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The Greener, The Happier?
The Effect of Urban Land Use on Residential Well-Being

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Abstract

We investigate the effect of urban land use on residential well-being in major German cities, using panel data from the German Socio-Economic Panel and cross-section data from the European Urban Atlas. We reduce concerns about endogeneity by employing fixed-effects (within) estimators, with individual and city of residence fixed effects, while controlling for a rich set of observables. The results show that access to green urban areas, such as gardens and parks, is positively associated with, whereas access to abandoned areas, such as waste or leftover land, is negatively associated with life satisfaction. The effects are strongest for residents who are older, accounting for up to a third of the size of the effect of being unemployed on life satisfaction. We calculate the marginal willingness-to-pay of residents in order to have access to green urban and abandoned areas in their surroundings, as well as the life-satisfaction maximising amounts of them. Finally, we provide a policy case study, while discussing limitations and avenues for future research.

Keywords:
Life Satisfaction, Urban Land Use, Green Urban Areas, Forests, Waters, Abandoned Areas, German Socio-Economic Panel, European Urban Atlas, Monetary Valuation, Spatial Analysis

JEL:
C23, Q51, Q57, R20

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1. Introduction

In major cities, space is a scarce commodity, and urbanisation puts increasing pressure on areas that provide important ecosystem services. Acknowledging that urban areas, such as parks and green space, contribute to their climate and environmental policy objectives, the European Commission promotes their preservation by incorporating them into national and regional policies across the European Union (European Commission, 2013), whereas the Federal Government in Germany promotes their preservation by incorporating them into its national strategy on biodiversity protection (Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, 2007).

These ongoing policy initiatives, meant to preserve urban ecosystem services, are encouraged by a growing body of literature that highlights their amenity value for residents in their surroundings, suggesting that urban areas, such as parks and green space, have positive effects on residential well-being and health (see Bell et al. (2008) and Croucher et al. (2008) for reviews). Using cross-section data on residential well-being from the Household, Income, and Labour Dynamics Survey in Australia and the amount of green space in the collection districts of major Australian cities, Ambrey and Fleming (2013) show that green space is positively associated with life satisfaction.[1] Smyth et al. (2008) and Smyth et al. (2011) confirm that green space per capita is positively associated with happiness in urban China, whereas, in a case study of Adelaide, Australia, Sugiyama et al. (2008) show that residents who rate to live in greener areas report higher mental and physical health. Importantly, these effects seem to be heterogeneous: Ambrey and Fleming (2013) suggest that single parents and people with lower levels of education benefit more in terms of life satisfaction, whereas, in the United Kingdom, Richardson and Mitchell (2010) find that men benefit more in terms of lower rates of cardiovascular and respiratory diseases, and Mitchell and Popham (2008) find that low-income households benefit more in terms of reduced health inequalities (Jorgensen and Anthopoulou, 2007). Maas et al. (2006) confirm the heterogeneous effect for people with lower levels of education in the Netherlands, and also add that older residents benefit more in terms of general health (Jorgensen et al., 2002). Most of these studies, however, use cross-section data, with the exception of White et al. (2013), who find positive effects of green space on life satisfaction and mental health in England.[2]

[1]In related studies, using the same dataset and empirical strategy, the authors also find that there is a positive relationship between scenic amenity and protected areas on the one hand and life satisfaction on the other (Ambrey and Fleming, 2011, 2012).

[2]Alcock et al. (2014) are a spin-off of White et al. (2013), focusing on residents who move.

In sharp contrast to these studies stands another stream of literature that investigates the disamenity value of vacant or abandoned areas in post-industrial cities. Using a quasi-experimental difference-in-differences design, Branas et al. (2011) show that the greening of vacant lots in Philadelphia, Pennsylvania, reduces certain crimes, in particular gun assaults and vandalism, and improves the self-reported health of residents in their surroundings, leading to lower levels of stress and higher levels of exercise. Using qualitative interviews in the same city, Garvin et al. (2013) find that respondents perceive vacant land to lead to lower community well-being, as well as physical and mental health. Kuo et al. (1998) suggest similar effects when it comes to common space on the one hand and perceived safety and fear of crime on the other. These results are supported by studies on the relationship between foreclosure, vacancy, and crime: Ellen et al. (2013) and Katz et al. (2013) find increases in violent and violent and property crime following foreclosure in New York City and Glendale, Arizona, respectively. Cui and Walsh (2015), using a difference-in-differences design and a more comprehensive dataset from Pittsburgh, Pennsylvania, show that this increase in crime is not due to foreclosure itself, but rather due to vacancy following foreclosure. The authors report an increase of roughly 19% for violent crime once dwellings become vacant. Although these studies do not directly investigate the effect of vacant or abandoned areas on life satisfaction, they still suggest that vacant or abandoned areas are associated with lower life satisfaction, in particular for residents that are more vulnerable, as health and safety are important determinants of subjective well-being (see, for example, Krekel and Poprawe (2014) and Dustmann and Fasani (2015)).

Generally, for the amenity and disamenity values associated with green urban and abandoned areas, as well as other types of urban land use, no market prices exist. Therefore, they are typically valued using stated preference approaches, such as contingent valuation and discrete choice experiments, or revealed preference approaches, such as hedonic pricing (see Brander and Koetse (2011) for a review).

We investigate the effect of urban land use on residential well-being in Germany and value different land use categories monetarily, using the *life satisfaction approach* (Welsch, 2007). To this end, we merge panel data from the German Socio-Economic Panel for the time period between 2000 and 2012 with cross-section data from the European Urban Atlas for the year 2006. Trading off the impact of different land use categories on life satisfaction against the impact of income, the life satisfaction approach allows us to calculate the marginal willingness-to-pay of residents in order to have access to different land use categories in their surroundings, as well as the life-satisfaction maximising amounts of them. As this approach has already been applied to value various other public goods and bads monetarily, including air pollution (Ferreira et al., 2013; Ambrey et al., 2014), noise pollution (van Praag and Baarsma, 2005; Rehdanz and Maddison, 2008), as well as scenic amenity (Ambrey and Fleming, 2011) and natural land areas (Kopmann and Rehdanz, 2013), we contribute to a steadily growing stream of literature.

Specifically, the richness of our data allows us to contribute to the literature on the relationship between urban land use and residential well-being in several ways. First, using the German Socio-Economic Panel allows us to estimate the effect of urban land use on residential well-being by employing fixed-effects (within) estimators, with individual and city of residence fixed effects, while controlling for a rich set of observables. This reduces concerns about endogeneity, especially simultaneity, as the effect is identified by between-city movers, who are less likely to move for reasons related to different land use categories in their surroundings. Second, using the European Urban Atlas allows us to employ data on land use rather than cover. This has the advantage that information based on actual usage is much more consistent in terms of provision of utility than information based on, for instance, cover. Moreover, this dataset allows us to jointly estimate the effects of different land use categories on residential well-being. We focus on green urban areas, forests, waters, and abandoned areas.[3] Third, merging both datasets through geographical coordinates allows us to calculate the exact distances between households and different land use categories, as well as the exact coverages of different land use categories in a pre-defined radius around households. This has the advantage that measuring access based on distances and coverages is much more precise than based on aggregated areas, which simply sum up the amounts of different land use categories in a district. Moreover, using both distances and coverages serves as a robustness check, as they are substitutes for measuring access to different land use categories. Finally, the literature on vacant land focuses mostly on its effect on health and safety. As health and safety are known to be important determinants of subjective well-being, the results of this study may also contribute to this stream of literature.

The rest of this paper is organised as follows. Section 2 describes the data and provides detailed definitions of the different land use categories employed. Section 3 introduces the empirical model and discusses identification issues. Section 4 presents

[3]Green urban areas are defined as "land for predominantly recreational use", including, for example, gardens and parks. There is an important distinction between green urban areas and forests, as forest within an urban setting, showing traces of recreational use, are classified as green urban areas. Abandoned areas are defined as "areas in the vicinity of artificial surfaces still waiting to be used or re-used", including, for example, waste land and gaps between new construction areas or leftover land (European Environment Agency, 2011, p. 21).

the results, while Section 5 gives policy implications. Section 6 discusses the results and limitations of this study against the status quo of the literature, and concludes by providing avenues for future research.

