AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

The influence of the natural environment and climate on life satisfaction in Australia

Christopher L. Ambrey[1] and Christopher M. Fleming[2]

A paper submitted for presentation at the 55th Annual AARES National Conference,

Melbourne 8-11 February 2011.

This paper uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) survey. The HILDA project was initiated and is funded by the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (FaHCSIA) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the authors and should not be attributed to either FaHCSIA or the Melbourne Institute.

[1] Department of Accounting, Finance and Economics, Gold Coast Campus, Griffith Business School, QLD 4222, Australia.

[2] Department of Accounting, Finance and Economics, Nathan Campus, Griffith Business School, QLD 4111, Australia. Corresponding Author: Phone +61 7 3735 7061, Fax +61 7 3735 7760, Email: chris.fleming@griffith.edu.au.

Abstract

The narrative of the twentieth century is dominated by three key trends: population growth, economic growth and urbanisation. Moreover, these trends are expected to continue well into the twenty-first century. Australia has not been immune to these trends. Australia's population is projected to increase by 65% to over 35 million by 2049, and be accompanied by an average growth in per-capita Gross Domestic Product of 1.5% per annum. Much of this population and economic growth will be concentrated in an already highly urbanised environment. As a consequence, the natural environment in which the majority of Australians live is likely to undergo rapid change. It is useful therefore, to better understand our relationship with this environment. Using data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, the Census of Population and Housing, and Geographic Information Systems (GIS), this paper examines the link between the natural environment and life satisfaction in Australia. The results indicate that certain natural environmental assets, such as national parks and the coastline are amenities, whereas creeks are disamenities. In regards to the influence of climate on life satisfaction, some unexpected results are found.

Keywords: Natural Environment; Climate; Geographic Information Systems (GIS); Life Satisfaction; Happiness; Household, Income and Labour Dynamics in Australia (HILDA).

JEL Classification: C21; I31; R10

1. Introduction

The narrative of the twentieth century is dominated by three key trends: population growth; economic growth; and urbanisation. These trends are expected to continue well into the twenty-first century. For example, at the beginning of the twentieth century the global population was just under 1.6 billion, by the beginning of the twenty-first century it was 6.6 billion, and by 2050 global population is expected to reach 9.2 billion. In terms of economic growth, between the early part of the twentieth century and 2001, income per-capita rose by almost 300 per cent from $1,525 to $6,049[3] and this level of growth is projected to continue (Sachs, 2008). In regards to urbanisation, it is estimated that over 50 per cent of the world's population now reside in urban areas and the United Nations (2010) projects that the world's urban areas will absorb all of the global population growth over the next four decades, while continuing to draw some of the rural population. Together these trends have shaped, and put unprecedented pressure on, the natural environment in which we live.

Australia has not been immune to these trends. Australia's population has grown from approximately 3.7 million in 1900 to over 22 million in 2010. This population is expected to increase by 65 per cent to over 35 million by 2049 and be accompanied by a growth in per-capita Gross Domestic Product of 1.5 per cent per annum (Commonwealth of Australia, 2010a). Much of this population and economic growth will be concentrated in an already highly urbanised environment and the 2010 Intergenerational Report (Commonwealth of Australia, 2010a) cites a number of pressure points originating from these past (and projected future) trends. These include increased greenhouse gas emissions, reduced biodiversity, reduced water availability, reduced urban amenity and increased infrastructure and government service requirements.

This paper seeks to improve our understanding of the link between the natural environment, climate and well-being, with the broader aim of hoping to inform public policy. Specifically, using data from the Household, Income and Labour Dynamics in Australia (HILDA) survey, the Australian Bureau of Statistics' (ABS) Census of Population and Housing, and Geographic Information Systems (GIS), this paper examines the link between

[3] Figures in 1990 international Geary-Khamis dollars.

various aspects of the natural environment and climate, and self-reported life satisfaction in Australia.

This paper builds on a small but growing body of literature and, with the exception of the influence of rainfall (previously investigated by Carroll et al. (2009)), to our knowledge is the first paper to examine the link between the natural environment and life satisfaction in an Australian context. The paper proceeds as follows. The remainder of Section 1 is devoted to discussing life satisfaction in economics, paying particular attention to previous findings regarding the influence of the natural environment and climate. Methodology is the subject of Section 2. Results are presented and discussed in Section 3. Section 4 concludes.

1.1. Life satisfaction in economics

Research into life satisfaction (or happiness) is increasingly the *foci* of a great deal of empirical investigation in economics. This research has been motivated, at least in part, by dissatisfaction with traditional means of measuring economic progress, as clearly evidenced by the findings of the Commission on the Measurement of Economic Performance and Social Progress (Stiglitz et al., 2008). This area of research also reflects a broader re-evaluation of the epistemological foundations of economic science, as seen in 2002 by Daniel Kahneman (a psychologist) and Vernon Smith (the pioneer of experimental economics) together being awarded the Nobel Prize in economic sciences.

At an individual level, the existing literature pays a great deal of attention to 'internal factors' that influence self-reported life satisfaction. That is, those factors directly related to the individual or the individual's household (cf. Blanchflower and Oswald, 2004a, b). In contrast, 'external factors', those that relate to the wider community in which the individual lives, have been explored to a much lesser extent. Potentially relevant external determinants include, but are not limited to, the unemployment rate, the level of crime, and the level of air and noise pollution. Despite this comparative lack of attention in the literature, the few existing studies suggest external determinants, in particular natural environments, have an important role in explaining an individual's life satisfaction (cf. Brereton et al., 2008; Luechinger, 2009, 2010; MacKerron, 2010; MacKerron and Mourato, 2009).

1.1.1. The natural environment, climate and life satisfaction

Several studies have found increased levels of air pollution, both actual and perceived, to have a negative impact on self-reported life satisfaction (cf. Luechinger, 2009, 2010; MacKerron, 2010; MacKerron and Mourato, 2009; Smyth et al., 2008). MacKerron (2010) also investigates the influence of the accessibility of green space on the life satisfaction of London residents, somewhat unexpectedly finding the relationship to be insignificant. In contrast, Smyth et al. (2008) find green area per capita to have a positive and significant impact on life satisfaction in urban China. Investigating another type of 'green' space, the beach, Brereton et al. (2008) find no significant relationship between distance to a beach and life satisfaction, whereas being close to the coast is found to have a positive impact.

Other authors have focused on the influence of the broader concept of natural capital (cf. Engelbrecht, 2009; Mulder et al., 2006; Vemuri and Costanza, 2006), all of which find it to be statistically significant and positive for subjective well-being, life satisfaction and quality of life.Furthermore, a study by Rehdanz (2007), recognising the benefits of natural capital, investigates species diversity and finds the higher a country's number of bird or mammal species, or the lower the percentage of bird species threatened, the more satisfied people are.

In regards to climate, across 67 countries it is found that people would prefer higher mean temperatures in the coldest month, lower temperatures in the hottest month, and that people living in regions with many dry months would prefer more precipitation (Rehdanz and Maddison, 2005). Reinforcing these findings, Brereton et al. (2008) find that comparatively moderate temperatures at times of extremes is positive for life satisfaction for residents of the Republic of Ireland. The authors also find that increased mean annual precipitation has a positive (although not significant) affect on life satisfaction, whereas wind speed and (unexpectedly) sunshine hours have a negative effect. In a study of Russian residents, Frijters and van Praag (1998) reveal that weather extremes are negative for well-being. Specifically, well-being is influenced negatively by harsh winters, but benefits from the number of sunshine hours, and that high levels of humidity together with high temperatures have a strong negative influence on well-being.

Using the Australian Unity Well-being Index, Carroll et al. (2009) estimate the cost of droughts by matching rainfall data with individual life satisfaction for Australia over the

period 2001 to 2004. The authors find that a spring drought has a detrimental effect on life satisfaction for rural residents, equivalent to an annual reduction in income of $A18 000.

Also looking at extreme weather events, Luechinger and Raschky (2009) investigate the valuation of flood disasters using the life satisfaction approach for 16 European countries between 1973 and 1998. The authors find a negative impact of floods on life satisfaction that is large, robust and significant. Kimball et al. (2006) look at the influence of Hurricane Katrina on reported life satisfaction over time. The results indicate that Hurricane Katrina significantly reduced reported happiness; the effect being most pronounced for the South Central region closest to Katrina. However, there was rapid adaptation, with reported happiness returning to normal after two weeks in the rest of the country and within three weeks in the South Central region. In a similar study, Smyth et al. (2008) finds that the number of environmental disasters is highly significant and negative for well-being in urban China.

