness to experience).

The 'big five' model of personality traits is not without its critics (see Block, 1995; Pervin, 1994). However, for the purposes of providing a broad description of personality traits, the model is found to perform well (Benet-Martinez and John, 1998; Borkenau and Ostendorf, 1990). The personality trait controls assist in mitigating potential bias in the income coefficient that may arise if, for example, extraverted people are both more likely to report higher levels of life satisfaction and be more productive in the labour market (Powdthavee, 2010).

To address the issue of reverse causality between income and life satisfaction, a number of instruments for income were investigated, including expenditure (see Kingdon and Knight, 2007), father's and spouse's education (see Knight *et al.*, 2009), social (occupational) class (see Brown, 2013; Ferreira and Moro, 2010) and industry of employment (see Pischke, 2011). All instruments, however, are found to violate the exclusion restriction (as indicated by the Hansen J statistic) and/or are weakly identified (as indicated by the Cragg–Donald Wald F statistic).[2] Further research effort is required to address this issue. Recognising that people compare their current income with their past income as well as with the income of others and despite the inclusion of controls for job-related characteristics such as hours worked and commute time, it is likely that a degree of downward bias in the income coefficient remains (see Powdthavee, 2010).

In contrast to the income coefficient, the public greenspace coefficient may be biased upwards as it is possible that people self-select where they reside. The magnitude of this effect is uncertain, although some authors (see Chay and Greenstone, 2005) observe that empirical evidence indicates the bias is small. Together, a downward bias in the income coefficient and an upward bias in the public greenspace coefficient may lead to exaggerated marginal willingness-to-pay estimates.

To address possible spatially omitted variable bias, we include numerous controls for additional spatial factors for which data are available. Finally, as we include explanatory variables at different spatial levels, standard errors are adjusted for clustering (see Moulton, 1990).

2.2 Household, Income and Labour Dynamics in Australia

The measure of self-reported life satisfaction and the socioeconomic and demographic characteristics of respondents are obtained from Wave 5 (2005) of the Household Income and Labour Dynamics in Australia (HILDA) survey. Wave 5 is employed as it closely matches the date of collection of the spatial data and includes a range of personality trait questions, thus allowing personality traits to be controlled for in model estimation. These data are then subset for Australia's capital cities (Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth and Sydney). The life satisfaction variable is obtained from individuals' responses to the question: 'All things considered, how satisfied are you with your life?'. The life satisfaction variable is an ordinal variable, the individual choosing a number between 0 (totally dissatisfied with life) and 10 (totally satisfied with life).

A prerequisite for the use of this life satisfaction variable is that self-reported life satisfaction must be regarded as a good proxy for an individual's utility. While some economists remain unconvinced (see Smith, 2008), there are many studies supporting the robustness, reliability, validity and comparability of these measures (see Frey and Stutzer, 2002; Krueger and Schkade, 2008). On the issue of single-item measures of life satisfaction, as opposed to multiitem instruments such as the Satisfaction With Life Scale (see Diener *et al.*, 1985), Lucas and Donnellan (2012) conclude that while single-item measures are less reliable, they remain sufficient for investigating determinants of life satisfaction. Crucially, the authors demonstrate that estimates for self-reported life satisfaction within the HILDA dataset exceed the frequently cited heuristic for minimally acceptable reliability of 0.70.

Similar to self-reported life satisfaction, self-reported income must be considered admissible as a measure of income. This is of particular importance to the valuation aspect of this paper. The income measure employed is the natural log of self-reported nominal disposable household income with imputed values for missing data. Consistent with the findings of Wooden *et al.* (2009), we find no statistical difference between imputed and reported values. For further detail about the imputation method used, see Hayes and Watson (2010).

2.3 Spatial Data

The measure of public greenspace (obtained using geographical information systems) is the percentage of public greenspace in the resident's local area, defined at the level of the Collection District (CD).[3,4] Following Bell *et al.* (2008), public greenspace is defined to include public parks, community gardens, cemeteries, sports fields, national parks and wilderness area.

The mean area of the CDs in the sample is 1.85 square km. Assuming that each CD takes the shape of a circle, the median radius from the centroid or centre point is approximately 750 metres. Thus, the public greenspace measured is in close proximity to the resident's dwelling. As noted by Schipperijn *et al.* (2010), major factors influencing the use of greenspace are size *and* proximity; in using the percentage of public greenspace within the CD, we have been able to conveniently synthesise these two factors into a single variable.

3. Results

In this section, OLS model estimates are reported and discussed; results for the ordered logit model, including marginal effects, are provided as Appendix 2. Estimates for equation (1) are presented in Table 2. In regard to socioeconomic and demographic characteristics, the results largely support the existing literature and *a priori* expectations. That is, life satisfaction is U-shaped in age, reaching a minimum when a resident is in their 40s. Males are found to be more satisfied than females when personality trait controls are included, however, in absolute terms, males report lower levels of life satisfaction.

Immigrants from non-English-speaking countries are found to be less satisfied than the native born, even after controlling for reported English-speaking ability. In terms of marital status, being married is associated with higher levels of life satisfaction than being in a *defacto* relationship and people in a *defacto* relationship are more satisfied than residents never before married. In contrast, separated and divorced residents experience much lower levels of life satisfaction than residents who have never been married. Being a widow is associated with higher levels of life satisfaction. Lone parents are found to have lower levels of life satisfaction, even after controlling for the number and age of children in the household, which itself (at least for children aged 5 to 14) is associated with lower levels of life satisfaction.

As expected, having a long-term health condition is associated with lower levels of life satisfaction, with the lowest levels of life satisfaction experienced by residents suffering a severe health condition. Also, unemployed residents, even after controlling for income and personality traits, are found to have much lower levels of life satisfaction. Not surprisingly, higher income is associated with higher levels of life satisfaction, while commuting time is associated with lower levels.

Four of the 'big five' personality trait variables are statistically significant at the 1 per cent level, with higher degrees of extraversion, agreeableness, conscientiousness and emotional stability all associated with higher levels of life satisfaction. Renters and residents living in other (non-standard) types of dwellings are found to have lower levels of life satisfaction than house owners and those living in a separate house.

Of the spatial variables employed, living within 3 kilometres of the coastline is associated with higher levels of life satisfaction, whereas living within 3 kilometres or between 3 and 5 kilometres of a major airport is found to be associated with much lower levels of life satisfaction, comparable with having a long-term health condition. With the exception of Melbourne residents, residents living in capital cities other than Sydney are generally found to have higher levels of life satisfaction, *ceteris paribus*.

Of particular importance to this study, public greenspace, as measured by the percentage of public greenspace in the resident's local area, is found to be welfare-enhancing at a statistically significant level (p-value of 0.0630), with an estimated coefficient of 0.0032.