2. Data

2.1. Data on Residential Well-Being

The German Socio-Economic Panel is a comprehensive and representative panel study of private households in Germany, including almost 11,000 households and 22,000 individuals every year. It provides information on all household members, covering Germans living in the old and new federal states, foreigners, and recent immigrants (Wagner et al., 2007, 2008). Most importantly, it provides information on the geographical locations of the places of residence of individuals, allowing to merge data on residential well-being with data on urban land use through geographical coordinates.[4] As such, the dataset is not only representative of individuals living in Germany today, but also provides the necessary geographical reference points for our analysis.[5]

To investigate the effect of urban land use on residential well-being, we select *satisfaction with life* as the dependent variable. The indicator is obtained from an eleven-point single-item Likert scale that asks respondents "How satisfied are you with your life, all things considered?". It has been found to validly reflect the quality of respondent's lives (Diener et al., 2013), and it is the indicator commonly used to value public goods monetarily, using the *life satisfaction approach*, which is named after it. Conceptually, life satisfaction, which is equivalent to subjective well-being (Welsch and Kühling, 2009) or experienced utility (Kahnemann et al., 1997), is defined as the cognitive evaluation of the circumstances of life (Diener et al., 1999).

2.2. Data on Urban Land Use

The European Urban Atlas, provided by the European Environment Agency, is a comprehensive and comparative cross-section study of urban land use in Europe,

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[4]The German Socio-Economic Panel provides the geographical coordinates at the street block level, which is very accurate in urban areas.

[5]The dataset is subject to rigorous data protection regulation. It is never possible to derive the household data from the geographical coordinates, as they are never visible to the researcher at the same time. See Göbel and Pauer (2014) for more information.

including data for major German cities (European Environment Agency, 2011).[6] Based on satellite imagery, in this dataset, urban areas greater than 0.25 hectare are assigned exclusively to well-defined land use categories.[7] A major advantage of having data on land use rather than cover is that information based on usage is far more homogeneous in terms of provision of utility and neighbourhood effects.

The definitions of the land use categories *green urban areas*, *forests*, *waters*, and *abandoned areas* are given in Table A.1.

Table A.1 about here

The European Urban Atlas defines *green urban areas* as "land for predominantly recreational use" (European Environment Agency, 2011, p. 21). Included are, for example, zoos, gardens, parks, and castle parks, as well as suburban natural areas used as parks. Moreover, forests and other green fields are considered green urban areas in case that there are traces of recreational use and they are surrounded by urban structures. Thus, forests within an urban setting, such as patches of parks densely canopied by trees, fall into this land use category. Not included are, for example, private gardens within housing areas, cemeteries, agricultural areas, and other green fields not managed for recreational use. Finally, sports and leisure facilities, such as golf courses and allotment gardens, are not considered green urban areas. As this land use category concentrates on publicly accessible land that provides space for social interaction, the results of this study are comparable to results of studies analysing the social value of public green space.

The land use category *forests* incorporates all (even privately owned) areas with ground coverage of tree canopy greater than 30% and tree height greater than five metres, including other kinds of vegetation at their borders, unless they are themselves part of green urban areas. The land use category *waters* incorporates all water bodies, such as lakes, rivers, and canals, exceeding one hectare. Notably, within parks, lakes are considered as waters and do not count among the green urban area surrounding them.

The European Urban Atlas defines *abandoned areas* as "areas in the vicinity of artificial surfaces still waiting to be used or re-used" (European Environment

[6]We restrict the data to the 32 major German cities with greater than or equal to 100,000 inhabitants in order to avoid confounding the effect of urban land use on residential well-being with that of urbanisation.

[7]The European Urban Atlas provides exact geographical coordinates in form of shapefiles.

Agency, 2011, p. 21).[8] Included are, for example, waste land, removed former industrial areas, and gaps between new construction areas or leftover land. As the European Urban Atlas distinguishes between land use patterns as opposed to land cover information, within this land use category, different types of land cover can occur. Not included are, for example, areas showing any signs of recreational or agricultural use. Importantly, privately owned green or brown fields used for recreational purposes do not fall into this land use category; they are classified as urban fabric (private gardens). In other words, this land use category does not mix up amenities and disamenities by including areas for recreational activities. As it is difficult to determine land without current use based on satellite imagery alone, assignment to this land use category often relies on locally gathered information based on actual usage (Lavalle et al., 2002, p. 45).

To investigate the effect of urban land use on residential well-being, we define two independent variables that measure access to the different land use categories. First, we define the *distance* to them, measured as the Euclidean distance in 100 metres between households and the border of the nearest land use category, respectively. Second, we define the *coverage* of them, measured as the hectares covered by the land use category in a pre-defined radius of 1,000 metres around households, respectively. Using both distances and coverages serves as a robustness check, given that distances do not make any assumptions, contrary to coverages.

For simplicity, the definition of the *coverage* is illustrated in Figure A.1.

Figure A.1 about here

We merge the data on residential well-being with the data on urban land use and add controls at the micro level, originating from the German Socio-Economic Panel, at the macro level, originating from the Federal Statistical Office, and at the geo level, originating from our own calculations. The controls at the micro level include demographic characteristics, human capital characteristics, and economic conditions at the individual level, as well as household characteristics and housing conditions at the household level. The controls at the macro level include macroeconomic conditions at the city level. The controls at the geo level include the location of the household within the city in terms of distance to the city centre and distance to the city periphery.[9]

[8] In some studies, abandoned areas are referred to as *land without current use*.

[9] The city centre is defined as the geographical location of the town hall.

The descriptive statistics of the final sample are given in Table A.2.

Table A.2 about here

3. Empirical Model

3.1. Regression Equation

We employ a linear regression model estimated by the fixed-effects (within) estimator, with individual and city of residence fixed effects, and robust standard errors clustered at the city of residence level.[10]. The specification test by Wu (1973) and Hausman (1978), as well as the robust version of this test by Wooldridge (2002) indicate that fixed effects are strictly preferable to random effects. Specifically, both tests reject the null hypothesis of identical parameter estimates between a fixed and a random effects model at the 1% significance level.[11]

We employ the following regression equation:

$$\begin{aligned} y_{it} = \beta_0 + \mathbf{MIC'_{it}}\boldsymbol{\beta}_1 + \mathbf{MAC'_{it}}\boldsymbol{\beta}_2 + \mathbf{GEO'_{it}}\boldsymbol{\beta}_3 + \\ + \mathbf{LUC'_{i}}\boldsymbol{\delta}_1 + \mathbf{LUC^{2\prime}_{i}}\boldsymbol{\delta}_2 + \eta_c + \mu_i + \epsilon_{it} \end{aligned}$$

where y is *satisfaction with life* as the regressand; β_0 is the constant; $\beta_1 - \beta_3$ and $\delta_1 - \delta_2$ are the coefficients; *MIC*, *MAC*, and *GEO* are the vectors of controls at the micro, macro, and geo level, respectively; η_c and μ_i are (time-invariant) unobserved heterogeneity or fixed effects at the city of residence and individual level, respectively; ϵ_{it} is the idiosyncratic disturbance of resident i in time period t; and *LUC* is a

[10]Notably, using a linear regression model introduces measurement error, as *satisfaction with life* is a discrete, ordinal variable. However, this has become common practice, as discrete models for ordinal variables are not easily applicable to the fixed-effects (within) estimator, and the bias resulting from this measurement error has been found to be negligible (see, for example, Ferrer-i Carbonell and Frijters (2004) for panel data and Brereton et al. (2008) and Ferreira and Moro (2010) for repeated cross-section data)

[11]The empirical values 720.32 and 894.27 exceed by far the critical value 56.06 of the χ^2-distribution with 34 degrees of freedom. As such, we cannot reject that the error terms are correlated with the regressors.

vector of either the distances to or the coverages of the different land use categories, respectively, as the regressors of interest.[12]

Following the literature on the use of green space (see, for example, Schipperijn et al. (2010) and Schipperijn et al. (2010)), we estimate one set of models including distances and another one including coverages. The rationale behind this approach is that, in this literature, both proximities and sizes are seen as proxies for the use of green space.[13] The intuition behind this is simple. Take, for example, a household that is surrounded by a high coverage of green space: it is very likely that this household is also located in close distance to green space.[14] As such, in accordance with this literature, we consistently interpret distances and coverages as different measures of the same concept, namely access to different land use categories.[15] Thus, we estimate both distances and coverages in separate models.

