The Value of Naturalness of Urban Green Spaces: Evidence from a Discrete Choice Experiment

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ABSTRACT The range of benefits for humans and biodiversity conservation provided by urban green spaces (UGS) receives substantial attention in relation to urban planning and

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management. However, little is known about the value of nature in UGS. We developed a graphical measurement scale for the naturalness of UGS, with 5 steps between largely sealed and largely wilderness, which was embedded in an online survey and a discrete choice experiment. Using mixed logit models, we find that German citizens have a mean willingness to pay of €20.25 per month for an increase in the naturalness of the closest UGS by one step. (JEL C14, Q51)

1 Introduction

Globally, biodiversity change is accelerating (IPBES, 2019) and concerns about biodiversity loss are widespread. In the last decades, cities with their fragmented structure of gardens and parks have received increasing attention as places for biodiversity conservation (Lepczyk et al., 2017; Staude et al., 2021). Especially urban green spaces (UGS) provide a wide range of benefits for humans; for example, for health and recreation (Aronson et al., 2017). Moreover, UGS are an important component of urban sustainability and can impact the cities in several ways; for example, by improving the air quality through filtration of polluted air (Janhäll, 2015) or by offering shade and cooling (Dimoudi and Nikolopoulou, 2003).

In the last decades, several stated preference studies estimated a positive willingness to pay (WTP) for UGS close to the place of residence (Del Saz Salazar and García Menéndez, 2007; Bernath and Roschewitz, 2008; Bullock, 2008). For instance, Tu et al. (2016) used Choice Experiments (CE) to investigate preference heterogeneity for distance to peri-urban forests and parks in France. Results show that the WTP for having UGS in the vicinity are heterogeneous among income classes and private garden ownership. They found that tenants have a particularly high WTP for living close to UGS, whereas having a house with a private garden may be a substitute for being close to UGS. However, little is known whether and to what extent people value, and are willing to pay for, the naturalness of UGS

and the urban biodiversity maintained by UGS. Moreover, the few existing studies found mixed results. The results of a CE in Dublin, Ireland, conducted by Bullock (2008) suggested that naturalness is considered as more important in larger UGS than in smaller ones. However, the study of Stessens et al. (2020) pointed to the fact that the naturalness of UGS is perceived as a less important quality factor for UGS in Brussels, Belgium. Giergiczny and Kronenberg (2014) used a CE to calculate the value of street trees in Poland and suggest how the findings would help to improve UGS. They found that respondents indeed have a WTP for increasing the number of street trees. Hwang et al. (2019) elicited preferences for natural growth in UGS in Singapore. They used binominal logistic regression models and showed that the people have preferences for wild and natural urban environments.

However, neither revealed nor stated preference studies so far have identified and quantified the value of naturalness of UGS. Using survey data, this study investigates the WTP for the naturalness of UGS and the walking distance to UGS in Germany using a discrete choice experiment (DCE). Of interest is the relative valuation of naturalness of UGS and the walking distance to the UGS, as visitors of UGS rate the naturalness of urban parks, which describes biodiversity-related characteristics (e.g. plant species richness and animal richness), as one of the most crucial attributes of the park characteristics, besides cleanliness and low level of crime (Bertram and Rehdanz, 2015). For urban planners, it is crucial to know if values are universal, or if they systematically differ between cities.

With our study, we aim to give a better understanding of preferences for natural and biodiverse UGS. Thus, to our best knowledge, we provide the first DCE study estimating the WTP for biodiverse urban green, using a sample of 22 large cities across Germany. We hypothesize that Germans have a higher preference for a more natural and biodiverse UGS compared to an UGS with less natural elements. However, this is not clear a priori, as biodiversity could also be perceived as a "bad", for example because naturalness is associated

with untidiness, or because it comes at the cost of lost space in parks for alternative uses such as sport. The results of the study are particularly relevant since almost three-quarters of the EU's population is living in urban areas (Eurostat 2016), and cities might therefore be the place where most people experience biodiversity. Moreover, we hypothesize that people have a higher WTP for a short walking distance to UGS. To answer our research questions, we first, designed a scale on which participants are asked to subjectively assess the biodiversity of their closest UGS, which they use most often. We operationalize perceived biodiversity by drawing on the term "naturalness" or "nearness to nature", previously used in surveys (Bertram and Rehdanz, 2015) and measure it with a graphical 5-point Likert scale. As biodiversity is a complex concept with which most Germans are not familiar, we use "naturalness" as a bridging concept.