Table 2. OLS model results

Variable name	*OLS estimate (S.E.)*	*Variable name*	*OLS estimate (S.E.)*
Constant	2.6477***	Emotional stability	0.2273***
	(0.4954)		(0.0212)
Age (15–19)	0.4226***	Openness to experience	−0.0186
	(0.0944)		(0.0209)
Age (20–29)	0.1069*	Others present	0.0269
	(0.0606)		(0.0411)
Age (40–49)	−0.1265*	Renter	−0.1073*
	(0.0650)		(0.0551)
Age (50–59)	−0.0423	Rent free	−0.0271
	(0.0782)		(0.1437)
Age (60+)	0.2174**	Medium rise	−0.0197
	(0.0982)		(0.0678)
Male	0.0928**	High rise	−0.0454
	(0.0383)		(0.1535)
ATSI	0.1158	Other dwelling	−0.4782*
	(0.1672)		(0.2493)
Immigrant English	0.0015	Years at current address	0.0016
	(0.0573)		(0.0021)
Immigrant non-English	−0.1106*	Inner regional	0.0889
	(0.0608)		(0.1105)
Poor English	−0.1828	Outer regional or remote	−0.0557
	(0.1927)		(0.2200)
Children (0–4)	−0.0759	Population density	0.0000
	(0.0683)		(0.0000)
Children (5–14)	−0.1565***	SEFIA index	0.0068
	(0.0564)		(0.0044)
Children (15–24)	−0.0832	Public greenspace	0.0032*
	(0.0633)		(0.0017)
Children (25+)	−0.0302	Proximity to coastline	0.2461***
	(0.1129)	($\delta_{r,k} \leq 3$ km)	(0.0845)
Married	0.2871***	Proximity to coastline	0.0729
	(0.0683)	($3 < \delta_{r,k} \leq 5$ km)	(0.0922)
Defacto	0.1658**	Proximity to coastline	0.0969
	(0.0728)	($5 < \delta_{r,k} \leq 10$ km)	(0.0720)
Separated	−0.5987***	Proximity to river	−0.0470
	(0.1601)	($\delta_{r,k} \leq 3$ km)	(0.0922)
Divorced	−0.2535**	Proximity to river	−0.0187
	(0.1063)	($3 < \delta_{r,k} \leq 5$ km)	(0.0968)
Widow	0.2946**	Proximity to river	−0.0670
	(0.1367)	($5 < \delta_{r,k} \leq 10$ km)	(0.0803)
Lone parent	−0.3770***	Proximity to lake	−0.0253
	(0.1403)	($\delta_{r,k} \leq 3$ km)	(0.1549)
Mild health condition	−0.1522**	Proximity to lake	−0.1149
	(0.0632)	($3 < \delta_{r,k} \leq 5$ km)	(0.1538)
Moderate health condition	−0.5788***	Proximity to lake	0.0443
	(0.0628)	($5 < \delta_{r,k} \leq 10$ km)	(0.1379)
Severe health condition	−1.0991**	Proximity to creek	0.1109
	(0.4485)	($\delta_{r,k} \leq 3$ km)	(0.1184)
Year 12 or below	0.0456	Proximity to creek	0.0305
	(0.0402)	($3 < \delta_{r,k} \leq 5$ km)	(0.1214)

(continued)

Table 2. (Continued)

Variable name	*OLS estimate (S.E.)*	*Variable name*	*OLS estimate (S.E.)*
Employed part-time	0.0106 (0.0702)	Proximity to creek ($5 < \delta_{r,k} \leq 10$ km)	0.0469 (0.0999)
Self employed	−0.1278* (0.0756)	Proximity to airport ($\delta_{r,k} \leq 3$ km)	−0.7359** (0.3487)
Unemployed	−0.3623** (0.1634)	Proximity to airport ($3 < \delta_{r,k} \leq 5$ km)	−0.2817* (0.1463)
Student	0.1542 (0.1240)	Proximity to airport ($5 < \delta_{r,k} \leq 10$ km)	−0.0976 (0.0736)
Non-participant	−0.1421 (0.2334)	Proximity to railway ($\delta_{r,k} \leq 3$ km)	−0.1234 (0.1283)
Retired	0.1556 (0.1287)	Proximity to railway ($3 < \delta_{r,k} \leq 5$ km)	−0.0579 (0.1273)
Home duties	0.1364 (0.1204)	Proximity to railway ($5 < \delta_{r,k} \leq 10$ km)	−0.0121 (0.1217)
Disposable income (ln)	0.1422*** (0.0308)	Proximity to major road ($\delta_{r,k} \leq 1$ km)	0.0964 (0.0953)
Hours worked (1st quartile)	0.0793 (0.0925)	Proximity to major road ($1 < \delta_{r,k} \leq 3$ km)	0.0416 (0.0912)
Hours worked (2nd quartile)	−0.0417 (0.1075)	Melbourne	0.6607 (0.4206)
Hours worked (3rd quartile)	−0.0234 (0.1117)	Brisbane	0.6764*** (0.1924)
Hours worked (4th quartile)	−0.0578 (0.1159)	Adelaide	0.8631* (0.4663)
Commute time	−0.0159*** (0.0058)	Perth	1.4065*** (0.5048)
Extraversion	0.0874*** (0.0174)	Hobart	0.8112*** (0.2306)
Agreeableness	0.1803*** (0.0246)	Darwin	1.9776*** (0.3228)
Conscientiousness	0.0978*** (0.0186)	Canberra	0.5772*** (0.2079)
Summary statistics			
Number of observations	6156		
Adjusted R^2	0.1789		

Notes: *** significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level. Omitted cases are: Age (30–39); Female; Not of indigenous origin; No children; Country of birth Australia; Speaks English well or very well; Never married and not defacto; Not a lone parent; Does not have a long-term health condition; Beyond year 12; Not self-employed; Employed working 35 hours or more per week; No hours worked; No others present during the interview or don't know—telephone interview; Owns/paying off mortgage on home; Separate house; Major city; Greater than 10 km from the coastline; Greater than 10 km from a river; Greater than 10 km from a lake; Greater than 10 km from a creek; Greater than 10 km from an airport; Greater than 10 km from a railway station; Greater than 3 km from a major road; Sydney.

Following the procedure described in equation (2), the average implicit willingness to pay in terms of annual household income, for a 1 per cent increase in public greenspace, is \$1172. Given, on average, there are 2.5 people living in each household in the sample, this implies a per capita implicit willingness to pay of \$469. To put these results in context, on average, a 1 per cent increase in greenspace from the mean is equivalent to a 143 square metres increase in public greenspace in the CD.

Similarly, a one standard deviation (12.49 per cent) increase in public greenspace from the mean yields an *ex ante* compensating surplus of $12,797, thus suggesting, following such an improvement, that a resident is able to sacrifice approximately $12,800 in annual household income and remain at his or her initial level of utility. The comparable *ex post* equivalent surplus estimate is $16,871, suggesting that a resident would require an increase in annual household income of approximately $16,900 for such an improvement *not to occur*.

3.1 Heterogeneity in Preferences for Public Greenspace

We use equation (6) to examine how a resident's preferences may vary depending on the characteristics of their local area.[5] The results indicate that public greenspace yields greater life satisfaction benefits for people living in more densely populated areas. Employing average marginal effects, the mean implicit willingness-to-pay estimates at the 25th, 50th and 75th population density per centiles are $1275, $1850 and $2414 respectively.

Again using equation (6), we investigate how the welfare effects of public greenspace depend on the characteristics of the resident. Interaction coefficients are presented in Table 3. The dominant finding is that many of the interactions do not yield statistically significant results. Focusing first on the statistically insignificant results, the benefits of public greenspace do not appear to depend on gender, ethnicity, level of health, employment status, dwelling type or hours worked.

We do, however, find some heterogeneity. Specifically, residents aged between 15 and 19 and between 40 and 49 are found to report lower levels of life satisfaction in areas of higher greenspace, as do those with young children. The reverse is true for lone parents and residents with an education level of year 12 or below.

4. Discussion

This paper set out to investigate heterogeneity in preferences for greenspace in the context of capital cities throughout Australia. In so doing, this paper makes a contribution to the spatial planning literature, as well as to the body of literature employing the life satisfaction approach to value environmental goods and services. Furthermore, this study assists in addressing the challenge urban consolidation presents in terms of the sourcing, provisioning and management of urban greenspace.