3.2. Identification Issues

Typically, when estimating the effect of urban land use on residential well-being, there are three sources from which endogeneity - correlation between the error terms and the regressors that leads to biased and inconsistent parameter estimates - can rise.

First, endogeneity can arise from *omitted variables*, meaning that an observable with explanatory power for the outcome is omitted from the regression, for example, the type of dwelling in which a resident lives. This observable can be either time-variant or time-invariant. We account for time-variant omitted variables by including a rich set of time-variant regressors as controls, all of which have been shown to affect the regressand in the literature.[16][17] Second, endogeneity can arise from *unobserved heterogeneity*, meaning that a time-invariant unobservable with

[12]When adding year fixed effects or a linear time trend to account for the fact that life satisfaction might systematically differ between years or change over time, respectively, the results remain qualitatively the same as in the baseline specification. The results are available upon request.

[13]Ambrey and Fleming (2013) even argue that coverages can be interpreted as the synthesis of proximities and sizes.

[14]In other words, there should be a negative correlation between distances and coverages, indicating that they are substitutes rather than complements, which is also what we find; for example, -0.5240 for green urban areas.

[15]Notably, when including both distances and coverages in the same regression equation, we find that one of them systematically becomes insignificant, although which one differs for different land use categories. The results are available upon request.

[16]See Frey (2010) for a review of the relevant controls.

[17]We automatically account for all time-invariant variables, both observable and unobservable, by including individual and city of residence fixed effects.

explanatory power for the outcome is omitted from the regression, for example, the baseline level of happiness (see, for example, Clark et al. (2008) for a discussion) or personality of a resident. We account for this type of endogeneity by including individual and city of residence fixed effects. Third, endogeneity can arise from *endogenous residential sorting (self-selection or reverse causality)*, meaning that a resident with a higher (lower) preference for a particular land use category self-selects into an urban area with a higher (lower) access to it, whereby the preference is correlated with the outcome. For example, happier (unhappier) residents might move to an urban area with more (less) green urban areas, which, in turn, makes them even happier (unhappier). This can happen either prior to the observation period, so that we have an issue of *preference heterogeneity*, which we already account for by including individual fixed effects, or during the observation period, so that we have an issue of *simultaneity*: this issue is rarely discussed in the literature, and including fixed effects alone does not solve it.

To account for simultaneity, we would need a source of exogenous variation (that is, an instrument) that changes the presence of a particular land use category (that is, relevance of the instrument) in an urban area without at the same time affecting the well-being of its residents (that is, exogeneity of the instrument). Unfortunately, our merged dataset is a quasi-panel, which includes only one observation on the different land use categories, with no variation over time. This is simply due to data limitations, as the European Urban Atlas, to date, includes only one wave. However, even if more than one wave was available, we would need a source of *exogenous* variation, such as an urban land reform, to solve the issue of simultaneity and establish causality. To our knowledge, such a source of exogenous variation does not exist for Germany during the observation period.

Given these data and institutional limitations, we cannot completely solve the issue of simultaneity, but we can try to work around it and evaluate the extent to which it plays a role in the given context. We work around it by including both individual and city of residence fixed effects to have the effects identified by between-city movers, which we assume are moving for reasons unrelated (that is, orthogonal) to the different land use categories in their surroundings. In fact, 79% of them are moving to another city for reasons that are not directly linked to their location.[18] We take this as initial evidence that simultaneity plays only a minor role,

[18]The German Socio-Economic Panel includes an item that asks respondents whether they moved in the previous time period, as well as a follow-up item that asks respondents about the main reason for moving, including notice given by the landlord; buying a house or an apartment; inheritance; job reasons; marriage, breakup, or other family reasons; the size of the dwelling; the price of

which is also found in other contexts (see, for example, Chay and Greenstone (2005) for the context of air pollution).[19]

As additional robustness checks, we estimate *(i)* a model that includes only within-city movers, which we assume to be more prone to endogenous residential sorting, and *(ii)* a model in which we regress a dummy variable that equals one in the time period in which a resident moves, and zero otherwise, on the distances to the different land use categories in order to test whether these distances affect moving behaviour. In the first robustness check, the results remain qualitatively the same as in the baseline specification, and in the second robustness check, none of the parameter estimates is significant (the same is true when using coverages instead of distances).[20] We take this as additional evidence that simultaneity plays only a minor role.

4. Results

The effects of the distances to and the coverages of the different land use categories on life satisfaction can be seen in Tables B.1 and B.2, respectively.[21]

Tables B.1 and B.2 about here

As can be seen in Table B.1, the distance to green urban areas has a significantly negative effect on life satisfaction at the 1% level, whereas the distance to abandoned

the dwelling; the standard of the dwelling; the standard of the location; the standard of the surroundings; and other reasons. We combine all categories except for the standard of the location and the standard of the surroundings into one category that we assume not to be directly linked to the location of respondents.

[19]However, even if we exclude the city of residence fixed effects to have the effects identified by all movers, including within-city movers that are more likely to move, for example, in order to live closer to a green urban area, the results remain qualitatively the same as in the baseline specification. The results are available upon request.

[20]The results are available upon request.

[21]Unreported, having very good health has a significantly positive effect on life satisfaction at the 1% level, whereas being older, having very bad health, and being disabled has a significantly negative effect on it at the 5% and 1% level, respectively. Moreover, being on parental leave has a significantly positive effect on life satisfaction at the 1% level, whereas individual and household income has a significantly positive effect on it at the 5% and 1% level, respectively. Finally, being unemployed and the unemployment rate are most detrimental to life satisfaction and among the largest regression coefficients (Clark and Oswald, 2004; Blanchflower, 2008). See the Online Appendix for the full tables.

areas has a significantly positive effect on it at the same level. Both effects are non-linear: increasing the distance to green urban areas significantly decreases life satisfaction, whereas increasing the distance to abandoned areas significantly increases it, at a decreasing rate, respectively. This is in line with the notion of diminishing marginal returns to utility or disutility in neoclassical theory.[22] Both effects are, however, rather small: increasing the distance to green urban areas by 100 metres, given a mean distance of 279 metres, decreases life satisfaction only by 1% of a standard deviation, whereas increasing the distance to abandoned areas by 100 metres, given a mean distance of 961 metres, increases it only by 2% of a standard deviation, compared to a 29% drop in life satisfaction when becoming unemployed. As can be seen in Table B.2, almost the same picture arises when looking at the effects of the coverages of green urban and abandoned areas in a pre-defined radius of 1,000 metres around households on life satisfaction. The sizes of these effects are slightly different, though: increasing the coverage of green urban areas by one hectare, given a mean coverage of 23 hectares, increases life satisfaction by 0.4% of a standard deviation, whereas increasing the coverage of abandoned areas by one hectare, given a mean coverage of one hectare, decreases it by 2% of a standard deviation.

Up to now, the effects of the distances to and the coverages of green urban and abandoned areas on life satisfaction were estimated jointly for all residents. Naturally, the question arises whether the rather small effects for average residents hide potentially larger effects for different types of residents. To shed light on this question, in Tables B.3 and B.4, they are estimated separately for different population sub-groups, including residents who are female, who are older, who live in low-income households, and who have at least one child in the household.[23]

Tables B.3 and B.4 about here

As can be seen in Tables B.3 and B.4, the effects of the distances to and the coverages of both green urban and abandoned areas on life satisfaction are stronger for residents who are older, whereas only the effects of abandoned areas are stronger

[22]However, the effects of the squared distance to green urban areas and the squared coverage of abandoned areas are significant at the 10% level only in the baseline specification.