Stated preference studies have to find an appropriate payment vehicle in a hypothetical market. Here, we use changes to the housing rent as payment vehicle, as numerous hedonic pricing studies have shown that changes in UGS characteristics affect the housing market, making this a credible payment vehicle that participants are familiar with. Our study reveals that the mean monthly WTP for naturalness in UGS is €20.25 per month for a one-step increase of naturalness on the 5-point scale that ranges from hardly natural to very natural. Moreover, the mean respondent has a negative monthly WTP of €-2.47 per month for an additional minute of walking distance to the closest UGS. However, we find higher negative WTPs for respondents with a short walking distance (€-5.79 per month) compared to people with a walking distance of more than 15 minutes (€-1.74 per month). The mean WTP values vary between cities. The mean WTP for naturalness range from €12.44 per month in Dresden to €35.88 per month in Bremen. The highest WTP for walking distance, in absolute value, is shown for Bremen (€-3.62 per month) while respondents from Dresden have the lowest WTP (€-1.64 per month). One possible explanation is that people sort

according to their preferences for local public goods and move to the city that offers the bundle of amenities that best suit their preferences, as suggested by Tiebout (1956). People with a high WTP for natural green space would tend to move to a city that offers a lot of natural green space. Based on that theory, we expect a positive correlation between the WTP for natural green space and the amount of natural green space in the city.

2 Experimental Design

Discrete choice experiments (DCE) have become a standard method to reveal determinants of people's behavior and investigate the WTP for specific attributes. In the period from the 16th of June 2020 to the 29th of June 2020, as well as from the 20th of July 2020 to the 28th of July 2020, we conducted an online survey to elicit preferences for the access to, and naturalness of, UGS. The survey addressed respondents that rent a flat in the capitals of the 16 federal states of Germany (Berlin, Bremen, Dresden, Düsseldorf, Erfurt, Hamburg, Hanover, Kiel, Magdeburg, Mainz, Munich, Potsdam, Saarbrucken, Schwerin, Stuttgart, Wiesbaden,), and six further major German cities (Cologne, Dortmund, Essen, Frankfurt, Leipzig and Nuremberg). Moreover, we ran an additional survey in 14 out of the initially 22 cities from November 16th 2021 to January 17th 2022, to investigate the preferences on the city level in more detail.

The survey consisted of four parts. In the first part, we asked questions regarding the housing situation of the respondents. In the second part, we asked questions about the perceptions and attitudes towards biodiversity in the neighborhood and their use of UGS. The third part asked (incentivized) to upload a photo of the immediate neighborhood of the flat and contains a DCE. In the last part of our survey, we collected the sociodemographic characteristics and personality traits of the respondents.

Johnstone et al. (2017) note that the valuation scenario should be seen as credible by respondents in order to derive valid value estimates from stated preference surveys. Consequently, the design was discussed in three independent two-hour online focus group discussions with five participants each to improve our questionnaire. A professional moderator from a marketing agency facilitated the focus group discussions. The survey was revised according to the feedback. One issue of particular importance in the focus group discussions was to gauge our graphical representation of the naturalness of the UGS, shown in Figure 1.[1] Additionally, the survey was pretested from the 15th of April 2020 to the 21st of April 2020 with 520 participants, of which 264 respondents answered the pretest completely. We used this pretest sample to assess the suitability of our survey, the comprehensibility of the questions, and to design the choice sets.

[Insert Figure 1 about here]

In total, 17,109 respondents were invited to participate in the online surveys by a marketing agency, of which 5,533 respondents answered the survey completely.[2] Among the remaining, we excluded responses with implausible answers and obvious misstatements.[3] This procedure left us a total of 4,913 responses, which were included in the analyses. The initial sample was commissioned to be nationally representative for age (18–70), gender, and income, with some deviations of the final sample from national figures (Appendix Table A1). On average, the survey required approximately 17 minutes to be completed (median 13 minutes). The number of respondents in each of the cities included in the survey, as well as the spatial distribution within Germany, is presented in Appendix Figure A1.