Our main finding indicates that higher levels of public greenspace are associated with higher levels of welfare for residents and that, on average, a resident has an implicit willingness to pay of approximately $1172 in annual household income for a 1 per cent (143 square metre) increase in public greenspace in their local area.

While there is not a great deal of literature with which to compare this main finding, it is evident that the positive correlation between greenspace and life satisfaction is consistent with the findings of other authors (see Maas *et al.*, 2006; Mitchell and Popham, 2007; Smyth *et al.*, 2008, 2011). However, the magnitude of the correlation in this study (and the ratio of the greenspace and income coefficients) is substantially smaller than in previous studies. We suggest this may reflect the relative abundance of greenspace in urban Australia compared with urban centres in other parts of the world.

While the dominant finding is that most interactions are not statistically significant, preferences do differ for some groups of residents. Specifically, we observe greater

Table 3. OLS public greenspace interaction results

Interaction term	*OLS estimate (S.E.)*
Age (15–19) x Public greenspace	−0.0129* (0.0069)
Age (20–29) x Public greenspace	−0.0028 (0.0069)
Age (40–49) x Public greenspace	−0.0101* (0.0006)
Age (50–59) x Public greenspace	−0.0081 (0.0070)
Age (60+) x Public greenspace	−0.0094 (0.0062)
Male x Public greenspace	−0.0011 (0.0036)
ATSI x Public greenspace	−0.0098 (0.0140)
Immigrant English x Public greenspace	−0.0023 (0.0053)
Immigrant non-English x Public greenspace	−0.0052 (0.0050)
Children (0–4) x Public greenspace	−0.0115** (0.0054)
Children (5–14) x Public greenspace	−0.0009 (0.0046)
Children (15–24) x Public greenspace	−0.0028 (0.0054)
Children (25+) x Public greenspace	0.0043 (0.0071)
Lone parent x Public greenspace	0.0224** (0.0103)
Mild health condition x Public greenspace	−0.0026 (0.0049)
Moderate health condition x Public greenspace	0.0021 (0.0044)
Severe health condition x Public greenspace	0.0295 (0.0308)
Year 12 or below x Public greenspace	0.0088*** (0.0031)
Unemployed x Public greenspace	0.0057 (0.0128)
Renter x Public greenspace	0.0013 (0.0039)
Rent free x Public greenspace	0.0095 (0.0066)
Medium rise x Public greenspace	−0.0055 (0.0062)
High rise x Public greenspace	0.0113 (0.0076)
Other dwelling x Public greenspace	−0.0210 (0.0138)
Hours worked (1st quartile) x Public greenspace	0.0047 (0.0047)
Hours worked (2nd quartile) x Public greenspace	0.0004 (0.0047)
Hours worked (3rd quartile) x Public greenspace	0.0023 (0.0047)
Hours worked (4th quartile) x Public greenspace	0.0063 (0.0050)
Summary statistics	
Number of observations	6156
Adjusted R^2	0.1798

Notes: *** significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level.

welfare effects of public greenspace in areas with higher population density. These results accord with those of Anderson and West (2006) who, using the hedonic property pricing method, find that the value of proximity to neighbourhood parks rises with population density.

This may reflect a combination of factors, including scarcity rent and high initial marginal utility attributable to what little public greenspace is available in particularly densely populated areas. These results provide some supporting evidence for the compensating hypothesis, as residents compensate poor access to private greenspace by making more use of public greenspace (Maat and de Vries, 2006).

In regard to the characteristics of the residents and their circumstances, the negative coefficients for two of the age interaction variables may suggest that available public greenspace is not compatible with the preferences of residents in these age-groups (specifically 15–19 and 40–49 year olds). This may reflect a neglect of the complex interaction between heterogeneous residents, heterogeneous greenspace and urban environments (see Bryne *et al.*, 2010). For the younger age-group, as found by Kong *et al.* (1999) for Singaporean youths, it may be that the benefits of greenspace are reduced due to a range of factors including: growing up in highly urbanised environments in which contact with nature is limited; overprotective parents who worry about the dangers children may be exposed to in public greenspace; and an abundance of other recreational and entertainment alternatives.

In summary, these findings reaffirm the role of public greenspace in supporting well-being and the importance of protecting or enhancing the provision of greenspace in urban environments in Australia. Projected population growth in urban areas, coupled with the finding that the welfare effects of public greenspace are greater in high-density environments, suggest that the role of public greenspace in maintaining the well-being of urban residents is likely to become more important over time. This needs to be recognised by policy-makers and given appropriate consideration in future urban planning decisions.

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Notes

1. As at 22 April 2013, 1AUD = 1.02USD; 1AUD = 0.78EUR; 1AUD = 1.22NZD. All figures are in AUD unless otherwise stated.
2. In the absence of a suitable external instrument, we employ the method outlined by Lawbel (2012), observing the generated variables to be collinear with the endogenous variable; obscuring the causal impact of income on life satisfaction. Specifically, we use the ivreg2h user written command (Baum and Schaffer, 2012). This is downloadable from the Statistical Software Components Archive using the Stata command "ssc install ivreg2h".
3. The CD is the smallest spatial unit in the Australian Standard Geographical Classification (Australian Bureau of Statistics, 2010)
4. Appendix 1 illustrates, for each capital city, the CD administrative boundaries and overlapping public greenspace.
5. Contrary to *a priori* expectations, we do not find any relationship between the welfare effects of public greenspace and the socio-economic status of the local area (as measured by the Australian Bureau of Statistics' Index of Relative Socio-economic

Disadvantage (Australian Bureau of Statistics, 2009) and median income).

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Appendix 1. Australian Capital Cities and Public Greenspace