[23]For these heterogeneity analyses, we split the final sample by mean gender (53% are female), age (50% are above 49 years old), monthly net household income (50% have a monthly net household income lower than 2,500 Euro), and presence of children in the household (24% have at least one child in the household).

for residents who live in high-income households and residents who do not have a child in the household. Moreover, there is some evidence that the effects are stronger for residents who are male, which is, in case of green urban areas, in line with Richardson and Mitchell (2010), who find that men benefit more from green urban areas in terms of health. To sum up, it seems that, although the evidence is partly different from what we expected, especially as we expected residents who have at least one child in the household to show stronger effects, the effects clearly differ for different types of residents. In fact, it seems that the rather small effects for average residents translate into substantial effects for older residents, being up to five times more sizeable: increasing the distance to green urban areas by 100 metres, given a mean distance of 277 metres, decreases the life satisfaction of older residents by 10% of a standard deviation, whereas increasing the distance to abandoned areas by 100 metres, given a mean distance of 967 metres, increases it by 4% of a standard deviation, compared to a 28% drop in the life satisfaction of older residents when becoming unemployed. As such, the sizes of the effects for older residents can account for up to a third of the size of the effect of becoming unemployed on life satisfaction. This is, in case of green urban areas, in line with Maas et al. (2006), who find that older residents benefit more from green urban areas in terms of health.[24]

What would residents be willing to pay in order to have better access to green urban areas, and to avoid having abandoned areas around them? To answer this question, we value the effects of the distances to and the coverages of green urban and abandoned areas on life satisfaction monetarily, using the *life satisfaction approach*. Compared to both stated and revealed preference approaches, the life satisfaction approach has a number of advantages. Compared to stated preference approaches, such as contingent valuation or discrete choice experiments, it avoids bias resulting from the complexity of or attitudes towards the public good, which might lead to superficial or symbolic valuation. Rather than asking individuals to value a complex public good in a hypothetical situation, the life satisfaction approach does not rely on the ability of individuals to consider all relevant consequences of a change in the provision of the public good, reducing the cognitive burden that is typically associated with stated preference approaches. Moreover, it does not reveal to individuals the relationship between life satisfaction and the public good, reducing the incentive to answer in a strategical or socially desirable way. Contrary to revealed preference approaches, such as hedonic pricing, it avoids bias resulting from the

[24]In another heterogeneity analysis, we also find that the effects of the distances to and the coverages of both green urban and abandoned areas on life satisfaction are stronger in cities with lower shares of them, *et vice versa*. The results are available upon request.

assumption that the market for the private good taken to be the complement of the public good is in equilibrium, which is violated in the presence of low variety of private goods, slow adjustment of prices, incomplete information, and transaction costs. Rather than assuming that the provision of the public good is reflected in market transitions, the life satisfaction approach requires only that life satisfaction constitutes a valid approximation of welfare. Finally, it avoids bias resulting from misprediction of utility, which is common to both stated and revealed preference approaches (Frey and Stutzer, 2013).[25]

We can calculate the marginal willingness-to-pay ($MWTP$) of residents in order to change the access to green urban and abandoned areas in their surroundings, using the following formula:[26]

$$MWTP = \left. \frac{\frac{\partial y}{\partial measure}}{\frac{\partial y}{\partial income_h} + \frac{\partial y}{\partial income_i}} \right|_{\partial y = 0} = \frac{\bar{X}_{income_h} \bar{X}_{income_i} (\hat{\beta}_{measure} + 2\hat{\beta}_{measure^2} \bar{X}_{measure})}{\hat{\beta}_{income_h} \bar{X}_{income_i} + \hat{\beta}_{income_i} \bar{X}_{income_h}}$$

where y is *satisfaction with life* as the regressand; $\bar{X}$ is the respective mean; $\hat{\beta}$ is the respective regression coefficient; *measure* is either the distance to or the coverage of green urban and abandoned areas, respectively; and $income_h$ and $income_i$ is the monthly net household and individual income, respectively.

We find that, *ceteris paribus*, residents are, on average, willing to pay 23 Euro of monthly net individual income in order to increase the coverage of green urban areas in a pre-defined radius of 1,000 metres around households by one hectare, given a mean coverage of 23 hectares, whereas they are, on average, willing to pay 442 Euro in order to decrease the coverage of abandoned areas by one hectare, given a mean coverage of one hectare.[27] Moreover, we find that, *ceteris paribus*, residents

[25] Naturally, the life satisfaction approach is not entirely free of methodological issues itself. For example, for life satisfaction to constitute a valid approximation of welfare, the data should be at least ordinal in nature. Moreover, the micro-econometric function that relates life satisfaction to the public good should be correctly specified. However, these requirements are typically met in practice (Welsch and Kühling, 2009).

[26] Notably, we include both household and individual income in the formula, as we include both of them in the baseline specification. Both household and individual income approximate the value individuals assign to income. As such, omitting one of them would lead to bias and inconsistency.

[27] Notably, the calculated marginal willingness-to-pay of 23 Euro in order to increase the coverage of green urban areas compares well to the 25 Euro calculated by Bertram and Rehdanz (2014), but is much less than the 1,806 Euro calculated by Ambrey and Fleming (2013), converted with an exchange rate of 1,5130 EUR/AUD, as of December 12, 2014.

are, on average, willing to pay 455 Euro in order to decrease the distance between households and green urban areas by 100 metres, given a mean distance of 279 metres, whereas they are, on average, willing to pay 96 Euro in order to increase the distance between households and abandoned areas by 100 metres, given a mean distance of 961 metres.[28] Note that the marginal willingness-to-pay is hypothetical and does not imply feasibility, neither that it is feasible for residents to actually pay the amount, given their budget constraints, nor that it is feasible for urban planners to actually implement the change, given their urban building, treasury, and policy constraints.

We can also calculate the optimal values (X^*) of the distances to and the coverages of green urban and abandoned areas, using the following formula:[29]

$$X^*_{measure} = -\frac{\hat{\beta}_{measure}}{2\hat{\beta}_{measure^2}}$$

where $\hat{\beta}$ is the respective regression coefficient and *measure* is either the distance to or the coverage of green urban and abandoned areas, respectively.

We find that, *ceteris paribus*, the optimal value of the coverage of green urban areas in a pre-defined radius of 1,000 metres around households is, on average, 33 hectares, whereas the optimal value of the coverage of abandoned areas is, on average, zero hectares. Moreover, we find that, *ceteris paribus*, the optimal value of the distance between households and green urban areas is, on average, zero metres, whereas it is, on average, 1,439 metres for abandoned areas.[30]

Figures B.2, B.3, B.4, and B.5 about here

The intuition behind the optimal values of zero hectares and metres, respectively, for the coverage of abandoned areas and the distance to green urban areas is straightforward: the life satisfaction of residents is maximised, everything else held constant, whenever there are no abandoned areas in their surroundings and whenever they live closest to the nearest green urban area.

[28] To provide more conservative calculations, we assume that the effects of the squared coverage of abandoned areas and the squared distance to green urban areas on life satisfaction, which are significant at the 10% level only in the baseline specification, are insignificant.

[29] Notably, the values are optimal in the sense that they maximise life satisfaction.

[30] The optimal values of zero for the coverage of abandoned areas and the distance to green urban areas come from the assumption that the effects of the squared coverage of abandoned areas and the squared distance to green urban areas on life satisfaction are insignificant.

5. Policy Implications

For urban planning and development, we can calculate the net well-being benefit in pecuniary terms that arises, on average, when increasing the coverage of green urban areas in a pre-defined radius of 1,000 metres around households by one hectare. This is especially interesting in view of the fact that there is, on average, an under-supply of green urban areas in major German cities; the mean and optimal value is 23 and 33 hectares, respectively. We know that the gross well-being benefit in pecuniary terms that arises, on average, when increasing the coverage of green urban areas in a pre-defined radius of 1,000 metres around households by one hectare is 933,647 Euro annually.[31] The costs of the construction and maintenance of green urban areas differ between cities and neighbourhoods depending on the type of facilities and intensity of usage. We take parks in Berlin as an example. The average construction costs of parks range from 5 Euro per square metre for parks located near the city periphery, with average quality and no particular infrastructure, to 201 Euro per square metre for parks located near the city centre, with high quality and cost-intensive infrastructure, yielding average construction costs of an additional hectare of park between 3,333 and 134,000 Euro annually (Senate Department for Urban Development and the Environment, 2010). The average life span of parks is 15 years, after which major reinvestments become necessary. The average maintenance costs of parks range from 2 Euro per square metre annually for parks with no particular infrastructure to 7 Euro per square metre annually for parks with cost-intensive infrastructure, yielding average maintenance costs of an additional hectare of park between 20,000 and 70,000 Euro annually (Senate Department of Finance, 2013). As such, the average total costs of an additional hectare of park range between 23,333 and 204,000 Euro annually. Thus, the net well-being benefit in pecuniary terms that arises, on average, when increasing the coverage of green urban areas in a pre-defined radius of 1,000 metres around households by one hectare ranges between 729,647 and 910,314 Euro annually.