In the DCE, the respondents were asked to consider that the closest UGS, which they state to use most often, will be restructured in terms of naturalness and that the walking

distance to the UGS will be changed by modifying roads or walks. In the following, we refer to this UGS by using the term "closest UGS." The cost of the rebuilding was supposed to be charged through the monthly rental payment, which can result in additional costs or savings. In the DCE, the participants had the choice between two alternative programs for the rebuilding of their closest UGS and their current situation (status quo). The attribute levels for the status quo were computed within the online survey based on the respondents' answers to previous questions in the questionnaire, where they were asked to indicate their monthly rental and additional payments for the flat, as well as the walking distance from their flat to the closest UGS.

Furthermore, the respondents were asked to assess the naturalness of the closest UGS on a 5-point Likert scale, ranging from *hardly natural* to *very natural*, which we designed for our survey. The Likert scale was described graphically, as shown in Figure 1. The scale depicts five iconic states of an UGS, ranging from a sealed playground with non-native plants and artificial light at the lower end to a pond with diverse vegetation, close to wilderness, at the upper end. At the latter several insect and bird species are visible, including species such as the kingfisher, which require a habitat in a good ecological state. The graphical scale was originally developed by several expert panel meetings of biologists and economists to reflect an increasing index of biodiversity and ecosystem services (such as water purification and carbon sequestration). It was validated and slightly revised in the three focus group discussions, where respondents were asked among the others (1) "What do you understand by the term 'naturalness'? (2) "What characteristics does a near-natural green space have for you?" (3) rank the five illustrations by the degree of naturalness.

Again, the focus group discussions as well as our pretest confirmed that our baseline (status quo) condition, as well as the proposed change(s) relative to the status quo, were well and consistently understood and viewed as credible by the respondents.

In our second survey, we additionally asked respondents to mark their most often used UGS on a map. This enabled us to detect who is using which UGS, and to test how different respondents perceive the same UGS. We found a high correlation of the perceived naturalness for the same UGS among the respondents. Thus, we assume that the perception of a respective UGS is homogenous among the respondents.We calculated a highly significant ($p < 0.01$) Cramers-V coefficient of 0.46 for the perception of naturalness of respondents in the same UGS if four or more respondents use this UGS.

The status quo is defined using the information provided by the participants in the survey. For the other alternatives, we define levels of the attributes, which can be found in Table 1.

The levels of the attribute *walking distance* were calculated following Kolbe and Wüstemann (2015), who estimate a mean distance to UGS in German cities of 300 m with a standard deviation (SD) of 300 m. Other studies also suggest that 300 m is an appropriate buffer zone for UGS (Kong et al., 2007; Liebelt et al., 2018; Grunewald et al., 2019).[4] In one survey question, we ask the respondents to state their walking distance to the closest UGS in minutes. We define a 100% change from this walking distance as 300 m (1SD). Changes in the original rental payments are derived from previous hedonic price studies, examining the price premiums for the distance to the closest UGS on the rent (Kolbe and Wüstemann, 2015; Schläpfer et al., 2015; Liebelt et al., 2018).

[Insert Table 1 about here]

For the two programs and the status quo, the levels for the attribute naturalness were described graphically, as shown in Figure 1.

Once the attributes and levels have been determined, these were combined into choice sets. A full factorial design included 150 profiles. As not all alternative choices are equally informative, we selected a subset of 30 choice sets using a fractional factorial Bayesian D-optimal design computed by means of the *NGene* software. To build the choice sets for the final experiments, a multinomial logit model (MNL) was estimated using the pretest data. The estimates served as priors to generate 30 choice sets, creating an efficient design to maximize the D-efficiency measure. The final design had a D-error of 0.051. Following Loureiro and Umberger (2007), the 30 choice sets were randomly allocated between the respondents to mitigate any potential ordering impacts. Each respondent was faced with 10 choice sets. Figure 2 shows an example of a choice set, in which the status quo shows the average attribute levels in the status quo over all respondents.