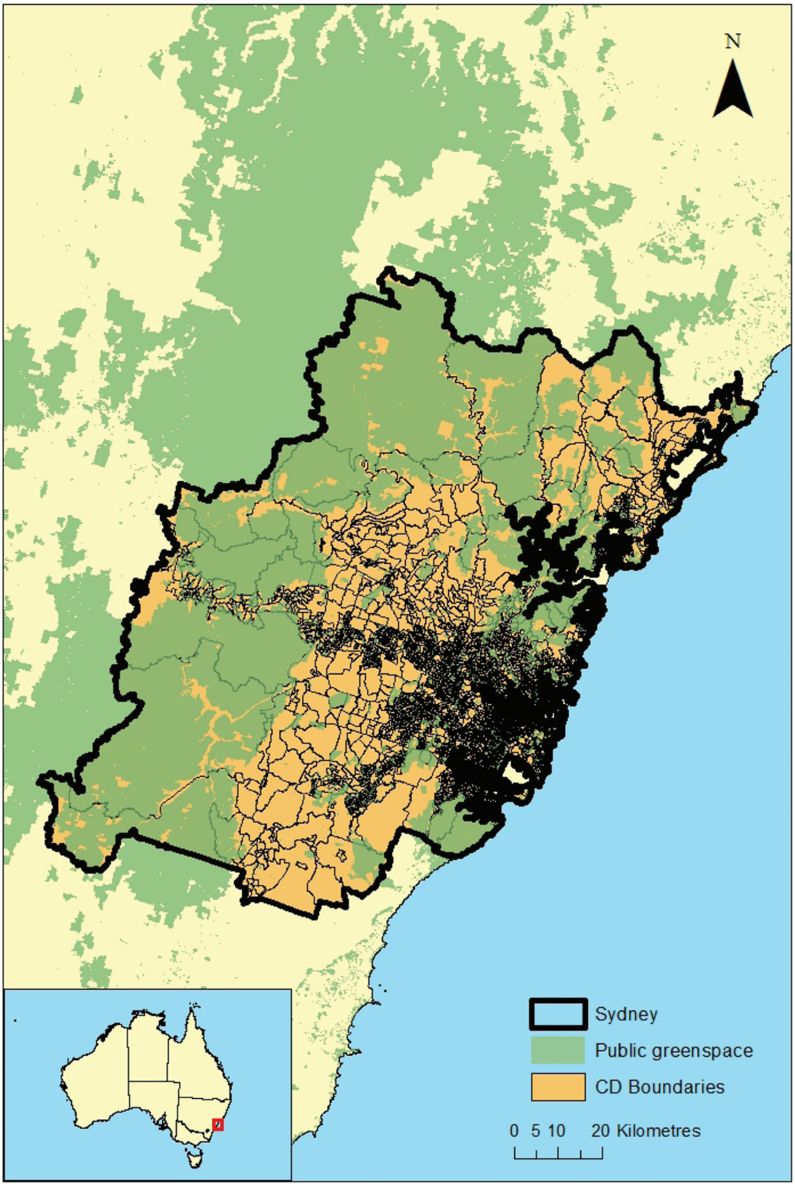

Figure A1. Sydney.
Source: NAVIGATE Pty Ltd (2010).

Figure A2. Melbourne.
Source: NAVIGATE Pty Ltd (2010).

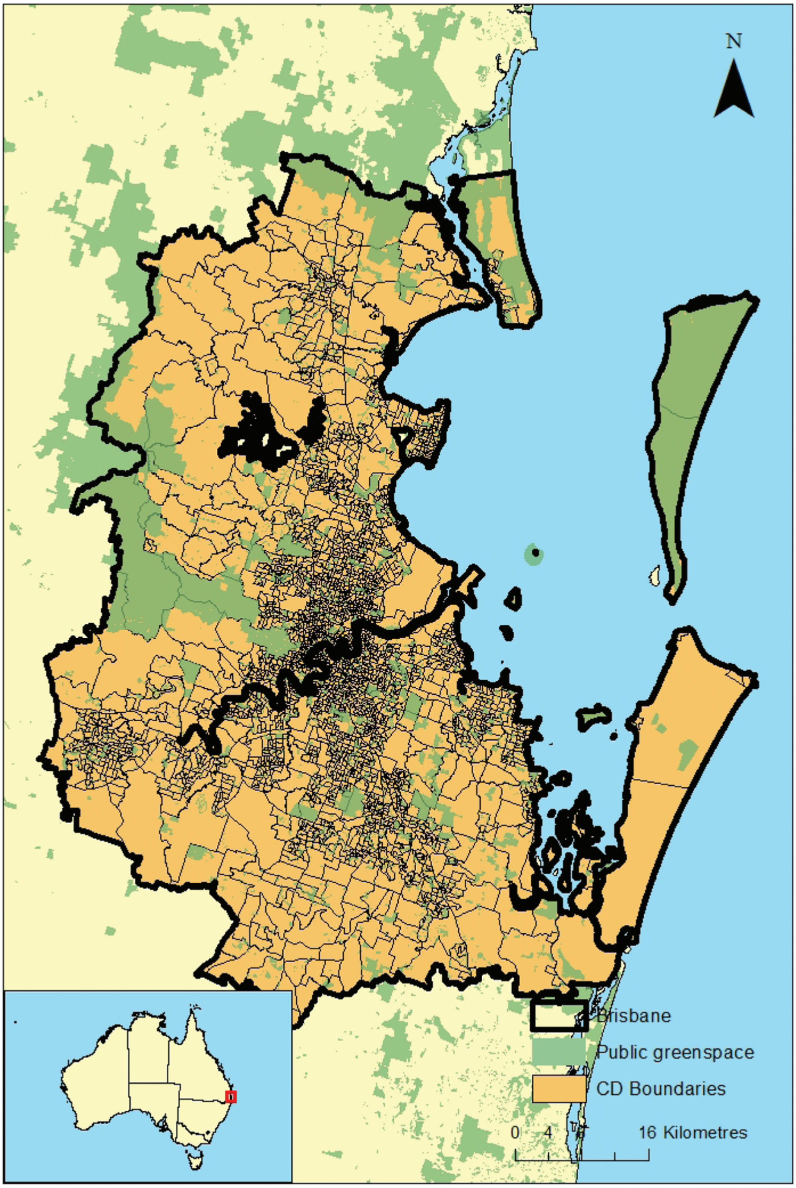

Figure A3. Brisbane.
Source: NAVIGATE Pty Ltd (2010).

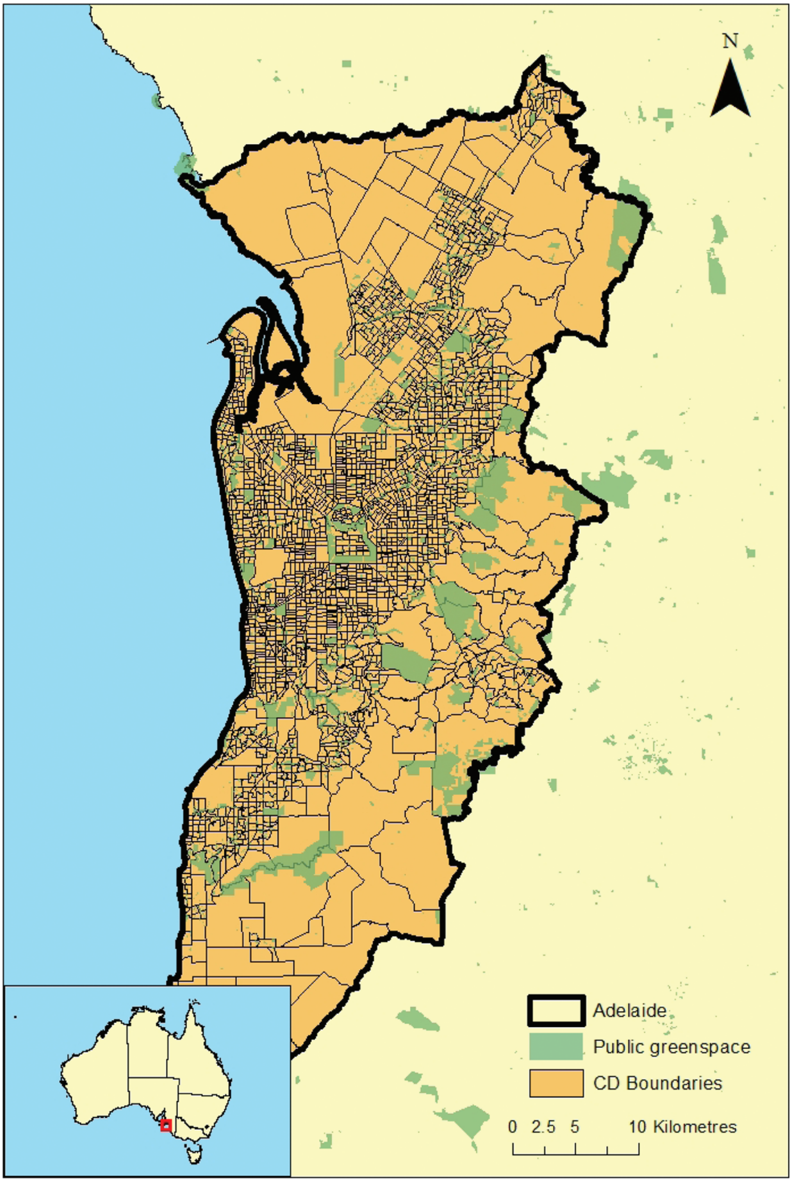

Figure A4. Adelaide.
Source: NAVIGATE Pty Ltd (2010).