2. Method

Following the general approach taken by Brereton et al. (2008), two models are developed. The first (Model 1) contains only internal variables that are thought to influence an individual's life satisfaction. The second (Model 2) includes both internal and external variables, and as such will augment Model 1 with spatial data extracted using GIS as well as ABS Census data. Model 1 takes the form of an indirect utility function for individual *i* in location *k* as follows:

$$U_{i,k} = \alpha + \beta x_{i.k} + \varepsilon_{i.k} \qquad i = 1 \dots I, k = 1 \dots K \tag{1}$$

Where x is a vector of socio-economic and demographic characteristics including age, income, marital status, employment status and education. In the microeconometric function the individual's true utility is unobservable; hence self-reported life satisfaction is used as a proxy. And for Model 2:

$$U_{i,k} = \alpha + \beta x_{i.k} + \gamma a_{i,k} + \varepsilon_{i.k} \tag{2}$$

Where a is a vector of spatial factors (some of which may vary at an individual level) and x is defined as for Model 1.

2.1. Model 1

The measure of self-reported life satisfaction and the various internal socio-economic and demographic characteristics are obtained from the HILDA survey. The HILDA survey was conceived by the Australian Government Department of Families, Housing, Community Services and Indigenous Affairs and was developed with the aim of supporting research and policy questions within the areas of: family and household dynamics; income and welfare dynamics; and labour market dynamics (Wooden and Watson, 2007). First conducted in 2001, by international standards the HILDA survey is a relatively new nationally representative sample and owes much to other household panel studies conducted elsewhere in the world; particularly the German Socio-Economic Panel and the British Household Panel Survey. For a review of household panel datasets throughout the world, see Haisken-DeNew (2001) and for a recent review of progress and future developments of the HILDA survey see Watson and Wooden (2010).

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).

Behind the answers to happiness or life satisfaction questions lies a cognitive assessment of to what extent the respondent's overall quality of life is judged in a favourable way (Veenhoven, 1993). Schwarz and Strack (1991) point out that these judgements by the individual are often partially dependent on transient influences, such as one's mood. Hence, these self-reported measures of life satisfaction are sometimes designated 'avowed' or 'reported' life satisfaction to infer that they may not reflect the true state of a respondent's feelings (Easterlin, 1974).

While not without its critics (cf. Smith, 2008), there is much evidence to support the objectivity and comparability of individual's responses to life satisfaction questions, with individual self-reports of life satisfaction (or happiness) being highly correlated with reports by others, as well as with physical measurements of brain electro-encephelograms (EEGs) and smiling behaviour (Diener and Suh, 2000). The literature also finds support in evidence of happy people being rated as such by family, friends and spouses (Costa and McCrae,

1988; Lepper, 1998; Sandvik et al., 1993). Reliability studies indicate that measurements of life satisfaction are stable and sensitive to life events (Sandvik et al., 1993). Consistency tests reveal happy people smile more often during social interactions (Fernandez-Dols and Ruiz-Belda, 1995) and are less likely to commit suicide (Koivumaa-Honkanen et al., 2001). In all, according to Ng (2008), despite the many conceptual and measurement issues, there are persuasive arguments that existing measures of life satisfaction, though imperfect, are rather reliable.

The inclusion of internal explanatory variables was guided by the existing literature, data availability, and assisted to a limited degree by SAS model selection tools. One estimation issue, identified by Ferrer-i-Carbonell and Frijters (2004) is that the treatment of time-invariant unobserved factors is critical to the validity of results. Specifically, the error term captures measurement errors as well as unobserved characteristics. Thus, results can be obscured by personality traits that aren't taken into account (Bertrand and Mullainathan, 2001; Ravallion and Lokshin, 2001). It is possible however for idiosyncratic effects, such as those caused by personality traits, to be controlled for if the same individuals are resurveyed over time, that is, if they are taken to be time-invariant (Ferrer-i-Carbonell and Frijters, 2004; Frijters et al., 2006; Frijters et al., 2004a, b).

To control for personality traits, this paper opts for a more parsimonious approach, employing a cross section of the HILDA data, Wave 5. Extending the efforts of Shields et al. (2009) and Gray et al. (2010) an attempt is made to capture the heterogeneity that arises from differences in personality through the inclusion of additional variables, namely: extraversion; agreeableness; conscientiousness; emotional stability; and openness to experience, the so-called taxonomic 'Big Five' (Saucier, 1994). Finally, social desirability bias is also controlled for by the inclusion of a variable indicating whether or not the individual was interviewed in the presence of another person, similar to Shields and Wooden (2003); Shields et al. (2009); and Wooden et al (2009). All Model 1 explanatory variables are summarised in Table 1.

[Insert Table 1 here]

2.2. Model 2

As noted above, Model 2 extends Model 1 through the inclusion of variables that are external to the individual or their household, yet are posited to potentially influence the individual's self-reported life satisfaction. Specifically, variables relating to the natural environment and climate are added. One such variable is the ABS' Accessibility/Remoteness Index of Australia (ARIA), for which a dummy variable takes the value 1 if the respondent resides in a major city and 0 if they do not. The objective of including a major city dummy variable is to control for heterogeneous factors unique to major cities that are not accounted for by the other spatial variables included in the model.

The first of these other spatial variables is calculated by extracting the extent of national park within a respondent's Statistical Local Area (SLA)[4] using ArcGIS and then dividing this area by the population of the SLA, thus yielding the extent of national park per capita.[5] The straight line distance from the centroid of the CD in which the respondent resides to the nearest urban park, river, lake and creek are also extracted from GIS using the Euclidean Distance geo-processing tool. Using the same tool, however employing a dummy variable, a respondent is deemed to live on the coast if the centroid of the CD in which they reside is less than one kilometre from the coast.

In regards to climate, the annual mean rainfall, annual mean maximum temperature and annual mean minimum temperature of the SLA in which the respondent resides are also calculated using GIS. The data, supplied in raster datasets, are processed and converted into vector format to arrive at a spatially weighted value for each SLA. The number of sunshine hours per day experienced by the respondent's SLA is extracted in a similar manner.

The computation of the annual mean wind speed (measured in kilometres per hour) proved to be particularly time and labour intensive. The Australian daily wind data consisted of data from approximately 1,740 weather stations across Australia, of which 829 contained data

[4] The SLA is the spatial base unit used to collect and disseminate statistics other than those collected from the Population Censuses. In non-Census years, the SLA is the smallest unit defined in the Australian Standard Geographical Classification. In aggregate SLAs cover the whole of Australia. Australian Bureau of Statistics, 2010. Australian Standard Geographical Classification, Catalogue No. 1216.0, Canberra.

[5] Due to changes in boundaries between the 2001 Census and the 2006 Census, a concordance file is used when calculating spatial variables containing ABS Census data. For further details see: Australian Bureau of Statistics, 2007b. Australian Standard Geographical Classification Concordances, Catalogue No. 1216.0.15.002, Canberra.

over the relevant period. Each station contained daily wind measurements, generally in kilometres per hour. These daily measurements were averages of three hourly wind observations taken throughout the day. Where the data were available and not impaired, these daily values were used to obtain a mean annual wind speed for that weather station. These values were then mapped to GIS using the longitude and latitude of the weather stations. All external (i.e. additional) Model 2 explanatory variables are summarised in Table 2.

[Insert Table 2 here]

3. Results

Two techniques are employed in model estimation, ordinary least squares (OLS) and ordered probit estimated by maximum likelihood estimation. This is similar to the estimation strategies employed by Brereton et al. (2008), Shields et al. (2009) and Smyth et al. (2008). Other estimation options include the binary probit or logit models (cf. Winklemann and Winklemann, 1998) and the ordered logit model (cf. MacKerron and Mourato, 2009).

In terms of evaluating the appropriateness of the estimation strategy, it is important to consider whether life satisfaction self-reports are assumed to be ordinal or cardinal. If assumed to be cardinal, then the coefficients obtained via OLS are biased and inconsistent, in which case the use of an ordered probit model is more appropriate (Hill et al., 2008). However, many authors (cf. 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 ordered probit) or treats the responses as cardinal (implied by the use of OLS).