[Insert Figure 2 about here]

Descriptive analyses show that out of the 4,913 respondents, 317 (6%) respondents always accepted one of the rebuilding schemes, 1,371 (28%) respondents never accepted a scheme, and a majority of 3,225 (66%) respondents decided selectively.

3 Data description

The median respondent is a 40-year-old female, who is married and who lives in a two-person household without children. She has an academic degree, works full-time with an average of 38 hours a week, and has a monthly net income of €2,252. The descriptive statistics of the socioeconomic characteristics are shown in Appendix Table A2.

In the second part of the survey, we asked questions regarding the closest UGS, as well as perception questions related to the biodiversity of this UGS. We are interested in

whether the two public environmental amenities, namely the access to UGS and the degree of UGS biodiversity, have some value for the respondents and, if so, to what extent.

The average walking distance from the rented flat to the closest UGS is 11.50 minutes (Table 2). Most of the respondents visit this UGS on a weekly basis (38%), followed by a daily (31%) and a monthly basis (22%). Just 3% of the respondents stated that they visit this UGS on a yearly basis or never. Many respondents (43%) indicated that they stay there between 31 and 60 minutes, followed by a number who stay there less than 30 minutes (27%). Scored on a 5-point Likert scale with categories ranging from "fully agree" (1) to "fully disagree" (5), the relative majorities of respondents fully agree with the statement that the UGS is relaxing (45%) and that they feel safe when visiting it (46%). 40% of the respondents rather agree with the statement that the closest UGS is clean. Furthermore, 27% of the respondents stated that they strongly disagree that having UGS in the vicinity was an important factor for choosing their flat.

Moreover, we asked for the approval for a set of potential reasons for visiting the closest UGS, also on 5-point Likert scale. Mainly, the respondents indicated the following reasons for the last visit: "to get some fresh air", "to switch off and get some distance from everyday life" or "to enjoy nature". Appendix Figures A2 and A3 illustrate respondents' agreement to a set of statements regarding the closest UGS, each scored on a 5-point Likert scale with categories ranging from "fully agree" (1) to "fully disagree" (5).

Based on the graphical 5-point Likert scale shown in Figure 1,[5] 28.68% of the respondents rate the naturalness of their closest UGS as near natural, followed by partly natural (28.37%) and very natural (20.82%). However, 13.76% state that their closest UGS is little natural, and 8.37% think it is hardly natural. As shown in Table 2, the mean respondent defines the closets UGS as partly natural (mean Likert scale value of 3.40). The distribution of the variables is shown in Appendix Figure A4.

[Insert Table 2 about here]

The average monthly rental payment is approximately €590, and the average additional utility costs the respondents pay are €192 per month.

4 Econometric Approach

Discrete-choice models are based on Lancaster's argument that attributes of goods determine the utility they provide (Lancaster, 1966) and random utility theory (McFadden, 1974). It is assumed that individuals choose an alternative that provides the highest level of utility. The utility U_{njt} of an individual *n* from an alternative *j* in a choice situation *t* is described by cost (*rent*) and non cost attributes *x* ,which are observable to the researcher, and a random component ε_{njt} which is unknown:

$$U_{njt} = -\alpha_n' rent_{njt} + \beta_n' x_{njt} + \epsilon_{njt}, \qquad [1]$$

where α_n is the cost coefficient, x_{njt} is a vector of variables describing goods or attributes of goods (naturalness and walking disrance), and ϵ_{njt} is assumed to be independently and identically distributed (i.i.d.) with an extreme value distribution, also known as Gumble distribution (Greene, 2012). As the variance of this distribution is π2/6, we are implicitly normalizing the scale of utility. To account for preference heterogeneity, the vector of taste β_n varies across individuals. Thus, we derive the Mixed Logit Model (Random Parameter Model) in preference space. To derive the WTP of the preference space model we follow Mariel and Meyerhoff (2018) using Monte Carlo simulations, as follows:

$$\widehat{WTP}_k = \frac{\hat{\beta}_k + \hat{\sigma}_k * \vartheta_k}{\exp\left(\hat{\alpha}_{rent} + \hat{\sigma}_{rent} * \vartheta_{rent}\right)}, \quad [2]$$

where β_k is the normal distributed random coefficient of any of the attributes $k \in \{naturalness, walkingdistance\}$ and α_{rent} is the log-normal distributed random coefficient of the monetary attribute; in our case, the rent. The estimated standard deviation of the attributes *k* and *rent* are indicated as $\hat{\sigma}_k$ and $\hat{\sigma}_{rent}$. The standard normal distributed random variables we denote as ϑ_k and ϑ_{rent}.