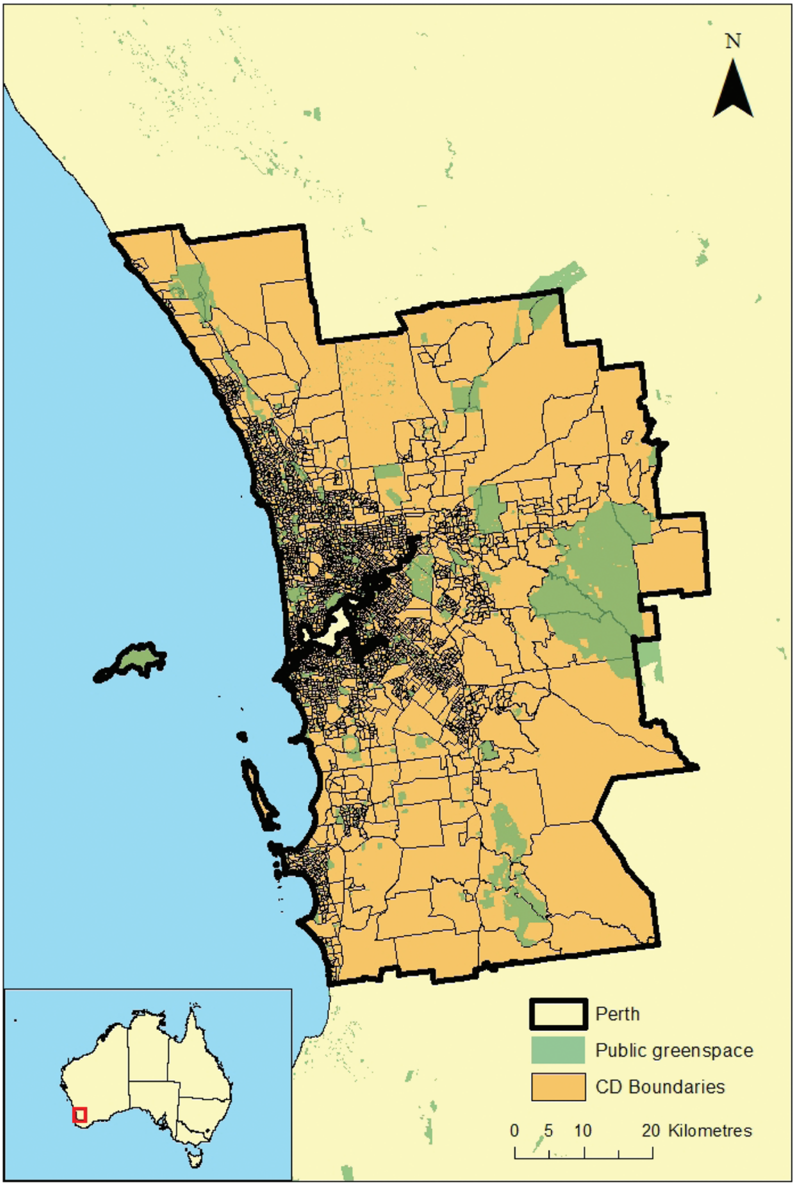

Figure A5. Perth.
Source: NAVIGATE Pty Ltd (2010).

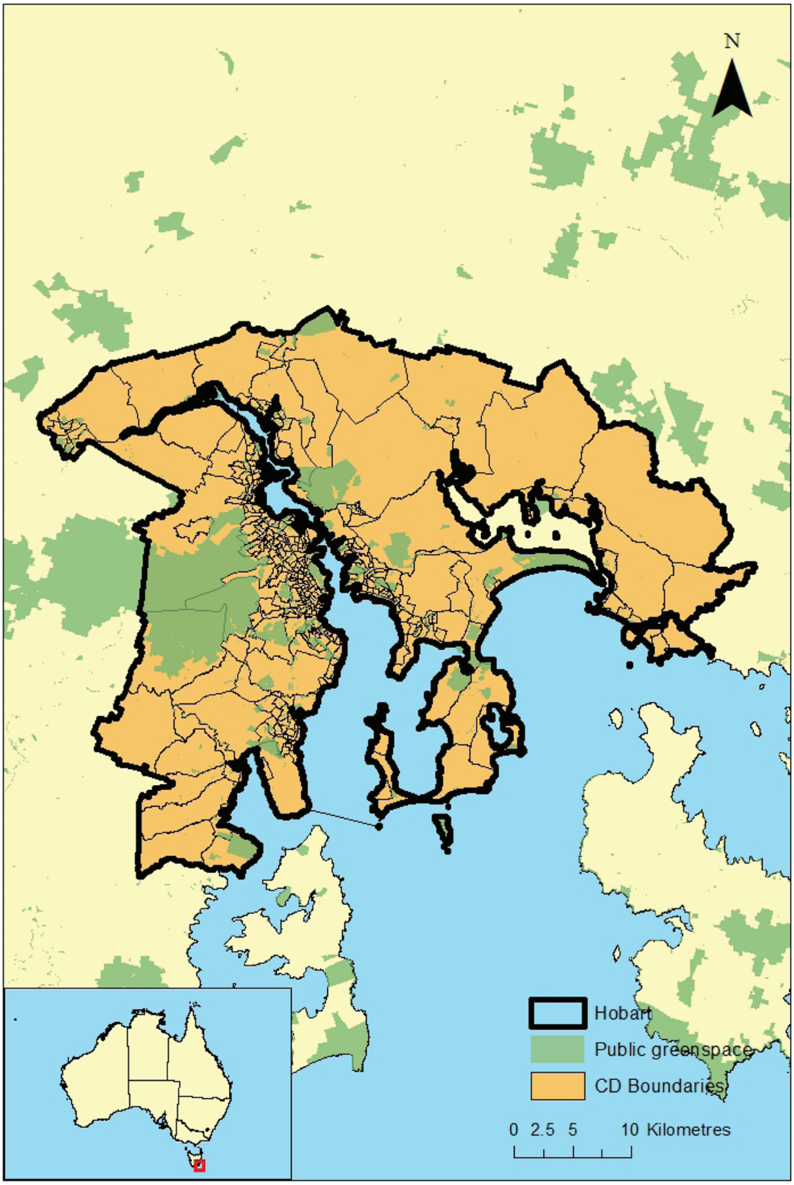

Figure A6. Hobart.
Source: NAVIGATE Pty Ltd (2010).