Due to the HILDA survey's sampling methodology, where individuals are drawn from clusters at the collection district (CD)[6] level, as well as the fact that Model 2 includes regressors at various spatial levels (individual, household, CD and SLA), cluster-adjusted standard errors are reported. For Model 1, standard errors are adjusted at the CD level, as per Hayes (2008). For Model 2, standard errors are adjusted at the SLA level, the highest

[6] The CD is the smallest spatial unit in the Australian Standard Geographical Classification. CDs aggregate to form the larger spatial units of SLAs. By design, CD boundaries do not cross SLA boundaries. Australian Bureau of Statistics, 2010. Australian Standard Geographical Classification, Catalogue No. 1216.0, Canberra.

level at which intra-cluster correlation in errors may be a problem (Nichols and Schaffer, 2007).

3.1. Model 1 results

The estimated results for Model 1 are presented in Table 3. For ease of interpretation and comparability with other studies, results from the OLS estimation are presented and discussed throughout. Where these results are substantially different to those obtained through estimation by ordered probit, the differences are noted and commented upon. The ordered probit results are presented in Appendix A.

Model 1's overall explanatory power, as measured by an adjusted R^2 of 0.1704, compares favourably with the existing cross-sectional models in the literature and even to some longitudinal models using many years of data and personality trait controls (cf. Schurer and Yong, 2010; Shields et al., 2009). Moreover, most explanatory variables are found to be significant at the one per cent level.

The fact that the explanatory power of this model exceeds that of models reported in previous studies that do not explicitly employ personality trait controls, and comes closer to the explanatory power of studies employing the random, or more frequently, fixed effects estimators, suggests the personality trait variables are explaining some of the previously unobserved heterogeneity.

3.1.1. Age, gender and ethnicity

Looking first at age, as expected, the results suggest life satisfaction is 'U' shaped in age, as is consistent with much of the literature (cf. Blanchflower and Oswald, 2004a, b, 2008, 2009). Specifically, life satisfaction reaches a minimum at the age of 38, as shown in Figure 1.

[Insert Figure 1 here]

Somewhat surprisingly, males are found to be more satisfied with their lives than females. This is in contrast to much of the literature, however is consistent with recent findings that female life satisfaction has deteriorated over time (Blanchflower and Oswald, 2004b). As also reported by Shields et al. (2009), respondents of Aboriginal and/or Torres Strait Islander origin are found to be more satisfied with their lives than the general population. In all

instances, in this research and that of Shields et al. (2009) these results differ by gender, with women experiencing effects of a lower magnitude and level of significance.[7] One could speculate that this is a case of Aboriginal and/or Torres Strait Islanders having lower expectations than non-Aboriginal or Torres Strait Islanders, perhaps because they maintain different social reference or comparison group. The OLS coefficient is quite large (0.2256). While this result is consistent with previous life satisfaction studies (cf. Shields et al., 2009; Shields and Wooden, 2003), it is at odds with existing Australian research relating to the mental health and psychological distress of indigenous Australians (cf. Brown, 2001). Thus, this finding could benefit from further investigation.

No statistically significant difference is found between immigrants from English speaking countries and native born, whereas, even after controlling for those with poor English speaking skills (who themselves report lower levels of life satisfaction), immigrants from non-English speaking countries are found to be significantly less satisfied than native born. Again this result is generally consistent with the findings of Shields and Wooden (2003) and Shields et al. (2009).

3.1.2. Marital status and children

In terms of marital status, marriage is found to have the highest positive effect on life satisfaction and being in a defacto relationship, the second highest positive effect. These results are consistent with *a priori* expectations and the literature (cf. Shields et al., 2009; Shields and Wooden, 2003). On the other hand, being separated is found to have a strong negative effect on a person's life satisfaction, the most pronounced negative effect of the marital status variables, followed by being divorced.

With regards to being a widow, the results indicate that this does not impact the life satisfaction of the individual. Again this is a result that accords with the findings of the literature (cf. Shields et al., 2009; Shields and Wooden, 2003). Evans and Kelley (2004) attribute this to the fact that there were no broken promises, unlike with separation or divorce. On the whole, these findings for marital status variables reflect the vulnerability and fragility of Aristotle's *relational goods* that are considered to be essential for the 'good life' (Nussbaum, 1986).

[7] The results of gender-specific models are available on request from the authors.

As is found by many authors (cf. Brereton et al., 2008; Margolis and Myrskyla, 2010; Shields et al., 2009; Shields and Wooden, 2003) a larger number of resident children in a household lowers a respondent's life satisfaction. It is worth noting that this result differs by gender, with females being more acutely adversely impacted than males.

3.1.3. Health and education

Having a long-term health condition, whether it is severe, moderate or mild, is associated with lower levels of life satisfaction, with the greatest impact felt by those with a severe health condition. This result is unequivocally consistent with the literature (cf. Shields et al., 2009; Wooden et al., 2009) and reaffirms the validity of life satisfaction as a measure of well-being.

With regards to education, having obtained a certificate or diploma, or a Bachelors degree or higher are both associated with a lower level of life satisfaction than having only obtained an education up to Year 11. These results are consistent with the literature (cf. Clark and Oswald, 1996; Hartog and Oosterbeek, 1998; Shields et al., 2009; Veenhoven, 1996). In unreported results, the transmission of the benefits of education is examined; Model 1 is estimated without income controls, revealing marginal attenuation of the negative effect of education, suggesting that education bears life satisfaction benefits in terms of income, although these are not great. One could conjecture that higher education, and even higher income, leads to a 'tyranny of choice' (cf. Irons and Hepburn, 2007; Iyengar et al., 2006; Schwartz, 2000; Schwartz et al., 2002) whereby utility is reduced by knowledge of opportunities foregone and/or that the number of choices available leads to less optimal decisions.

3.1.4. Employment and income

In terms of employment, being unemployed is found to be associated with lower life satisfaction than being employed full-time, although the result is not found to be significant in the ordered probit model. As most previous studies (cf. Ferrer-i-Carbonell and Frijters, 2004) have shown OLS and order probit estimation to yield consistent estimates, this result is unexpected. Undoubtedly the negative effect of unemployment on life satisfaction is a common finding (cf. Carroll, 2007; Headey and Wooden, 2004; Winklemann and Winklemann, 1998). In contrast to being unemployed, being employed part-time, retired,

undertaking home duties or being a student are all associated with higher levels of life satisfaction than working full-time.

Interestingly, being engaged in home duties is found to have a positive effect on life satisfaction. This positive coefficient suggests that home duties are only undertaken by choice, contingent upon a sufficient level of financial stability and satisfaction with current levels of material well-being. The ability and decision to make this choice leads to higher levels of life satisfaction than for those who are unable to make this choice due to for example, the need to remain in the labour force to maintain a material level of comfort. However, in unreported results, the coefficient and level of significance is starkly different for males compared to females, with females experiencing statistically significant higher levels of life satisfaction. Although, this could also demonstrate Biernat and Wortman's (1991) observation that the redistribution of roles outside of the home falls short of match the sharing of roles outside the home, despite women being satisfied with their husband's home involvement. From this it could be inferred that perhaps society and the individual are more comfortable with, or conform more easily to, traditional gender roles. This could be examined more thoroughly from a constructivist point of view.

It is interesting to note that being a non-working student exhibits positive effects on life satisfaction, suggesting some procedural utility (utility associated with the activity) is yielded from the process of study and/or benefits of social interactions. Despite this, as previously noted, increasingly highly educated individuals experience lower life satisfaction.

The estimated coefficient for being a non-participant in the labour market is positive but not significant in the OLS model, whereas it is positive and significant at the 5 per cent level in the ordered probit model. This result is not greatly different to findings of existing studies. As expected, higher levels of disposable income are found to be associated with higher levels of life satisfaction; this is consistent with the results of other studies (cf. Frijters et al., 2006; Frijters et al., 2004a, b). To economists it is often surprising to see the comparatively small coefficient of income on life satisfaction (0.0472); in this case, this is partially a result of the natural log transformation of the income variable.