Additionally, we estimate the model also in WTP space (Train and Weeks, 2005; Scarpa et al., 2008). The advantage of the WTP space model is that the estimated coefficients can be directly interpreted as WTP measures. Thus, we are able to compare the two applications and the resulting WTP estimates:

$$U_{njt} = -\lambda_n(rent_{njt} + w_n' x_{njt}) + \varepsilon_{njt}, \quad [3]$$

where $rent_{njt}$ is the cost according to the payment vehicle, w_n is a vector of WTP for each noncost attribute (naturalness and walking distance), and λ_n is a random scalar. The scalar $\lambda_n = \frac{\alpha_n}{k_n}$, where α_n is the cost coefficient in preference space and k_n is the scale parameter of individual *n*, and $w_n = \frac{\beta_n}{\lambda_n}$, where β_n is the vector of the noncost coefficients in preference space. Finally, ε_{njt} is the random component. With homogeneous preferences (i.e., α_n and β_n, identical for all individuals), models 1 and 3 are fully equivalent. The difference comes about due to the different assumptions about the type of preference heterogeneity. In utility space, model 1, the coefficients of the utility function follow normal or log-normal distributions, in WTP space, model 3, the corresponding assumptions on the distribution of heterogeneity are imposed directly on the willingness to pay parameter.

Equations [1] and [3] are estimated using a simulated maximum likelihood estimation of a mixed logit model with 1,000 Sobol draws, respectively. We used the Apollo package in *R* for this purpose (Hess and Palma, 2019). In our models, we included the alternative specific constants (ASC1 and ASC2), which show the preferences for programs 1 and 2 over the status quo. The attributes naturalness and the walking distance are assumed to be normally distributed, whereby the price coefficient (rent) is assumed to be log-normally distributed.

5 Empirical Results

Two empirical specifications, for both, the WTP space and the preference space specification, were estimated to elicite the WTP for the naturalness of and walking distance to the closest UGS in 22 German cities. The results of the WTP space models are indicated with (a) and the calculated WTP measures of the preference space models are indicated with (b), and are presented in Table 3.[6] Additionally, Figure 3 and 4 show the estimated WTP values for *naturalness* and *walking distance* obtained from the WTP space models.

In the first model specification, model Ia and Ib, the variables *naturalness* and *walking distance* are treated as being continuous. We extend this model specification in model IIa and model IIb and included the different level of *naturalness* as dummy variables. Moreover, we followed Mariel et al. (2021) and applied a piecewise linear approach for *walking distance*. We choose the quartiles of the walking distance as thresholds and generated the following variables: WD_1 = min(x,3); WD_2 = max(0,min(0-3,3)); WD_3 = max(0,min(x-6,9)); WD_4 = max(0,x-15). The statistically significant standard deviations in all models reveal unobserved preference heterogeneity among the respondents (Table 3).

[Insert Table 3 about here]

Looking at the WTP space models, Ia and IIa, the estimated mean WTP are statistically significant at the 1% level. We found a negative WTP for both ASC variables, which indicates, that on average, choosing any rebuilding option leads to a lower WTP compared to the status quo. In model Ia, we estimated a mean WTP for *naturalness* of €20.25 per month for a one-step increase on the Likert scale. The WTP for the choice attribute *walking distance* shows a negative WTP of €-2.47 per month for an additional minute of walking to the closest UGS.