Naturally, this cost-benefit analysis is based only on a partial equilibrium analysis,

[31] We obtain this number from the following thought experiment: We describe a circle around a new green urban area of one hectare size such that all households within this circle have the new green urban area in a pre-defined radius of 1,000 metres around them. We know that residents are, on average, willing to pay 23 Euro of monthly net individual income in order to increase the coverage of green urban areas in a pre-defined radius of 1,000 metres around households by one hectare. We know that the average household size is 1.8 and the average population density is 2,177 individuals per square metre, yielding 6,089 individuals within the circle around the new green urban area. We obtain the gross well-being benefit in pecuniary terms as $(12 \times 23 \times 6,089)/1.8 = 933,647$. See Figure C.6 for an illustration.

as it does not take into account the effects of the new green urban area on the house prices and rents in its surroundings, as well as other externalities. Moreover, taking the example of parks in Berlin, we implicitly assume that green urban areas are equivalent to parks; there is, however, quite some heterogeneity in this land use category, which can include, for example, zoos, gardens, parks, and castle parks, as well as suburban natural areas used as parks, all of which are likely to differ in their effect on residential well-being. Nevertheless, the above cost-benefit analysis shows that there is a substantial net well-being benefit in pecuniary terms from reducing the under-supply of green urban areas in major German cities, and, as the heterogeneity analysis suggests, urban areas with high shares of elderly might profit most. A straightforward, and potentially cost-effective, way to reduce this under-supply would be to transform abandoned areas, if available and feasible, into green urban areas (Garvin et al., 2013).

6. Discussion

We show that, for the 32 major German cities with greater than or equal to 100,000 inhabitants, access to green urban areas matters for residential well-being, but access to abandoned areas matters even more, whereas access to forests and waters does not matter much. In fact, coverage of and, even more so, proximity to green urban areas are significantly positively associated with, whereas proximity to and, even more so, coverage of abandoned areas are significantly negatively associated with life satisfaction. Moreover, these relationships are concave in nature. Finally, the effects are strongest for residents who are older, accounting for up to a third of the size of the effect of being unemployed on life satisfaction. While the positive effect of green urban areas on life satisfaction might be explained by their provision of publicly accessible land for recreation and social interaction, the negative effect of abandoned areas might be explained by the negative effect of vacant land on mental and physical health identified in earlier studies (see, for example, Branas et al. (2011) and Garvin et al. (2013)). Moreover, there is a considerable emerging literature on vacant land and social segregation, (perceived) unsafety, and (fear of) crime in response to land use characteristics and neighbourhood physical environment (see, for example, Bixler and Floyd (1997), Kuo et al. (1998), Branas et al. (2011), and Branas et al. (2012)). All these aspects might be important transmission mechanisms through which the negative effect of abandoned areas on life satisfaction might arise.

Our results on green urban areas confirm the results of a similar study by White et al. (2013). White et al. (2013) show that green urban areas do not only have a positive effect on the mental health of residents in England, but also on their life satisfaction. However, besides the fact that the authors only investigate the effects of green urban areas and waters on residential well-being, there are other important differences between their study and ours. White et al. (2013), using panel data from the British Household Panel Study, adopt a similar approach in terms of the empirical model, especially when it comes to using fixed-effects (within) estimators, but, using cross-section data from the General Land Use Database, adopt a different approach in terms of the data on urban land use. In fact, their data are based on aggregated areas, which are, in turn, based on population densities. As a result, these areas differ from each other in size and shape, implying that more densely populated areas are smaller than less densely populated ones, *et vice versa*. On the contrary, our data are, among others, based on coverages, which are, in turn, based on pre-defined radii around households. As a result, these areas are equal to each other in size and shape. Moreover, they are free from methodological issues that arise when aggregating geographical information. This is a strong advantage, especially when considering the geographical location and mobility of households.[32] Nevertheless, White et al. (2013), like us, have only cross-section data on urban land use, essentially relying on residents who move from one urban area to another in order to provide variation in and therewith identify the effect of green urban areas on residential well-being. As a result, White et al. (2013), like us, cannot account for simultaneity and therewith cannot claim that the identified effects are causal; in fact, their empirical model is more prone to simultaneity than ours, as they do not include both individual and city of residence fixed effects. In any case, this issue has been found to be minor in other contexts, and we conduct several robustness checks to show that it is also minor here.

Naturally, our data on urban land use are not entirely free of limitations themselves. First, they only include objects of a minimum size of 0.25 hectare. This introduces measurement error, as the accumulation of objects of smaller sizes is neglected, which is especially problematic for coverages in case that radii are small. However, the bias resulting from this measurement error is likely to be minor, as the pre-defined radius of 1,000 metres around households is rather small. Second, the European Urban Atlas is only available for the year 2006, whereas the German Socio-Economic Panel is available for the time period between 2000 and 2012. This introduces measurement error, as the data on urban land use are cross-section data and the data on residential well-being are panel data, implying that single-year observations of urban land use are assigned to multiple-year observations of residential well-being. However, the bias resulting from this measurement error

[32] See Holt et al. (1996) for a review of issues regarding the use of aggregated data.

is, again, likely to be minor, as the presence of the different land use categories is rather persistent over time.[33] Another aspect that could limit our findings is bias resulting from omitted or unobserved variables. For example, the amenity value of privately owned open space is often discussed in the literature (see, for example, Bolitzer and Netusil (2000) and Irwin and Bockstael (2001), as well as Walsh (2007) and Strong and Walsh (2008) for theoretical models on endogenous, private provision of open space), and our data on urban land use provide only information on public open space, ignoring privately owned green or brown fields. However, considering the fact that only a very small part of open space in major German cities is privately owned and that such time-invariant unobserved heterogeneity between cities should be captured by the city of residence fixed effects, the bias resulting from omitted or unobserved variables in form of privately owned open space is, once again, likely to be minor.

In view of these limitations, there is a lot of room for further research. Most importantly, further research should be directed towards establishing the causality of the identified effects, potentially by exploiting novel panel data on and exogenous variation in urban land use, which might become available in the future. Moreover, further research should be directed towards incorporating the role that the quality of the different land use categories plays for residential well-being. Taken together, the spatial analysis of the relationship between urban land use and residential well-being remains a promising field of research.

[33]In a robustness check, we narrow down the observation period around the year 2006, and the results remain qualitatively the same as in the baseline model. The results are available upon request.