3.1.5. Personality traits

The use of the personality trait variables in Model 1 increases explanatory power by 66 per cent in the OLS model. To see the role of personality traits in estimating the internal determinants of life satisfaction, consider the example of the income variable. The OLS coefficient for income with personality trait controls is 0.0472, compared to 0.0544 when personality trait controls are not included, both significant at the one per cent level. Thus, the inclusion of personality traits reduces the impact of income on life satisfaction. A possible explanation for this effect is that being extroverted or conscientious leads to higher income and directly controlling for this reduces the income coefficient.

Similarly, for unemployment the OLS coefficient without personality trait controls is -0.2771 and with personality trait controls -0.1996, both significant at the one per cent level. So again, the inclusion of personality traits reduces the impact of unemployment on life satisfaction. This finding reinforces Carroll's (2007) observation that time-invariant unobservable heterogeneous factors are correlated with lower life satisfaction and unemployment.

The results show that the Big Five personality trait variables are all statistically significant at the one per cent level, with higher degrees of extraversion, agreeableness, conscientious and emotional stability all associated with higher levels of life satisfaction. In contrast, openness to experience is found to have a negative impact on life satisfaction. These results are consistent with Schurer and Yong (2010) and are in keeping with the findings of DeNeve and Cooper (1998) and De Neve et al. (2010). Finally, there is some evidence of social desirability bias, with others being present during the interview having a positive and significant effect on self-reported life satisfaction, a result consistent with the findings of Shields and Wooden (2003); Shields et al. (2009); and Wooden et al. (2009).

[Insert Table 3 here]

3.2. Model 2 results

The inclusion of natural environment and climate variables leads to a modest improvement in the model's explanatory power, with Model 2 achieving an adjusted R^2 of 0.1748 compared to Model 1's 0.1704. This contrasts with Brereton et al. (2008) who find a substantial improvement in the explanatory power of the happiness function with the

inclusion of similar external variables. Nonetheless, Model 2's results indicate many factors to be significant explanatory variables for life satisfaction (see Table 4).

3.2.1. Impact on internal (Model 1) results

Looking first at the variables consistent to both models; having poor English speaking skills, being an immigrant from a non-English speaking country, being in a defacto relationship and others being present during the interview are all marginally less significant with the inclusion of external variables. Thus it appears that geographic location provides some moderating effects for these variables on life satisfaction. That is, where people live has an impact on life satisfaction and reduces the negative effects of having poor English speaking skills and being an immigrant from a non-English speaking country. Inclusion of the external variables also reduces the significance of being in a defacto relationship and another person or persons being present during the interview. While outside the scope of this study, these results deserve further investigation.

3.2.2. Living in a major city

Living in a major city is found to have a negative influence on life satisfaction, significant at a one per cent level. This is consistent with previous findings in the literature (cf. Brereton et al., 2008; Smyth et al., 2008). When *only* the major city variable is added to Model 1, it enters with a larger coefficient than when it is included alongside all of the other external explanatory variables. This suggests that the additional external variables included in Model 2 explain some of the unique aspects peculiar to major cities. However, as the major city variable remains statistically significant, it appears more remains to be explained. This presents an opportunity for further research.

3.2.3. Climate and the natural environment

The extent of national park per person within a respondent's local area is found to have a positive and significant impact on life satisfaction. This variable synthesises the influence of both extent and proximity, factors that have been proven to influence the use of green space (Schipperijn et al., 2010). The result demonstrates the importance of national parks to life satisfaction, something that becomes increasingly valuable as population increases. This result is consistent with Smyth et al. (2008) who employ a more aggregated 'green area per capita'. Furthermore, this is also consistent with the spatial planning literature, where there

is a great deal of evidence that green space produces positive externalities for both health and well-being (cf. Croucher et al., 2008).

As illustrated in Figure 2, the relationship between life satisfaction and distance to an urban park is found to take an inverted 'U' shape. Crompton (2001) summarises similar findings in the hedonic pricing literature, namely that the benefits associated with proximity and accessibility decay as distance increases, as do nuisance factors (which are most pronounced for houses in close proximity to parks). This quadratic functional form is unique to the distance to urban park variable and did not appear in other distance variables.

[Insert Figure 2 here]

Exploring the effects of living on the coast, the results indicate that this has a positive influence on life satisfaction, a result consistent with intuition and other studies (cf. Brereton et al., 2008). Distance to the nearest river is negative and significant at the 10 per cent level. This suggests living closer to a river has a positive effect on life satisfaction, whereas living closer to a lake is found to have no significant, impact on life satisfaction, although again the coefficient is negative. These welfare effect accord with evidence from the hedonic pricing literature (cf. Sander and Polasky, 2009), which demonstrates that being closer to lakes and streams increases house prices. In contrast, living close to a creek has a negative impact on life satisfaction. This could be attributed to the flood risk posed by creeks. While the influence of creeks specifically has not been explored in happiness studies, Bin and Polasky (2004), in another hedonic study, investigate the effects of flood hazards on property values and find that when flood hazards are controlled for, creeks are an amenity and increase property values. However, when flood hazard controls are removed, creeks become a disamenity, reducing property values.

In regards to climate, while most variables are found to be significant, rainfall and wind speed are not, although in both cases the coefficient is positive. For rainfall, Brereton et al. (2008) similarly find a positive yet not significant result, suggesting that increased rainfall slightly increases life satisfaction; a result the authors explain by reasoning that higher precipitation is correlated with scenic beauty. In further support of the view that rainfall is positive for life satisfaction, Rehdanz and Maddison (2005) find people living in areas with many dry months would prefer more precipitation and, as previously mentioned, Carroll et

al (2009) find that spring droughts are detrimental to the life satisfaction of people in rural areas.

With regards to wind speed, the results are in contrast to much of the literature (cf. Brereton et al., 2008; Frijters and van Praag, 1998; Moro et al., 2008) in that we find a positive effect for wind on life satisfaction. A candidate explanation for these results is that negative effects of wind are offset by enhanced visual amenity and that, in summer at least, the cooling effect of wind is an amenity in Australia.

Mean annual maximum temperature is found to be positive and significant at the five per cent level, suggesting higher mean maximum temperatures increase life satisfaction. In somewhat of a contradiction, the coefficient for mean annual minimum temperature is negative and significant, suggesting lower average minimum temperatures also increase life satisfaction. One possible explanation is that people prefer some seasonal variation over the span of a calendar year, as opposed to relatively constant temperature. While these results are not directly comparable to the existing literature, given the wide diversity of the Australian climate, further investigation of this result at a more localised level is perhaps warranted.

Examining the influence of sunshine hours on life satisfaction, increased sunshine hours are found to be associated with lower levels of life satisfaction. This is consistent with the result found by Brereton et al. (2008), who posit that this may be driven by the correlation between elements of rainfall not captured in the data (e.g. intensity and frequency) and sunshine.

[Insert Table 4 here]

4. Discussion

This paper sits within the context of a significant spatial planning challenge to accommodate a growing, and increasingly urbanised, population. Specifically, the paper has investigated how the natural environment and climate influences life satisfaction in Australia. While these results are not without their limitations, they inform the existing literature and, it is hoped, public policy.

Broadly speaking, while the inclusion of external variables leads to only a modest improvement in the model's explanatory power, many of the coefficients associated with

the natural environment and climate are statistically significant. The fact that external effects persist, suggests models of choice that assume rationality and efficiency of markets are deficient. For example, if people 'vote with their feet' (Tiebout, 1956) and move to areas of higher environmental quality, this should, according to the locational equilibrium model, be reflected in house prices, rents and wages (Roback, 1982; Rosen, 1979) and hence not translate into impacts on life satisfaction.

Moreover, it is highly likely that these effects are enduring in nature, with 2006 Census data indicating that more than half of responding individuals resided in the same address as five years previously (Australian Bureau of Statistics, 2007a). Additionally, more than 80 per cent of respondents to the HILDA survey resided in the same residence as one year ago. While adaptation of an individual to their local surrounds presents an area for further research, *prima facie*, it could be expected that, even after adaptation, these significant external effects prove durable.

In terms of specific results, beginning with Model 1, confirmatory evidence of the existing literature is provided, reinforcing the importance of the internal drivers of life satisfaction. Some of the statistically significant results that provoke further inquiry include findings that: respondents of Aboriginal and/or Torres Strait Islander origin are found to be more satisfied with their lives than other respondents; and immigrants from non-English speaking countries are found to be significantly less satisfied with their lives, even after controlling for English speaking ability.