Model IIa shows that the mean WTP inceases with the level of the naturalness of the UGS. The estimated mean WTP ranges from €-59.21 per month for hardly natural to €12.32 per month for very natural compared to the base category nearly natural (step 4 on the Likert scale). Furthermore, the results of the piecewise linear specification of the attribute *walking distance* show significant negative WTP (Table 3; Figure 4). When the walking distance to the closest UGS is less than 3 minutes respondents have a negative mean WTP of €-5.79 per month per minute whereas when the walking distance exceeds 15 minutes the mean WTP is €-1.74 per month per minute.

[Insert Figure 3 about here]

[Insert Figure 4 about here]

Preference heterogeneity implies that only a share has a preference that goes in the same direction as the mean estimate. The share of individual level coefficients that is positive is shown in the column "share" in Table 3. Model Ia indicates that most respondents (90%) have a positive WTP for UGS with a higher level of naturalness. Furthermore, a share of 6%

prefer a longer walking distance to the clostest UGS, whereas the majority of the respondents (94%) have a positive WTP for a shorter walking distance from their flat to the closest UGS.

Model IIa shows that around 90% of the respondents have a negative WTP for hardly, little or party natural UGS compared to a nearly natural UGS, respectively. Furthermore, our results reveal that a share of 92% of the respondents have a positive WTP for a very natural UGS compared to a nearly natural UGS. For *walking distance*, the picture is similar. We find, that 80% of the respondents with a walking distance of less than 3 minutes have a positive WTP for a short walking distance to their closest UGS. Also, most respondents with a walking distance of 3–6 minutes, 6–15 minutes, and more than 15 minutes have a positive WTP for a shorter walking distance (90%, 84% and 94%).

The simulated median WTP (equation 2) from the preference space models are presented in the last two columns of Table 3 (model Ib and IIb). In accordance with Train and Weeks (2005) the results of the preference space and WTP space specification are similar. However, the WTP space models yielded in a more plausible distribution of WTP, with fewer respondents having very high WTP than in the preference-space models (see also Appendix Table A4 for detailed results and Appendix Figures A5 and A6 for the distributions of WTP of the preference-space models).

Additionally, we tested the robustness of the results and include sociodemographic variables in the model which we interacted with the naturalness variable (Appendix Table A5). Again, the WTP for a higher walking distance is negative, and the respondents prefer a UGS, which is more natural. For these variables, the standard deviations are significant and similar to the magnitudes of our basic model Ia, indicating heterogeneity among the respondents. Regarding the interaction terms we find that more educated people have an higher WTP for more natural UGS. The number of children and the size of the flat have negative effect on the respondents' mean WTP for naturalness. As we expected inter-city

differences in monthly WTP values, we estimated the WTP space models for all cities with more than 100 observations separately to estimate the WTP of the mean respondent for a marginal increase in *naturalness* and *walking distance* as well for the factor and piecewise variables specifications, as shown in Table 4.[7]

[Insert Table 4 about here]

The estimated mean WTP values vary between cities. The mean WTP for *naturalness* range from €12.44 per month in Dresden to €35.88 per month in Bremen. The highest absolute value for the (negative) WTP for *walking distance* is also shown for Bremen (€-3.62 per month), and the lowest WTP can be attributed to Dresden.

As discussed above, a sorting mechanism as proposed by Tiebout (1956) might play a role here. If this is the case, we expect a positive correlation between the amount of UGS that the city offers and the WTP for natural green space. We test this in two ways. First, we correlate the WTP for naturalness of UGS with the UGS per capita in the respective city (model IIIa). In a second specification, we correlate the aggregate WTP (population size times mean WTP) with the aggregated UGS in the city, using GDP as control variable (model IIIb). Results from model IIIb are consistent with the Tiebout mechanism, as illustrated in Figure 5, and detailed in Appendix Table A6. However, this effect is not present in model IIIa.

[Insert Figure 5 about here]

6 Discussion and Conclusion

In this article, we studied how citizens value the naturalness of their closest UGS they use most often. While it is well known that public amenities like UGS generate price premiums in housing markets (Cho et al., 2009), much less is known about individual preferences for characteristics of UGS. With our study, we contribute to a better understanding of preferences for natural and biodiverse UGS and proximity to UGS. We introduced a graphical measurement scale for naturalness of UGS that varies in five steps between hardly natural and very natural. For estimating the WTP for changes in the naturalness or proximity of UGS, we used changes to the housing rent as payment vehicle. This seems appropriate, as the attractiveness of the neighborhood commonly affects urban housing rents, but we can not exclude that some doubts about the consequentiality of their choices led to some noise in responses.