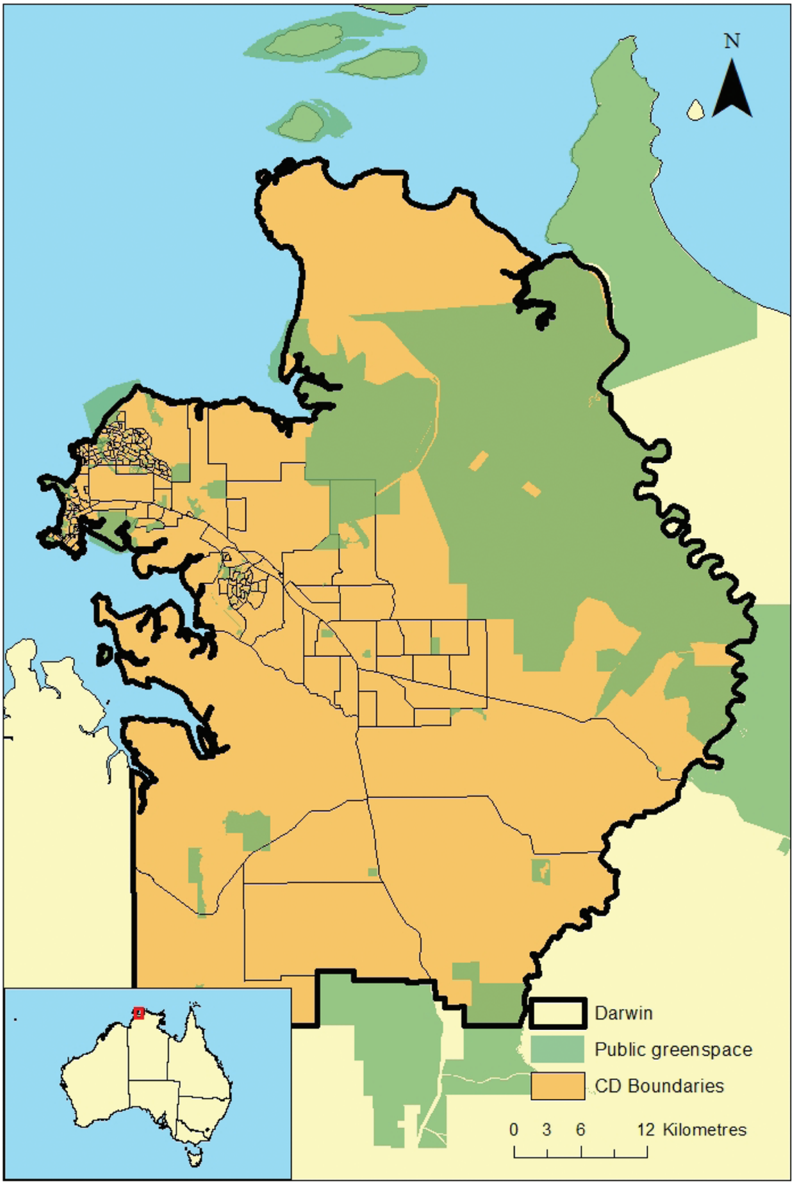

Figure A7. Darwin.
Source: NAVIGATE Pty Ltd (2010).

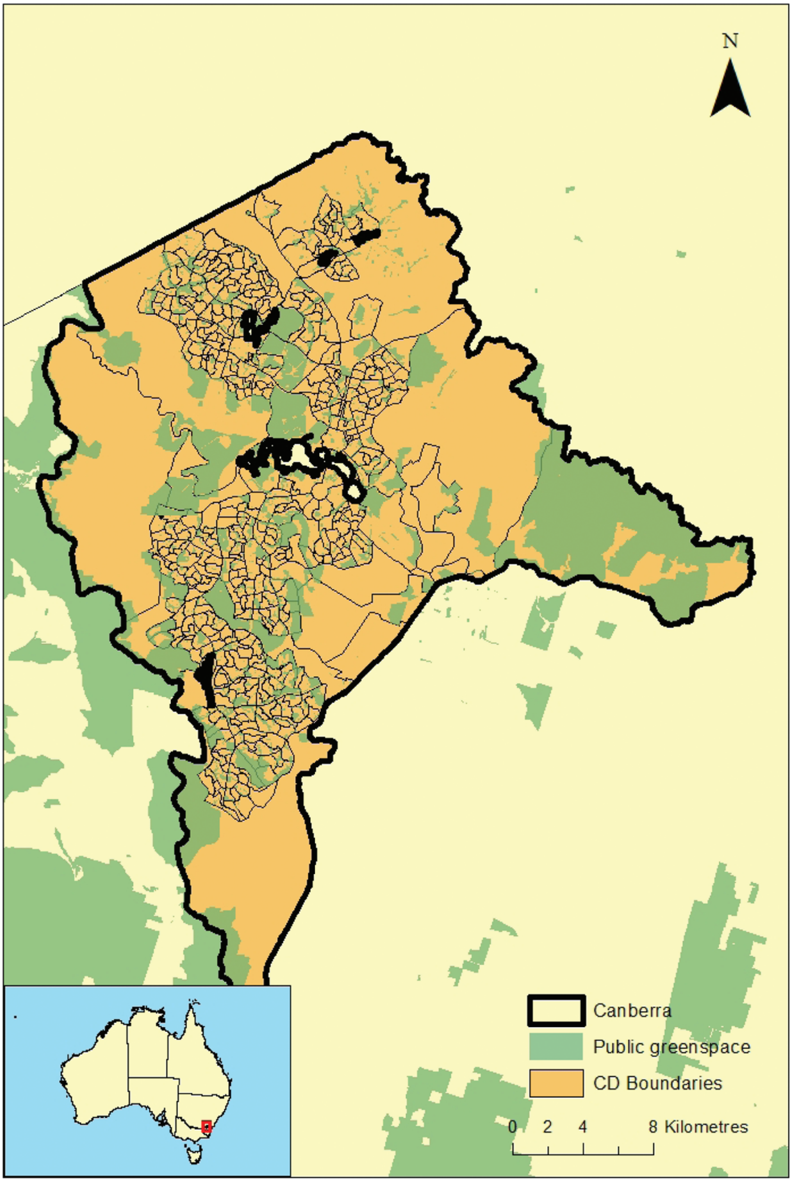

Figure A8. Canberra.
Source: NAVIGATE Pty Ltd (2010).

Appendix 2. Ordered Logit Model Results

Table A1. Model results

Variable name	*Coefficient (S.E.)*	*Variable name*	*Coefficient (S.E.)*
Age (15–19)	0.6535***	Openness to experience	−0.0379
	(0.1395)		(0.0304)
Age (20–29)	0.1563*	Others present	0.0460
	(0.0843)		(0.0580)
Age (40–49)	−0.1775**	Renter	−0.1809**
	(0.0902)		(0.0757)
Age (50–59)	−0.0765	Rent free	−0.0810
	(0.1101)		(0.2189)
Age (60+)	0.2904**	Medium rise	0.0407
	(0.1355)		(0.0932)
Male	0.1550***	High rise	−0.0937
	(0.0550)		(0.2353)
ATSI	0.1704	Other dwelling	−0.4163
	(0.2473)		(0.3119)
Immigrant English	0.0202	Years at current address	0.0025
	(0.0811)		(0.0031)
Immigrant non-English	−0.1434*	Inner regional	0.0175
	(0.0841)		(0.1565)
Poor English	−0.2710	Outer regional or remote	−0.3362
	(0.2558)		(0.2827)
Children (0–4)	−0.1742*	Population density	0.0000
	(0.0965)		(0.0000)
Children (5–14)	−0.2605***	SEFIA index	0.0076
	(0.0796)		(0.0067)
Children (15–24)	−0.1590*	Public greenspace	0.0042*
	(0.0923)		(0.0023)
Children (25+)	−0.0619	Proximity to coastline	0.2759**
	(0.1528)	($\delta_{r,k} \leq 3$ km)	(0.1171)
Married	0.4929***	Proximity to coastline	0.1296
	(0.0955)	($3 < \delta_{r,k} \leq 5$ km)	(0.1268)
Defacto	0.2794***	Proximity to coastline	0.1085
	(0.0978)	($5 < \delta_{r,k} \leq 10$ km)	(0.0972)
Separated	−0.5607***	Proximity to river	−0.0825
	(0.1948)	($\delta_{r,k} \leq 3$ km)	(0.1334)
Divorced	−0.2410*	Proximity to river	−0.0906
	(0.1403)	($3 < \delta_{r,k} \leq 5$ km)	(0.1412)
Widow	0.5470***	Proximity to river	−0.1063
	(0.1976)	($5 < \delta_{r,k} \leq 10$ km)	(0.1187)
Lone parent	−0.5442***	Proximity to lake	−0.0742
	(0.1837)	($\delta_{r,k} \leq 3$ km)	(0.2078)
Mild health condition	−0.1857**	Proximity to lake	−0.1876
	(0.0924)	($3 < \delta_{r,k} \leq 5$ km)	(0.2063)
Moderate health condition	−0.7389***	Proximity to lake	0.0162
	(0.0826)	($5 < \delta_{r,k} \leq 10$ km)	(0.1863)
Severe health condition	−1.1913**	Proximity to creek	0.1350
	(0.5504)	($\delta_{r,k} \leq 3$ km)	(0.1617)