Education is another area of interest. The results reveal that students are significantly more satisfied with their lives than respondents in other employment status categories. Despite this, increasingly high educational attainment results in a statistically significant reduction in life satisfaction, a result robust to the exclusion of income from the happiness function. This suggests that the benefits of education flowing through income to impact on life satisfaction are minor.

It is worth noting the substantial improvement in explanatory power provided by the inclusion of the Big Five personality trait variables. It is also worth pointing out the impact of these personality traits on the unemployment and income variables. The inclusion of the personality trait variables reduced the OLS unemployment coefficient by 28 per cent and

the OLS income coefficient by 13 per cent. In short, these results provide a strong case for the inclusion of the Big Five personality trait controls in subsequent research.

With regards to Model 2, the results suggest natural environmental factors along with climate, moderate to some degree the reduced life satisfaction of respondents having poor English speaking skills and being an immigrant from a non-English speaking country. The fact that the coefficient for the specific major city variable, which can be considered a dummy variable encapsulating numerous factors unique to living in a major city, remains statistically significant and negative, suggests that other factors, particularly disamenities, have not yet been investigated. Nonetheless, a number of telling relationships between various external variables and life satisfaction were found.

The extent and proximity of national parks, relative to the population, is found to be positive and statistically significant for the life satisfaction of individuals in the area. The policy implications that follow from this per capita measure, given that Australia has been forecast to experience significant population growth, are that, in order to maintain well-being, it is essential that there be concomitant growth in the extent of national park in the vicinity of population centres.

Furthermore, observing the negative influence on life satisfaction resulting from being further from an urban park, it follows that urban green space similarly needs to be preserved and considered if welfare is to be at least maintained. The inverted quadratic relationship found between life satisfaction and urban parks reaffirms evidence in the hedonic pricing literature that parks provide positive and negative externalities. For households in close proximity to parks, the negative effects are most prominent, although with distance these effects decay and the benefits of accessibility take prominence until distance is such that accessibility benefits disappear.

Consistent with intuition, living in close proximity to the coast is positive and statistically significant for life satisfaction. Similar, but less robust results are found for living close to a river. These findings illustrate the desirability of living near the coast or near a river and hence also the need to preserve these factors directly and indirectly contributing to well-being. All of the results relating to the natural environment inform policy, as existing policy documents, for example the 2010 Intergenerational Report (Commonwealth of Australia,

2010a) and the State of the Australian Cities Report (Commonwealth of Australia, 2010b) have little to say on these matters.

With regards to the influence of climate variables on life satisfaction, it appears that rainfall does not significantly influence life satisfaction, Australians prefer some seasonal variation in temperature over the calendar year, and have a preference for fewer hours of sunshine. While it is difficult to draw any firm policy conclusions from these results, given the influence of increased urbanisation on the surrounding climate, as well as the impact of anthropogenic climate change, this is perhaps an area worthy of further investigation.

Acknowledgements

We thank Griffith University Business School for the Griffith Business School Honours Scholarship funding which was instrumental in facilitating this research. Additionally, this research would not have been possible without the data provided by NAVIGATE Pty Ltd, the Australian Bureau of Meteorology and Australian Bureau of Statistics.

References

Australian Bureau of Statistics, 2007a. 2006 Census of Population and Housing: Quick Stats, Canberra.

Australian Bureau of Statistics, 2007b. Australian Standard Geographical Classification Concordances, Catalogue No. 1216.0.15.002, Canberra.

Australian Bureau of Statistics, 2010. Australian Standard Geographical Classification, Catalogue No. 1216.0, Canberra.

Bertrand, M., Mullainathan, S., 2001. Do people mean what they say? Implications for subjective survey data. The American Economic Review 91, 67-72.

Biernat, M., Wortman, C., 1991. Sharing of home responsibilties between professionally employed women and their husbands. Journal of Personality and Social Psychology 60, 844-860.

Bin, O., Polasky, S., 2004. Effects of flood hazards on property values: Evidence before and after Hurricane Floyd. Land Economics 80, 490-500.

Blanchflower, D., Oswald, A., 2004a. Money, sex and happiness: An empirical study. Scandinavian Journal of Economics 106, 393-415.

Blanchflower, D., Oswald, A., 2004b. Well-being over time in Britain and the USA. Journal of Public Economics 88, 1359-1386.

Blanchflower, D., Oswald, A., 2008. Hypertension and happiness across nations. Journal of Health Economics 27, 218-233.

Blanchflower, D., Oswald, A., 2009. The U-shape without controls: A response to Glenn. Social Science & Medicine 69, 486-488.

Brereton, F., Clinch, J., Ferreira, S., 2008. Happiness, geography and the environment. Ecological Economics 65, 386-396.

Brown, R., 2001. Australian indigenous mental health. Australian and New Zealand Journal of Mental Health Nursing 10, 33-41.

Carroll, N., 2007. Unemployment and psychological well-being. The Economic Record 83, 287-302.

Carroll, N., Frijters, P., Shields, M., 2009. Quantifying the costs of drought: New evidence from life satisfaction data. Journal of Population Economics 22, 445-461.

Clark, A., Oswald, A., 1996. Satisfaction and comparison income. Journal of Public Economics 61, 359-381.

Commonwealth of Australia, 2010a. Australia to 2050: Future Challenges - the 2010 Intergenerational Report, Canberra.

Commonwealth of Australia, 2010b. State of Australian Cities 2010, Infrastructure Australia: Major Cities Unit, Canberra.

Costa, P., McCrae, R., 1988. Personality in adulthood: A six-year longitudinal study of self-reports and spouse ratings on the NEO personality inventory. Journal of Personality and Social Psychology 54, 853-563.

Crompton, J., 2001. The impact of parks on property values: A review of the empirical evidence. Journal of Leisure Research 33, 1-31.

Croucher, K., Myers, L., Bretheron, J., 2008. The links between greenspace and health: A critical literature review, Greenspace Scotland Research Report, Stirling.

De Neve, J., Fowler, J., Frey, B., 2010. Genes, economics and happiness, CESifo Working Paper No. 2946, Munich.

DeNeve, K., Cooper, H., 1998. The happy personality: A meta-analysis of 137 personality traits and subjective well-being. Psychological Bulletin 124, 197-229.

Diener, E., Suh, E., 2000. Subjective Well-being Across Cultures. MIT Press, Cambridge, MA.

Easterlin, R., 1974. Does economic growth improve the human lot? Some empirical evidence, in: David, P., Redler, M. (Eds.), Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz. Academic Press, New York, pp. 89-125.

Engelbrecht, H., 2009. Natural capital, subjective well-being, and the new welfare economics of sustainability: Some evidence from cross-country regressions. Ecological Economics 69, 380-388.

Evans, M., Kelley, J., 2004. Effect of family structure on life satisfaction: Australian evidence. Social Indicators Research 69, 303-349.

Fernandez-Dols, J., Ruiz-Belda, M., 1995. Are smiles a sign of happiness? Gold medal winners at the Olympic games. Journal of Personality and Social Psychology 69, 1113-1119.

Ferrer-i-Carbonell, A., Frijters, P., 2004. How important is methodology for the estimates of the determinants of happiness? The Economic Journal 114, 641-659.

Frijters, P., Geishecker, I., Haisken-DeNew, J., Shields, M., 2006. Can the large swings in Russian life satisfaction be explained by the ups and downs in real incomes? Scandinavian Journal of Economics 108, 433-458.

Frijters, P., Haisken-DeNew, J., Shields, M., 2004a. Investigating the patterns and determinants of life satisfaction in Germany following reunification. The Journal of Human Resources 39, 649-674.

Frijters, P., Haisken-DeNew, J., Shields, M., 2004b. Money does matter! Evidence from increasing real income and life satisfaction in East Germany following reunification. American Economic Review 94, 730-740.

Frijters, P., van Praag, B., 1998. The effects of climate on welfare and well-being in Russia. Climatic Change 39, 61-81.

Gray, M., de Vaus, D., Qu, L., Stanton, D., 2010. Divorce and the wellbeing of older Australians, Research Paper No. 46. Australian Institute of Family Studies, Canberra.