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Appendix A. Data

Figure A.1: Data - Definition of Coverage

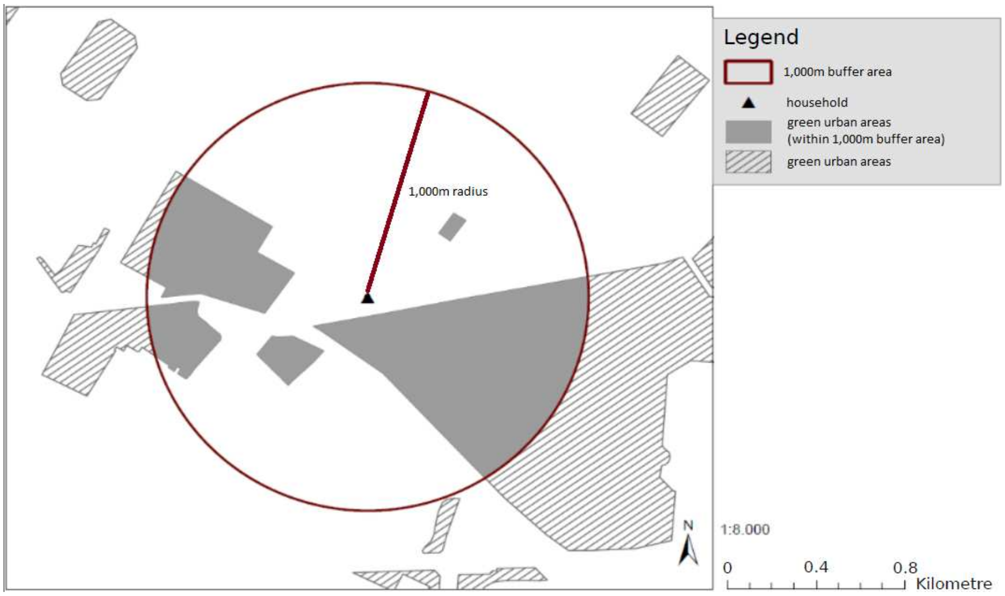

Table A.1: Independent Variables of Interest

Variables	Descriptions	Examples	Categories
Green urban areas	Includes all land for predominantly recreational use[a] ; not included are private gardens within housing areas, cemeteries, agricultural areas, green fields not managed for recreational use, sports and leisure facilities	Zoos, gardens, parks, castle parks, suburban natural areas used as parks	1.4.1
Forests	Includes all (even privately owned) areas with ground coverage of tree canopy greater than 30% and tree height greater than five metres	-	3
Waters	Includes all water bodies exceeding one hectare	Lakes, rivers, canals	4
Abandoned areas	Includes all areas in the vicinity of artificial surfaces still waiting to be used or re-used; not included are areas showing any signs of recreational or agricultural use	Waste land, removed former industrial areas, gaps between new construction areas or leftover land	1.3.4

[a] Incorporates playgrounds located within green urban areas

Source: European Urban Atlas 2006

Table A.2: Descriptive Statistics

Variables	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Dependent Variable					
Satisfaction With Life	6.9946	1.7699	0	10	42,256
Independent Variables of Interest					
Distance to Green Urban Areas	2.7860	2.6819	0	40.0621	42,256
Distance to Forests	18.5378	16.9615	0	91.2399	42,256
Distance to Waters	13.0626	9.7460	0	85.3310	42,256
Distance to Abandoned Areas	9.6092	6.6843	0	53.4247	42,256
Coverage of Green Urban Areas	22.6464	20.3382	0	194.2405	42,256
Coverage of Forests	11.3870	26.2562	0	261.8127	42,256
Coverage of Waters	6.1407	13.6202	0	148.7035	42,256
Coverage of Abandoned Areas	1.4027	2.1019	0	35.8380	42,256
Other Independent Variables - Geo Level					
Distance to City Centre	58.7486	39.7389	0.6122	253.0730	42,256
Distance to City Periphery	32.1597	22.1740	0.0490	117.2422	42,256
Other Independent Variables - Micro Level					
Age	48.7359	17.5575	17	99	42,256
Is Female	0.5304	0.4991	0	1	42,256
Is Married	0.5670	0.4955	0	1	42,255
Is Divorced	0.0853	0.2793	0	1	42,255
Is Widowed	0.0611	0.2394	0	1	42,255
Has Very Good Health	0.1003	0.3004	0	1	42,203
Has Very Bad Health	0.0409	0.1980	0	1	42,203
Is Disabled	0.1280	0.3341	0	1	42,078
Has Migration Background	0.1655	0.3717	0	1	42,103
Has Tertiary Degree	0.3599	0.4800	0	1	41,143
Has Lower Than Secondary Degree	0.1321	0.3386	0	1	41,143
Is in Education	0.0188	0.1357	0	1	42,256
Is Full-Time Employed	0.4065	0.4912	0	1	42,256
Is Part-Time Employed	0.0988	0.2984	0	1	42,256
Is on Parental Leave	0.0209	0.1430	0	1	42,256
Is Unemployed	0.0719	0.2583	0	1	42,256
Individual Income[a]	1,285.2635	2,256.8580	0	50,000.0860	24,208
Has Child in Household	0.2367	0.4250	0	1	42,256

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Variables	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Household Income[a]	2,512.9267	1,659.3480	0	101,097.7700	42,240
Lives in House[b]	0.2244	0.4172	0	1	6,698
Lives in Small Apartment Building	0.0991	0.2989	0	1	6,698
Lives in Large Apartment Building	0.3235	0.4679	0	1	6,698
Lives in High Rise	0.0340	0.1813	0	1	6,698
Number of Rooms per Individual	1.6888	0.8555	0.2500	13	38,078
Other Independent Variables - Macro Level					
Unemployment Rate	11.9809	3.9593	4.5000	20.8000	40,649
Average Household Income[a]	1,484.1110	244.8841	1,047.2000	2,050.4000	34,974

[a] Annually in Euro/Inflation-Adjusted (Base Year 2000), [b] Detached, Semi-Detached, or Terraced

Note: The respective distance is measured as the Euclidean distance in 100 metres between households and the border of the nearest land use category of interest. The respective coverage is measured as the hectares covered by the land use category of interest in a pre-defined radius of 1,000 metres around households. All figures are rounded to four decimal places.

Source: German Socio-Economic Panel 2000-2012, individuals aged 17 or above, own tabulations

Appendix B. Results

Table B.1: Results - Final Sample, Satisfaction With Life, FE Model, *Distances*

Regressors	Satisfaction With Life FE
Distance to Green Urban Areas	-0.0409***
	(0.0134)
Distance to Forests	-0.0020
	(0.0050)
Distance to Waters	0.0049
	(0.0067)
Distance to Abandoned Areas	0.0259***
	(0.0099)
Distance to Green Urban Areas Squared	0.0012*
	(0.0006)
Distance to Forests Squared	-0.0000
	(0.0001)
Distance to Waters Squared	-0.0001
	(0.0002)
Distance to Abandoned Areas Squared	-0.0009**
	(0.0004)
Controls	Yes
Constant	6.9023***
	(0.4662)
Number of Observations	33,782
Number of Individuals	6,959
F-Statistic	369.8400
R^2	0.0575
Adjusted R^2	0.0556

[a] Annually in Euro/Inflation-Adjusted (Base Year 2000), [b] Detached, Semi-Detached, or Terraced

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Note: The respective distance is measured as the Euclidean distance in 100 metres between households and the border of the nearest land use category of interest. All figures are rounded to four decimal places.

Source: German Socio-Economic Panel 2000-2012, individuals aged 17 or above, own calculations

Table B.2: Results - Final Sample, Satisfaction With Life, FE Model, *Coverages*

Regressors	Satisfaction With Life FE
Coverage of Green Urban Areas	0.0066***
	(0.0025)
Coverage of Forests	-0.0019
	(0.0020)
Coverage of Waters	-0.0046
	(0.0031)
Coverage of Abandoned Areas	-0.0395***
	(0.0145)
Coverage of Green Urban Areas Squared	-0.0001***
	(0.0000)
Coverage of Forests Squared	0.0000
	(0.0000)
Coverage of Waters Squared	0.0001*
	(0.0000)
Coverage of Abandoned Areas Squared	0.0015*
	(0.0009)
Controls	Yes
Constant	6.8627***
	(0.3773)
Number of Observations	33,782
Number of Individuals	6,959
F-Statistic	391.3500
R^2	0.0575
Adjusted R^2	0.0557

[a] Annually in Euro/Inflation-Adjusted (Base Year 2000), [b] Detached, Semi-Detached, or Terraced

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Note: The respective coverage is measured as the hectares covered by the land use category of interest in a pre-defined radius of 1,000 metres around households.
All figures are rounded to four decimal places.