(continued)

Table A1. (Continued)

Variable name	*Coefficient (S.E.)*	*Variable name*	*Coefficient (S.E.)*
Year 12 or below	0.1027*	Proximity to creek	0.0421
	(0.0549)	($3 < \delta_{r,k} \leq 5$ km)	(0.1617)
Employed part-time	0.0245	Proximity to creek	0.0487
	(0.1021)	($5 < \delta_{r,k} \leq 10$ km)	(0.1370)
Self-employed	−0.1596	Proximity to airport	−1.1347**
	(0.1062)	($\delta_{r,k} \leq 3$ km)	(0.4426)
Unemployed	−0.3866*	Proximity to airport	−0.2925*
	(0.2217)	($3 < \delta_{r,k} \leq 5$ km)	(0.2107)
Student	0.2031	Proximity to airport	−0.0671
	(0.1902)	($5 < \delta_{r,k} \leq 10$ km)	(0.1043)
Non-participant	−0.1324	Proximity to railway	−0.2875
	(0.3101)	($\delta_{r,k} \leq 3$ km)	(0.1829)
Retired	0.2740	Proximity to railway	−0.1431
	(0.1814)	($3 < \delta_{r,k} \leq 5$ km)	(0.1829)
Home duties	0.2743	Proximity to railway	−0.0883
	(0.1753)	($5 < \delta_{r,k} \leq 10$ km)	(0.1770)
Disposable income (ln)	0.2042***	Proximity to major road	0.1565
	(0.0418)	($\delta_{r,k} \leq 1$ km)	(0.1424)
Hours worked (1st quartile)	0.0992	Proximity to major road	0.1013
	(0.1383)	($1 < \delta_{r,k} \leq 3$ km)	(0.1379)
Hours worked (2nd quartile)	−0.1047	Melbourne	0.2480
	(0.1536)		(0.3373)
Hours worked (3rd quartile)	−0.1068	Brisbane	0.5725*
	(0.1618)		(0.3015)
Hours worked (4th quartile)	−0.1412	Adelaide	0.6486*
	(0.1678)		(0.3815)
Commute time	−0.0222***	Perth	0.4872
	(0.0080)		(0.4475)
Extraversion	0.1484***	Hobart	0.7855
	(0.0239)		(2.5820)
Agreeableness	0.2905***	Darwin	−0.3676
	(0.0354)		(0.4856)
Conscientiousness	0.1545***	Canberra	0.3818
	(0.0264)		(0.3115)
Emotional stability	0.3301***		
	(0.0289)		
Summary statistics			
Number of observations	6156		
Pseudo R^2	0.0711		

Notes: *** significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level. Omitted cases are: Age (30–39); Female; Not of indigenous origin; No children; Country of birth Australia; Speaks English well or very well; Never married and not defacto; Not a lone parent; Does not have a long-term health condition; Beyond year 12; Not self-employed; Employed working 35 hours or more per week; No hours worked; No others present during the interview or don't know—telephone interview; Owns/paying off mortgage on home; Separate house; Major city; Greater than 10 km from the coastline; Greater than 10 km from a river; Greater than 10 km from a lake; Greater than 10 km from a creek; Greater than 10 km from an airport; Greater than 10 km from a railway station; Greater than 3 km from a major road; Sydney. These coefficient estimates cannot be interpreted as marginal effects.

Table A2. Model results (marginal effects)

Variable name	*Marginal effect (S.E.)*	*Variable name*	*Marginal effect (S.E.)*
Age (15–19)	0.0589***	Openness to experience	−0.0034
	(0.0127)		(0.0027)
Age (20–29)	0.0141*	Others present	0.0041
	(0.0076)		(0.0052)
Age (40–49)	−0.0160**	Renter	−0.0163**
	(0.0081)		(0.0068)
Age (50–59)	−0.0069	Rent free	−0.0073
	(0.0099)		(0.0197)
Age (60+)	0.0262**	Medium rise	0.0037
	(0.0123)		(0.0084)
Male	0.0140***	High rise	−0.0084
	(0.0050)		(0.0212)
ATSI	0.0154	Other dwelling	−0.0375
	(0.0223)		(0.0281)
Immigrant English	0.0018	Years at current address	0.0002
	(0.0073)		(0.0003)
Immigrant non-English	−0.0129*	Inner regional	0.0016
	(0.0076)		(0.0141)
Poor English	−0.0244	Outer regional or remote	−0.0303
	(0.0231)		(0.0255)
Children (0–4)	−0.0157*	Population density	0.0000
	(0.0087)		(0.0000)
Children (5–14)	−0.0235***	SEFIA index	0.0007
	(0.0072)		(0.0006)
Children (15–24)	−0.0143*	Public greenspace	0.0004*
	(0.0083)		(0.0002)
Children (25+)	−0.0056	Proximity to coastline	0.0249**
	(0.0138)	($\delta_{r,k} \leq 3$ km)	(0.0106)
Married	0.0444***	Proximity to coastline	0.0117
	(0.0088)	($3 < \delta_{r,k} \leq 5$ km)	(0.0114)
Defacto	0.0252***	Proximity to coastline	0.0098
	(0.0089)	($5 < \delta_{r,k} \leq 10$ km)	(0.0088)
Separated	−0.0505***	Proximity to river	−0.0074
	(0.0176)	($\delta_{r,k} \leq 3$ km)	(0.0120)
Divorced	−0.0217*	Proximity to river	−0.0082
	(0.0127)	($3 < \delta_{r,k} \leq 5$ km)	(0.0127)
Widow	0.0493***	Proximity to river	−0.0096
	(0.0180)	($5 < \delta_{r,k} \leq 10$ km)	(0.0107)
Lone parent	−0.0493***	Proximity to lake	−0.0067
	(0.0166)	($\delta_{r,k} \leq 3$ km)	(0.0187)
Mild health condition	−0.0167**	Proximity to lake	−0.0169
	(0.0084)	($3 < \delta_{r,k} \leq 5$ km)	(0.0187)
Moderate health condition	−0.0666***	Proximity to lake	0.0169
	(0.0078)	($5 < \delta_{r,k} \leq 10$ km)	(0.0186)
Severe health condition	−0.0167**	Proximity to creek	0.0122
	(0.0837)	($\delta_{r,k} \leq 3$ km)	(0.0146)
Year 12 or below	0.0093*	Proximity to creek	0.00380
	(0.0050)	($3 < \delta_{r,k} \leq 5$ km)	(0.0151)
Employed part-time	0.0022	Proximity to creek	0.0044
	(0.0092)	($5 < \delta_{r,k} \leq 10$ km)	(0.0123)

(continued)

Table A2. (Continued)