Haisken-DeNew, J., 2001. A hitchhiker's guide to the world's household panel data sets. The Australian Economic Review 34, 356-366.

Hartog, J., Oosterbeek, H., 1998. Health, wealth and happiness: Why pursue a higher education? Economics of Education Review 17, 245-265.

Hayes, C., 2008. HILDA standard errors: User guide, HILDA Project Technical Paper Series, Melbourne Institute of Applied Economic and Social Research, Melbourne.

Headey, B., Wooden, M., 2004. The effects of wealth and income on subjective well-being and ill-being. The Economic Record 80, s24-s33.

Hill, R., Griffiths, W., Lim, G., 2008. Principles of Econometrics, third ed. John Wiley & Sons, New Jersey.

Irons, B., Hepburn, C., 2007. Regret theory and the tyranny of choice. Economic Record 83, 191-203.

Iyengar, S., Wells, R., Schwartz, B., 2006. Doing better but feeling worse: Looking for the "best" job undermines satisfaction. Psychological Science 17, 143-150.

Kimball, M., Levy, H., Ohtake, F., Tsutsui, Y., 2006. Unhappiness after Hurricane Katrina, Working Paper No. 12062. National Bureau of Economic Research, Cambridge, MA.

Koivumaa-Honkanen, H., Honkanen, R., Viinamaki, H., Heikkila, K., Kaprio, J., Koskenvuo, M., 2001. Life satisfaction and suicide: A 20-year follow-up study. American Journal of Psychiatry 158, 433-439.

Lepper, H., 1998. Use of other-reports to validate subjective well-being measures. Social Indicators Research 44, 367-379.

Luechinger, S., 2009. Valuing air quality using the life satisfaction approach. The Economic Journal 119, 482-515.

Luechinger, S., 2010. Life satisfaction and transboundary air pollution. Economic Letters 107, 4-6.

Luechinger, S., Raschky, P., 2009. Valuing flood disasters using the life satisfaction approach. Journal of Public Economics 93, 620-633.

MacKerron, G., 2010. Mean streets, green streets: Valuing urban environmental quality with spatial subjective wellbeing data, Sire Workshop on Well-being, Happiness and the Environment, University of Stirling.

MacKerron, G., Mourato, S., 2009. Life satisfaction and air quality in London. Ecological Economics 68, 1441-1453.

Margolis, R., Myrskyla, M., 2010. A global perspective on happiness and fertility, Working Paper No. 2010-025. Max Plank Institute for Demographic Research, Rostock.

Moro, M., Brereton, F., Ferreira, S., Clinch, J., 2008. Ranking quality of life using subjective well-being data. Ecological Economics 65, 448-460.

Mulder, K., Costanza, R., Erickson, J., 2006. The contribution of built, human, social and natural capital to quality of life in intentional and unintentional communities. Ecological Economics 59, 13-23.

Ng, Y., 2008. Happiness studies: Ways to improve comparability and some public policy implications. The Economic Record 84, 253-266.

Nichols, A., Schaffer, M., 2007. Clustered errors in Stata, Paper Presented at the United Kingdom Stata Users' Group Meeting, September 2007, London.

Nussbaum, M., 1986. The Fragility of Goodness: Luck and Ethics in Greek Tragedy and Philosophy. Cambridge University Press, Cambridge.

Ravallion, M., Lokshin, M., 2001. Identifying welfare effects from subjective questions. Economica 68, 335-357.

Rehdanz, K., 2007. Species diversity and human well-being: A spatial econometric approach, Working Paper No. FNU-151. Hamburg University Centre for Marine and Atmospheric Science, Hamburg.

Rehdanz, K., Maddison, D., 2005. Climate and happiness. Ecological Economics 52, 111-125.

Roback, J., 1982. Wages, rents, and the quality of life. Journal of Political Economy 90, 1257-1278.

Rosen, S., 1979. Wages-based indexes of urban quality of life, in: Mieszkowski, P., Straszheim, M. (Eds.), Current Issues in Urban Economics. John Hopkins University Press, Baltimore, pp. 74-104.

Sachs, J., 2008. Common wealth: Economics for a crowded planet. Penguin, New York.

Sander, H., Polasky, S., 2009. The value of views and open space: Estimates from a hedonic pricing model for Ramsey County, Minnesota, USA. Land Use Policy 26, 837-845.

Sandvik, E., Diener, E., Seidlitz, L., 1993. Subjective well-being: The convergence and stablity of self-report and non-self-report measures. Journal of Personality 61, 317-342.

Saucier, G., 1994. Mini-markers: A brief version of Goldberg's unipolar Big-Five markers. Journal of Personality Assessment 63, 506-516.

Schipperijn, J., Stigsdotter, U., Randrup, T., Troelsen, J., 2010. Influences on the use of urban green space: A case study in Odense, Denmark. Urban Forestry & Urban Greening 9, 25-32.

Schurer, S., Yong, J., 2010. Personality, well-being and heterogeneous valuations of income and work, Melbourne Institute Working Paper No. 14/10. University of Melbourne, Melbourne.

Schwartz, B., 2000. Self-determination: The tyranny of freedom. American Psychologist 55, 75-88.

Schwartz, B., Ward, A., Monterosso, J., Lyubomirsky, S., White, K., Lehman, D., 2002. Maximizing versus satisficing: Happiness is a matter of choice. Journal of Personality and Social Psychology 83, 1178-1197.

Schwarz, N., Strack, F., 1991. Context effects in attitude surveys: Applying cognitive theory to social research. European Review of Social Psychology 2, 31-50.

Shields, M., Price, S., Wooden, M., 2009. Life satisfaction and the economic and social characteristics of neighbourhoods. Journal of Population Economics 22, 421-443.

Shields, M., Wooden, M., 2003. Investigating the role of neighbourhood characteristics in determining life satisfaction, Paper prepared for the Department of Family and Community Services, Canberra.

Smith, V., 2008. Reflections on the literature. Review of Environmental Economics and Policy 2, 292-308.

Smyth, R., Mishra, V., Qian, X., 2008. The environment and well-being in urban China. Ecological Economics 68, 547-555.

Stiglitz, J., Sen, A., Fitoussi, J., 2008. Report by the Commission on the Measurement of Economic Performance and Social Progress, Paris.

Tiebout, C., 1956. A pure theory of local expenditures. Journal of Political Economy 64, 416-424.

United Nations, 2010. World Urbanization Prospects: The 2009 Revision, Department of Economic and Social Affairs, New York.

Veenhoven, R., 1993. Happiness in Nations: Subjective Appreciation of Life in 56 Nations. Erasmus University Press, Rotterdam.

Veenhoven, R., 1996. Developments in satisfaction research. Social Indicators Research 37, 1-46.

Vemuri, A., Costanza, R., 2006. The role of human, social, built, and natural capital in explaining life satisfaction at the country level: Toward a National Well-Being Index (NWI). Ecological Economics 58, 119-133.

Watson, N., Wooden, M., 2010. The HILDA survey: Progress and future developments. The Australian Economic Review 43, 326-336.

Winklemann, L., Winklemann, R., 1998. Why are the unemployed so unhappy? Evidence from panel data. Economica 65, 1-15.

Wooden, M., Warren, D., Drago, R., 2009. Working time mismatch and subjective well-being. British Journal of Industrial Relations 47, 147-179.

Wooden, M., Watson, N., 2007. The HILDA survey and its contribution to economic and social research (so far). The Economic Record 83, 208-231.