Source: German Socio-Economic Panel 2000-2012, individuals aged 17 or above, own calculations

Table B.3: Results - Other Sub-Samples, Satisfaction With Life, FE Models, *Distances*

	Satisfaction With Life							
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance to Green Urban Areas	-0.0351*	-0.0450**	-0.1811***	-0.0170	-0.0168	-0.0448	-0.0127	-0.0865***
	(0.0187)	(0.0197)	(0.0388)	(0.0150)	(0.0205)	(0.0279)	(0.0254)	(0.0215)
Distance to Forests	0.0030	-0.0065	-0.0130	-0.0034	0.0020	-0.0037	-0.0261**	0.0082
	(0.0072)	(0.0071)	(0.0114)	(0.0058)	(0.0084)	(0.0078)	(0.0112)	(0.0063)
Distance to Waters	0.0112	-0.0002	0.0326*	-0.0039	0.0162	-0.0015	0.0017	0.0046
	(0.0094)	(0.0098)	(0.0169)	(0.0076)	(0.0123)	(0.0101)	(0.0145)	(0.0088)
Distance to Abandoned Areas	0.0247*	0.0305**	0.0689***	0.0153	0.0665***	-0.0047	0.0165	0.0282**
	(0.0139)	(0.0144)	(0.0235)	(0.0113)	(0.0161)	(0.0151)	(0.0194)	(0.0130)
Distance to Green Urban Areas Squared	0.0006	0.0019**	0.0089***	0.0003	0.0005	0.0015	0.0003	0.0049***
	(0.0009)	(0.0009)	(0.0023)	(0.0007)	(0.0007)	(0.0018)	(0.0009)	(0.0015)
Distance to Forests Squared	-0.0001	-0.0000	0.0000	0.0000	-0.0001	0.0001	0.0003*	-0.0001*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Distance to Waters Squared	-0.0002	-0.0000	-0.0007	0.0001	-0.0004	0.0000	0.0001	-0.0002
	(0.0002)	(0.0003)	(0.0005)	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0002)
Distance to Abandoned Areas Squared	-0.0008	-0.0010*	-0.0021**	-0.0006	-0.0020***	-0.0000	-0.0002	-0.0009*
	(0.0005)	(0.0005)	(0.0008)	(0.0004)	(0.0006)	(0.0005)	(0.0007)	(0.0005)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.6440***	7.7063***	6.2500***	6.5588***	7.6760***	6.7902***	7.3581***	6.4217***
	(0.6563)	(0.6740)	(1.2801)	(0.6477)	(0.7809)	(0.7546)	(1.1134)	(0.5834)
Number of Observations	17,886	15,896	16,524	17,258	17,153	16,629	8,226	25,556
Number of Individuals	3,647	3,312	3,248	4,309	4,392	4,271	2,170	5,702
F-Statistic	335.8400	602.1700	1,167.3600	177.0500	6,133.4500	442.2200	90.5700	298.3500
R^2	0.0570	0.0632	0.0667	0.0546	0.0546	0.0618	0.0495	0.0619
Adjusted R^2	0.0535	0.0592	0.0640	0.0509	0.0514	0.0580	0.0443	0.0594

[a] Annually in Euro/Inflation-Adjusted (Base Year 2000), [b] Detached, Semi-Detached, or Terraced

(1) Female Sub-Sample, (2) Male Sub-Sample, (3) Old-Age Sub-Sample, (4) Young-Age Sub-Sample,
(5) High-Income Sub-Sample, (6) Low-Income Sub-Sample, (7) Child Sub-Sample, (8) Non-Child Sub-Sample

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Note: The respective distance is measured as the Euclidean distance in 100 metres between households and the border of the nearest land use category of interest. All figures are rounded to four decimal places.

Source: German Socio-Economic Panel 2000-2012, individuals aged 17 or above, own calculations

Table B.4: Results - Other Sub-Samples, Satisfaction With Life, FE Models, *Coverages*

	Satisfaction With Life							
Regressors	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Coverage of Green Urban Areas	0.0064*	0.0064*	0.0184***	0.0036	0.0080**	0.0099**	0.0062	0.0059*
	(0.0035)	(0.0037)	(0.0061)	(0.0029)	(0.0039)	(0.0040)	(0.0052)	(0.0032)
Coverage of Forests	-0.0015	-0.0025	-0.0004	-0.0012	0.0010	-0.0047	0.0043	-0.0030
	(0.0025)	(0.0033)	(0.0046)	(0.0023)	(0.0038)	(0.0030)	(0.0037)	(0.0027)
Coverage of Waters	-0.0083*	-0.0011	-0.0037	-0.0037	-0.0151**	0.0079*	-0.0215***	0.0026
	(0.0046)	(0.0042)	(0.0076)	(0.0035)	(0.0059)	(0.0048)	(0.0077)	(0.0038)
Coverage of Abandoned Areas	-0.0437*	-0.0310	-0.0663**	-0.0201	-0.1957***	0.0004	-0.0166	-0.0542***
	(0.0230)	(0.0193)	(0.0292)	(0.0190)	(0.0412)	(0.0214)	(0.0296)	(0.0183)
Coverage of Green Urban Areas Squared	-0.0000	-0.0001**	-0.0002***	-0.0000	-0.0001	-0.0001***	-0.0001	-0.0001*
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Coverage of Forests Squared	0.0000	0.0000	0.0000	0.0000	-0.0000	0.0000	-0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Coverage of Waters Squared	0.0001*	0.0000	0.0000	0.0001*	0.0002**	-0.0000	0.0002**	-0.0000
	(0.0001)	(0.0000)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0000)
Coverage of Abandoned Areas Squared	0.0003	0.0017	0.0026**	-0.0004	0.0170***	0.0001	-0.0003	0.0029**
	(0.0016)	(0.0010)	(0.0012)	(0.0015)	(0.0046)	(0.0010)	(0.0013)	(0.0012)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	6.8905***	7.3775***	4.3171***	6.8238***	7.8716***	6.8743***	7.3522***	6.6755***
	(0.5256)	(0.5536)	(1.1226)	(0.5603)	(0.6762)	(0.6106)	(1.0055)	(0.4745)
Number of Observations	17,886	15,896	16,524	17,258	17,153	16,629	8,226	25,556
Number of Individuals	3,647	3,312	3,248	4,309	4,392	4,271	2,170	5,702
F-Statistic	358.9500	634.7800	1,246.8500	187.3400	5,134.3200	478.0600	97.9100	314.3900
R^2	0.0571	0.0627	0.0638	0.0545	0.0546	0.0624	0.0486	0.0614
Adjusted R^2	0.0538	0.0590	0.0613	0.0510	0.0516	0.0588	0.0438	0.0591

[a] Annually in Euro/Inflation-Adjusted (Base Year 2000), [b] Detached, Semi-Detached, or Terraced

(1) Female Sub-Sample, (2) Male Sub-Sample, (3) Old-Age Sub-Sample, (4) Young-Age Sub-Sample,
(5) High-Income Sub-Sample, (6) Low-Income Sub-Sample, (7) Child Sub-Sample, (8) Non-Child Sub-Sample

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Note: The respective coverage is measured as the hectares covered by the land use category of interest in a pre-defined radius of 1,000 metres around households. All figures are rounded to four decimal places.

Source: German Socio-Economic Panel 2000-2012, individuals aged 17 or above, own calculations