Variable name	*Marginal effect (S.E.)*	*Variable name*	*Marginal effect (S.E.)*
Self-employed	−0.0144	Proximity to airport	−0.1023**
	(0.0096)	($\delta_{r,k} \leq 3$ km)	(0.0400)
Unemployed	−0.0349*	Proximity to airport	−0.0264*
	(0.0200)	($3 < \delta_{r,k} \leq 5$ km)	(0.0190)
Student	0.0183	Proximity to airport	−0.0061
	(0.0172)	($5 < \delta_{r,k} \leq 10$ km)	(0.0094)
Non-participant	−0.0119	Proximity to railway	−0.0259
	(0.0279)	($\delta_{r,k} \leq 3$ km)	(0.0167)
Retired	0.0247	Proximity to railway	−0.0129
	(0.0164)	($3 < \delta_{r,k} \leq 5$ km)	(0.0167)
Home duties	0.0247	Proximity to railway	−0.0080
	(0.0159)	($5 < \delta_{r,k} \leq 10$ km)	(0.0160)
Disposable income (ln)	0.0184***	Proximity to major road	0.0141
	(0.0038)	($\delta_{r,k} \leq 1$ km)	(0.0128)
Hours worked (1st quartile)	0.0089	Proximity to major road	0.0091
	(0.0125)	($1 < \delta_{r,k} \leq 3$ km)	(0.0124)
Hours worked (2nd quartile)	−0.0094	Melbourne	0.0224
	(0.0139)		(0.0304)
Hours worked (3rd quartile)	−0.0096	Brisbane	0.0516*
	(0.0146)		(0.0273)
Hours worked (4th quartile)	−0.0127	Adelaide	0.0585*
	(0.0151)		(0.0345)
Commute time	−0.0020***	Perth	0.0439
	(0.0007)		(0.0404)
Extraversion	0.0134***	Hobart	0.0708
	(0.0022)		(0.2329)
Agreeableness	0.0262***	Darwin	−0.0331
	(0.0033)		(0.0438)
Conscientiousness	0.0139***	Canberra	0.0344
	(0.0024)		(0.0281)
Emotional stability	0.0298***		
	(0.0027)		
Summary statistics			
Number of observations	6156		
Pseudo R^2	0.0711		

Notes: *** significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level. Omitted cases are: Age (30–39); Female; Not of indigenous origin; No children; Country of birth Australia; Speaks English well or very well; Never married and not defacto; Not a lone parent; Does not have a long-term health condition; Beyond year 12; Not self-employed; Employed working 35 hours or more per week; No hours worked; No others present during the interview or don't know—telephone interview; Owns/paying off mortgage on home; Separate house; Major city; Greater than 10 km from the coastline; Greater than 10 km from a river; Greater than 10 km from a lake; Greater than 10 km from a creek; Greater than 10 km from an airport; Greater than 10 km from a railway station; Greater than 3 km from a major road; Sydney. The marginal effects can be interpreted as the probability of reporting a life satisfaction score of 10 for a one-unit increase in the explanatory variable. For instance, on average for one additional unit increase in extraversion (scale 1 to 7) individuals are 1.3 per cent more likely to report a life satisfaction score of 10.

Table A3. Public greenspace interaction results

Interaction term	*Coefficient (S.E.)*
Age (15–19) x Public greenspace	−0.0127 (0.0107)
Age (20–29) x Public greenspace	0.0011 (0.0067)
Age (40–49) x Public greenspace	−0.0109* (0.0080)
Age (50–59) x Public greenspace	−0.0093 (0.0096)
Age (60+) x Public greenspace	0.0020 (0.0084)
Male x Public greenspace	−0.0012 (0.0049)
ATSI x Public greenspace	−0.0131 (0.0204)
Immigrant English x Public greenspace	−0.0036 (0.0072)
Immigrant non-English x Public greenspace	−0.0111 (0.0071)
Children (0–4) x Public greenspace	−0.0116 (0.0076)
Children (5–14) x Public greenspace	−0.0008 (0.0007)
Children (15–24) x Public greenspace	−0.0074 (0.0079)
Children (25+) x Public greenspace	−0.0001 (0.0111)
Lone parent x Public greenspace	0.0300** (0.0150)
Mild health condition x Public greenspace	−0.0075 (0.0073)
Moderate health condition x Public greenspace	0.0051 (0.0057)
Severe health condition x Public greenspace	0.0281 (0.0504)
Year 12 or below x Public greenspace	0.0123*** (0.0042)
Unemployed x Public greenspace	0.0088 (0.0216)
Renter x Public greenspace	0.0013 (0.0058)
Rent free x Public greenspace	0.0011 (0.0097)
Medium rise x Public greenspace	−0.0045 (0.0070)

(continued)

Table A3. (Continued)

Interaction term	*Coefficient (S.E.)*
High rise x Public greenspace	0.0259** (0.0119)
Other dwelling x Public greenspace	−0.0315* (0.0174)
Hours worked (1st quartile) x Public greenspace	0.0136* (0.0070)
Hours worked (2nd quartile) x Public greenspace	−0.0052 (0.0067)
Hours worked (3rd quartile) x Public greenspace	−0.0075 (0.0064)
Hours worked (4th quartile) x Public greenspace	0.0154 (0.0075)
Summary statistics	
Number of observations	6156
Pseudo R^2	0.0730

Notes: *** significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level. These coefficient estimates cannot be interpreted as marginal effects.

Table A4. Public greenspace interaction results (marginal effects)

Interaction term	*Marginal effect (S.E.)*
Age (15–19) x Public greenspace	−0.0004 (0.0009)
Age (20–29) x Public greenspace	0.0006 (0.0004)
Age (40–49) x Public greenspace	−0.0007* (0.0004)
Age (50–59) x Public greenspace	−0.0005 (0.0007)
Age (60+) x Public greenspace	0.0003 (0.0007)
Male x Public greenspace	−0.0001 (0.0004)
ATSI x Public greenspace	−0.0008 (0.0017)
Immigrant English x Public greenspace	−0.0003 (0.0007)
Immigrant non-English x Public greenspace	−0.0010* (0.0006)
Children (0–4) x Public greenspace	−0.0007 (0.0006)
Children (5–14) x Public greenspace	−0.0004 (0.0004)
Children (15–24) x Public greenspace	−0.0008* (0.0005)
Children (25+) x Public greenspace	−0.0001 (0.0012)
Lone parent x Public greenspace	0.0013* (0.0008)
Mild health condition x Public greenspace	−0.0008 (0.0007)
Moderate health condition x Public greenspace	0.0002 (0.0004)
Severe health condition x Public greenspace	0.0082 (0.0023)
Year 12 or below x Public greenspace	0.0010*** (0.0004)
Unemployed x Public greenspace	0.0000 (0.0011)
Renter x Public greenspace	0.0001 (0.0004)
Rent free x Public greenspace	0.0011 (0.0008)
Medium rise x Public greenspace	−0.0002 (0.0005)
High rise x Public greenspace	0.0020** (0.0009)
Other dwelling x Public greenspace	−0.0015 (0.0010)
Hours worked (1st quartile) x Public greenspace	0.0009* (0.0005)
Hours worked (2nd quartile) x Public greenspace	−0.0004 (0.0004)
Hours worked (3rd quartile) x Public greenspace	−0.0002 (0.0004)
Hours worked (4th quartile) x Public greenspace	0.0004 (0.0004)
Summary statistics	
Number of observations	6156
Pseudo R^2	0.0730

Notes: *** significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level. The marginal effects can be interpreted as the probability of reporting a life satisfaction score of 10. For instance, on average for a 1 per cent increase in public greenspace, lone parents are 0.13 per cent more likely to report a life satisfaction score of 10.