Table 1: Model 1 variables

Variable name	Definition
Age	Age of respondent in years
Age squared	Age of respondent in years squared
Male	Dummy variable = 1 if respondent is male
ATSI	Dummy variable = 1 if respondent is of Aboriginal and/or Torres Strait Islander origin
Immigrant English	Dummy variable = 1 if 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	Dummy variable = 1 if respondent is not born in Australia or a Main English Speaking country
Poor English	Dummy variable = 1 if respondent speaks English either not well or not at all
Number of children	Number of respondent's own resident children in respondent's household at least 50 per cent of the time and number of own children who usually live in a non-private dwelling but spend the rest of the time mainly with the respondent
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	Dummy variable = 1 if 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	Respondent's highest level of education is Year 12
Certificate or diploma	Respondent's highest level of education is a certificate or diploma
Bachelors degree or higher	Respondent's highest level of education is a Bachelors degree or higher
Employed part-time	Respondent is employed and works less than 35 hours per week
Self employed	Dummy variable = 1 if the 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 equivalentised disposable household income

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)
Others present	Dummy variable = 1 if someone was present during the interview

Table 2: Model 2 external variables

Variable name	Definition
Major city	Dummy variable = 1 if respondent lives in a major city.
NP per capita (km^2/per capita)	The area of the SLA in square kilometres divided by the total population of the SLA.
Distance to UP (km)	The straight line distance to the nearest urban park, including for instance, local parklands, golf courses, recreation areas, rifle ranges, ovals and so on.
Distance to UP $(km)^2$	The straight line distance to the nearest urban park squared.
On coast	Dummy variable = 1 if straight line distance to coast is 0.
Distance to river (km)	The straight line distance to the nearest river, including line features named 'river'.
Distance to lake (km)	The straight line distance to the nearest lake, including polygon features named 'lake'.
Distance to creek (km)	The straight line distance to the nearest creek, including line features named 'creek'.
Rainfall (mm)	The annual mean rainfall, the result of averaging monthly total rainfall over the year.
Max Temp (°C)	The annual mean maximum temperature, the result of averaging mean maximum monthly temperature over the year.
Min Temp (°C)	The annual mean minimum temperature, the result of averaging mean minimum monthly temperature over the year.
Sunshine (hrs)	The number of sunshine hours per day for the SLA.
Wind speed (km/hr)	The wind speed in kilometres per hour for the SLA.

Table 3: Model 1 results (OLS)

Variable name	OLS estimate (standard error)	Variable name	OLS estimate (standard error)
Constant	5.2902*** (0.1935)	Year 12	0.0471 (0.0711)
Age	-0.0410*** (0.0056)	Certificate or diploma	-0.0698** (0.0305)
Age squared	0.0005*** (0.0001)	Bachelors degree or higher	-0.1802*** (0.0378)
Male	0.0695** (0.0273)	Employed part-time	0.1577*** (0.0352)
ATSI	0.2256* (0.1181)	Self employed	-0.0269 (0.0483)
Immigrant English	-0.0453 (0.0423)	Unemployed	-0.1996** (0.1001)
Immigrant non-English	-0.1487*** (0.0513)	Retired	0.2017*** (0.0610)
Poor English	-0.3082* (0.1570)	Home duties	0.2258*** (0.0614)
Number of children	-0.0382** (0.0156)	Student	0.3863*** (0.0649)
Married	0.2501*** (0.0524)	Non-participant	0.0731 (0.1267)
Defacto	0.1565*** (0.0565)	Disposable income (ln)	0.0472*** (0.0113)
Separated	-0.4728*** (0.1210)	Extraversion	0.1130*** (0.0129)
Divorced	-0.2908*** (0.0851)	Agreeableness	0.1924*** (0.0170)
Widow	-0.0021 (0.0895)	Conscientiousness	0.0764*** (0.0136)
Lone parent	-0.1843*** (0.0644)	Emotional stability	0.2148*** (0.0153)
Mild health condition	-0.1629*** (0.0453)	Openness to experience	-0.0464*** (0.0146)
Moderate health condition	-0.6757*** (0.0427)	Others present	0.0468* (0.0275)
Severe health condition	-1.1088*** (-0.7067)		
Summary statistics			
Number of observations	11259		
Adjusted R^2	0.1704		

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Omitted cases are: Female; Not of indigenous origin; Country of birth Australia; Speaks English well or very well; Never married and not de facto; Does not have a long-term health condition; Year 11 or below; Not self employed (employee, employee of own business, unpaid family worker); Employed working 35 hours or more per week; and No others present during the interview or don't know – telephone interview.

Table 4: Model 2 results (OLS)

Variable name	OLS estimate (standard error)	Variable name	OLS estimate (standard error)
Constant	4.6640*** (0.1466)	Retired	0.1973*** (0.0646)
Age	-0.0424*** (0.0053)	Home duties	0.2133*** (0.0612)
Age squared	0.0005*** (0.0001)	Student	0.3778*** (0.0639)
Male	0.0680** (0.0280)	Non-participant	0.0612 (0.1318)
ATSI	0.2129* (0.1143)	Disposable income (ln)	0.0542*** (0.0111)
Immigrant English	-0.0277 (0.0429)	Extraversion	0.1145*** (0.0130)
Immigrant non-English	-0.1129** (0.0482)	Agreeableness	0.1952*** (0.0173)
Poor English	-0.2675 (0.1739)	Conscientiousness	0.0757*** (0.0147)
Number of children	-0.0371** (0.0145)	Emotional stability	0.2112*** (0.0146)
Married	0.2425*** (0.0543)	Openness to experience	-0.0444*** (0.0144)
Defacto	0.1461** (0.0570)	Others present	0.0340 (0.0272)
Separated	-0.4901*** (0.1182)	Major city	-0.0974*** (0.0370)
Divorced	-0.2865*** (0.0824)	NP per capita	1.8955** (0.7996)
Widow	0.0041 (0.0933)	Distance to UP	0.0070** (0.0031)
Lone parent	-0.1806*** (0.0638)	Distance to UP squared	-0.0001** (0.0000)
Mild health condition	-0.1579*** (0.0464)	On coast	0.1033*** (0.0364)
Moderate health condition	-0.6748*** (0.0440)	Distance to river	-0.0006* (0.0003)
Severe health condition	-1.1137*** (0.1920)	Distance to lake	-0.0003 (0.0002)
Year 12	0.0606 (0.0674)	Distance to creek	0.0010*** (0.0003)
Certificate or diploma	-0.0609** (0.0304)	Rainfall	0.0003 (0.0010)
Bachelors degree or higher	-0.1564*** (0.0394)	Max temp	0.0508** (0.0200)
Employed part-time	0.1579*** (0.0354)	Min temp	-0.0384** (0.0173)
Self employed	-0.0671 (0.0485)	Sunshine	-0.0443** (0.0221)

Unemployed	-0.2087** (0.1010)	Wind speed	0.0145 (0.0092)
Summary statistics			
Number of observations	11259		
Adjusted R^2	0.1748		

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Omitted cases are: Female; Not of indigenous origin; Country of birth Australia; Speaks English well or very well; Never married and not defacto; Does not have a long-term health condition; Year 11 or below; Not self employed (employee, employee of own business, unpaid family worker); Employed working 35 hours or more per week; No others present during the interview or don't know – telephone interview; Not a major city (inner regional Australia, outer regional Australia, remote Australia, very remote Australia and migratory); and Not on the coast.