Figure B.2: Results - Optimal Value of Distance to Green Urban Areas

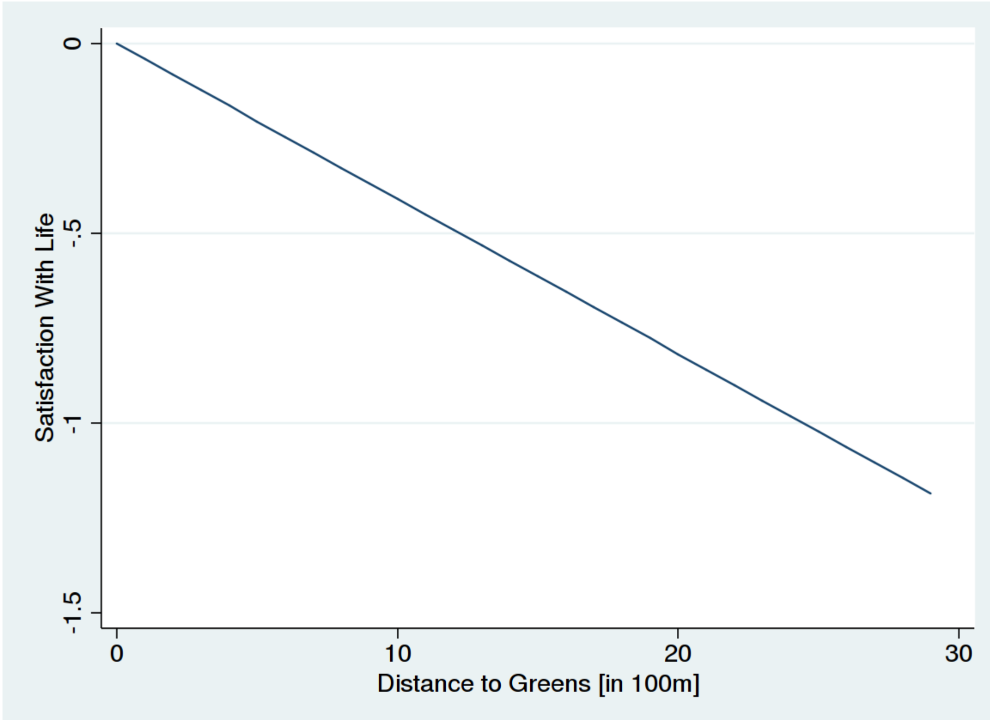


Figure B.3: Results - Optimal Value of Distance to Abandoned Areas

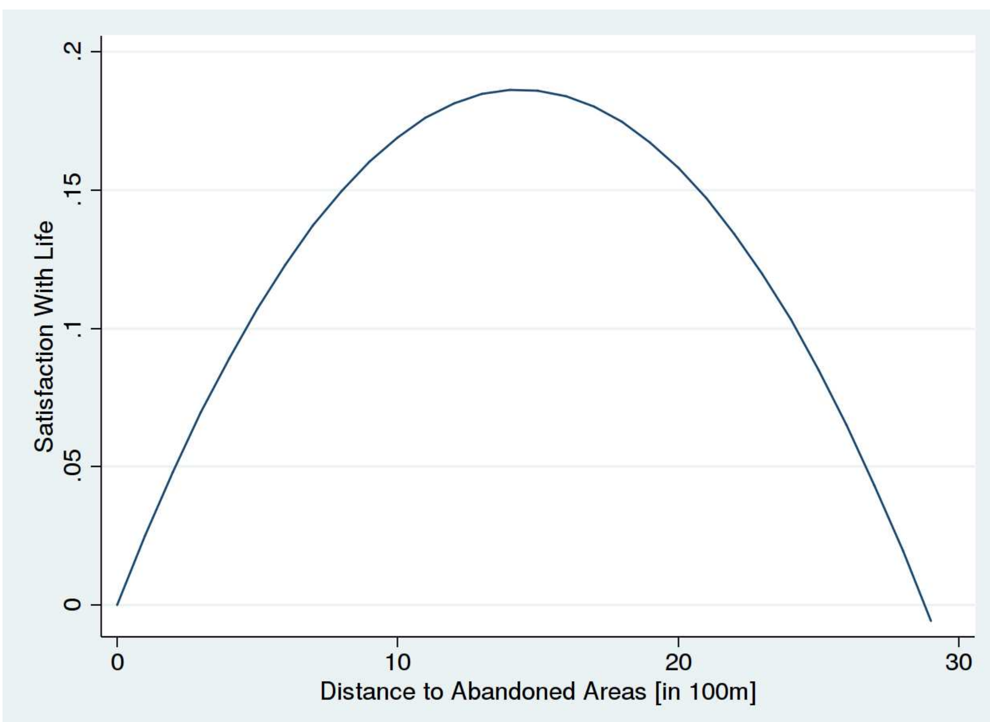


Figure B.4: Results - Optimal Value of Coverage of Green Urban Areas

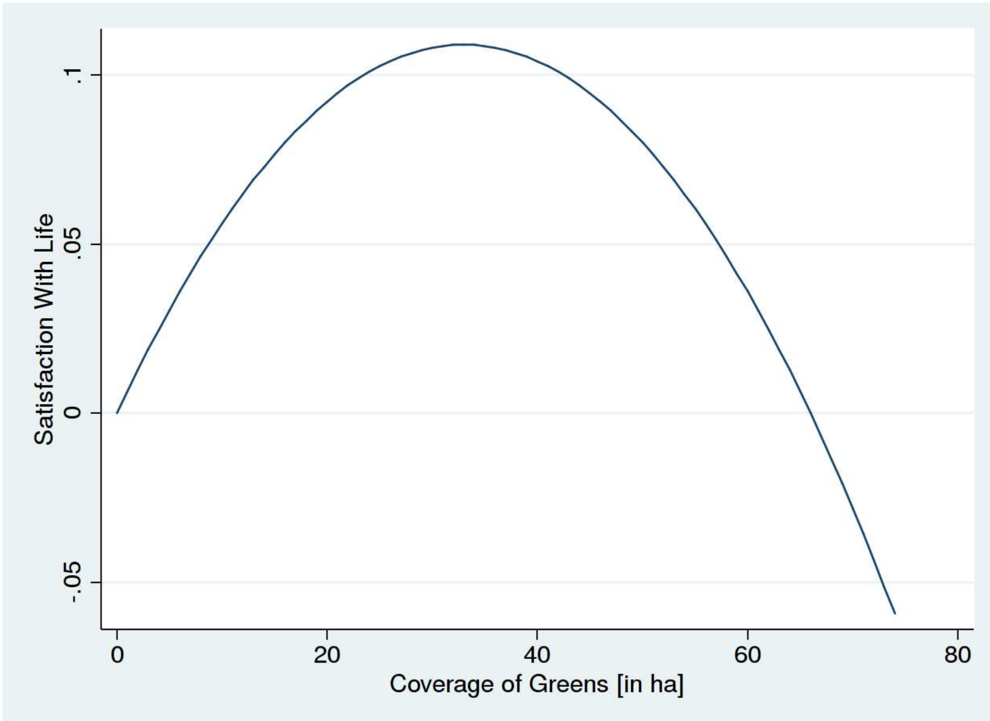
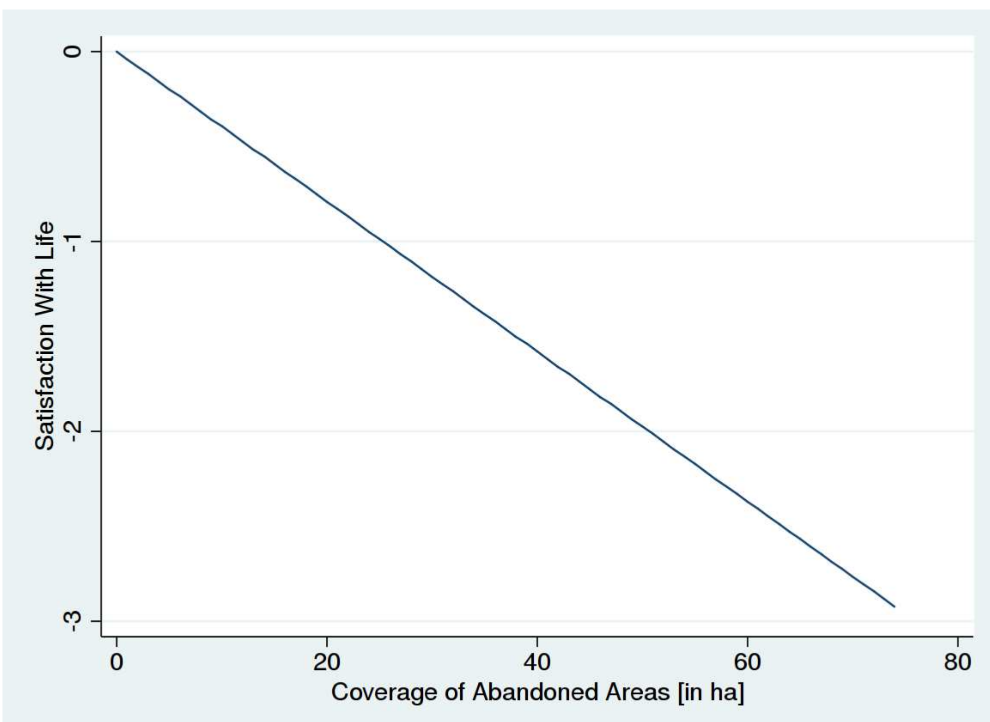


Figure B.5: Results - Optimal Value of Coverage of Abandoned Areas



Appendix C. Policy Implications

Figure C.6: Thought Experiment