Figure 1: Life satisfaction is 'U' shaped in age

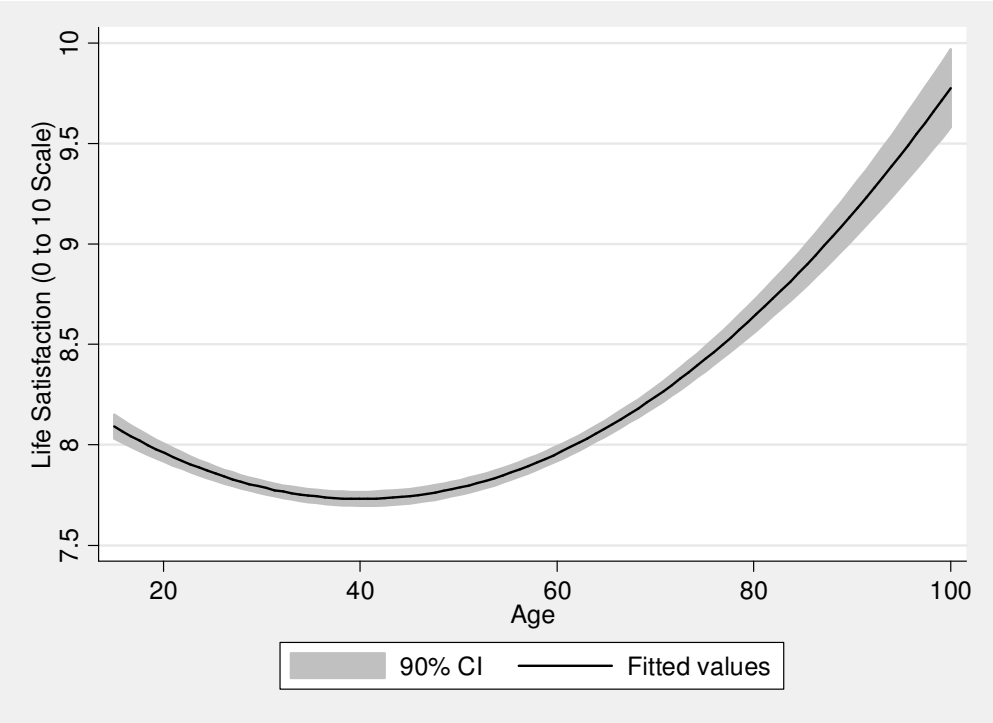
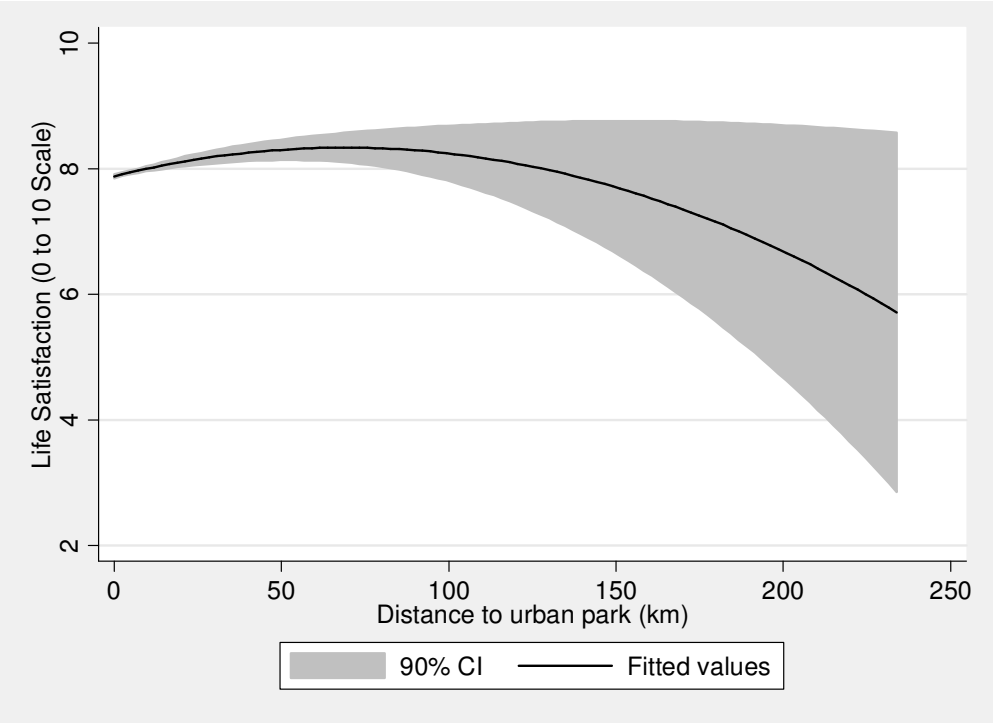


Figure 2: Life satisfaction is an inverted 'U' shape in relation to distance to urban park



Appendix A: Additional results

Table A1: Model 1 results (ordered probit)

Variable name	**Probit estimate** (standard error)	**Variable name**	**Probit estimate** (standard error)
Age	-0.0335***	Year 12	0.0223
	(0.0046)		(0.0565)
Age squared	0.0004***	Certificate or diploma	-0.0738***
	(0.0001)		(0.0244)
Male	0.0674***	Bachelors degree or	-0.1598***
	(0.0220)	higher	(0.0293)
ATSI	0.2215**	Employed part-time	0.1463***
	(0.0957)		(0.0284)
Immigrant English	-0.0286	Self employed	-0.0193
	(0.0331)		(0.0381)
Immigrant non-English	-0.1105***	Unemployed	-0.0527
	(0.0389)		(0.0702)
Poor English	-0.2556**	Retired	0.2096***
	(0.1085)		(0.0475)
Number of children	-0.0380***	Home duties	0.2565***
	(0.0124)		(0.0480)
Married	0.2055***	Student	0.3339***
	(0.0409)		(0.0536)
Defacto	0.1274***	Non-participant	0.1762**
	(0.0442)		(0.0893)
Separated	-0.2759***	Disposable income (ln)	0.0364***
	(0.0813)		(0.0079)
Divorced	-0.1876***	Extraversion	0.0951***
	(0.0613)		(0.0101)
Widow	0.0065	Agreeableness	0.1678***
	(0.0727)		(0.0135)
Lone parent	-0.1215**	Conscientiousness	0.0624***
	(0.0469)		(0.0106)
Mild health condition	-0.1064***	Emotional stability	0.1646***
	(0.0363)		(0.0115)
Moderate health condition	-0.5081***	Openness to experience	-0.0445***
	(0.0316)		(0.0116)
Severe health condition	-0.8583***	Others present	0.0418*
	(0.1357)		(0.0220)
Summary statistics			
Number of observations	11259		
Likelihood ratio	-17962.872		
Pseudo R^2	0.0578		

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Omitted cases are: Female; Not of indigenous origin; Country of birth Australia; Speaks English well or very well; Never married and not de facto; Does not have a long-term health condition; Year 11 or below; Not self employed (employee, employee of own business, unpaid family worker); Employed working 35 hours or more per week; and No others present during the interview or don't know – telephone interview.

Table A2: Model 2 results (ordered probit)

Variable name	Probit estimate (standard error)	Variable name	Probit estimate (standard error)
Age	-0.0348*** (0.0044)	Home duties	0.2471*** (0.0476)
Age squared	0.0004*** (0.0000)	Student	0.3267*** (0.0523)
Male	0.0661*** (0.0222)	Non-participant	0.1665* (0.0898)
ATSI	0.2090** (0.0932)	Disposable income (ln)	0.0423*** (0.0076)
Immigrant English	-0.0141 (0.0338)	Extraversion	0.0964*** (0.0101)
Immigrant non-English	-0.0800** (0.0369)	Agreeableness	0.1705*** (0.0138)
Poor English	-0.2220* (0.1227)	Conscientiousness	0.0619*** (0.0112)
Number of children	-0.0373*** (0.0117)	Emotional stability	0.1623*** (0.0112)
Married	0.2000*** (0.0424)	Openness to experience	-0.0429*** (0.0114)
Defacto	0.1189*** (0.0449)	Others present	0.0316 (0.0216)
Separated	-0.2910*** (0.0802)	Major city	-0.0855*** (0.0294)
Divorced	-0.1847*** (0.0601)	NP per capita	1.4716** (0.7167)
Widow	0.0113 (0.0765)	Distance to UP	0.0054** (0.0025)
Lone parent	-0.1186** (0.0479)	Distance to UP squared	-0.0001** (0.0000)
Mild health condition	-0.1018*** (0.0369)	On coast	0.0804*** (0.0292)
Moderate health condition	-0.5099*** (0.0328)	Distance to river	-0.0006** (0.0003)
Severe health condition	-0.8664*** (0.1291)	Distance to lake	-0.0002 (0.0002)
Year 12	0.0342 (0.0544)	Distance to creek	0.0008*** (0.0002)
Certificate or diploma	-0.0672*** (0.0238)	Rainfall	0.0003 (0.0008)
Bachelors degree or higher	-0.1405*** (0.0309)	Max temp	0.0363** (0.0158)
Employed part-time	0.1460*** (0.0280)	Min temp	-0.0295** (0.0135)
Self employed	-0.0521 (0.0377)	Sunshine	-0.3002* (0.0169)
Unemployed	-0.0614 (0.0701)	Wind speed	0.0117 (0.0072)

Retired	0.2060***
	(0.0497)
Summary statistics	
Number of observations	11259
Likelihood ratio	-17925.052
Pseudo R^2	0.0597

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Omitted cases are: Female; Not of indigenous origin; Country of birth Australia; Speaks English well or very well; Never married and not defacto; Does not have a long-term health condition; Year 11 or below; Not self employed (employee, employee of own business, unpaid family worker); Employed working 35 hours or more per week; No others present during the interview or don't know – telephone interview; Not a major city (inner regional Australia, outer regional Australia, remote Australia, very remote Australia and migratory); and Not on the coast.