We found that German citizens, on average, hold preferences for a higher *naturalness* of their closest UGS and value a short *walking distance* to this UGS. The mean respondent is willing to pay €20.25 per month for an increase in the naturalness of their closest UGS by one step on the naturalness scale. Thus, on average the respondents would benefit when their closest UGS would become more natural.

On the other hand, respondents receive on average a loss in terms of a negative WTP of €-2.47 per month for an additional walking minute to their closest UGS. Regarding the UGS vicinity, our findings are in line with previous revealed preference studies (Palmquist, 1992; Plant et al., 2017; Łaszkiewicz et al., 2019). Park et al. (2017) show that an increase in the distance to the green space by one meter causes a decrease in the expected house value by $309. In the few studies which consider renting prices, Zhang et al. (2020) found that the presence of the park within 500 m vicinity lead to a rent rise of 1.39% in Beijing, China whereas Donovan and Butry (2011) found that an increase of the distance to a park by 1 km increases the price by 3.3 % in the area of Portland, Oregon, USA.

Using our 5-point scale to measure the naturalness of the UGS, we were able to elicit preferences and WTP measures for the rebuilding of the closest UGS in terms of different levels of naturalness. This is important, as UGS with different characteristics provide different types of benefits (e.g., sports facilities, areas for social and cultural interactions) and the acceptance of potential rebuilding measures depends on how this will affect the utility of the UGS. Our results reveal that the mean respondent receives the highest benefit, measured in WTP, from rebuilding schemes that increase the naturalness of their closest UGS. We find a mean WTP of €12.32 per month for very natural UGS relative to near natural. The average respondent indicates a loss of €-59.21 for a decrease in naturalness from near natural to hardly natural.

In general, urban development is facing significant societal challenges. Especially the demographic change takes place in a very differentiated manner in different areas (Martinez-Fernandez et al., 2012). Thus, we were interested in analysing intercity differences among important German cities. Indeed, can show that the WTP measures differ among the cities. For distance, they range between a monthly mean WTP for an extra minute walking to the closest UGS of €-1.63 in Dresden to €-3.62 in Bremen. Future research should be devoted to the investigation of this spatial preference heterogeneity, which should be of key interest for urban planners.

Overall, our results highlight the importance of urban nature for city life. Considering the rapid urbanization (United Nations, 2014) our insights might be of use for urban planning and management as they provide evidence for the importance of preserving and improving biodiversity in cities, in particular in those areas where citizens use green spaces around their places of residence in the daily life. The high appreciation of a high level of naturalness suggests that many urban residents support nature-oriented rebuilding schemes of UGS in Germany.

Future research may use our multi-site choice experiment as a starting point for gaining a better understanding of what drives the inter-city differences in the median WTP for biodiverse urban greenery. Among the others, these differences might depend on the level and spatial distribution of urban greenery in cities as well its correlation with income (Meya, 2020) or on the availability of substitutes, such as environmental amenities outside the city or private gardens. Understanding heterogeneity in the WTP for biodiversity in cities on the respondent level could inform benefit transfer and add to an emerging literature on spatial heterogeneity in the WTP for environmental public goods (Czajkowski et al., 2017; Liu et al., 2020).

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Table 1

Attributes and levels included in the DCE

Attribute	Level
Naturalness of the closest UGS	hardly natural, little natural, partly natural, nearly natural, very natural. Graphical scale as shown in Figure 1.
Walking distance to the closest UGS in minutes	-50% from actual walking distance reported in the survey, +50% from actual walking distance, +100% from actual walking distance, +200% from actual walking distance, +400% from actual walking distance. Figures were presented in absolute values.
Monthly rental payments for the flat in €	-1% from actual rent reported in the survey, -0.5% from actual rent, +0.5% from actual rent, +1% from actual rent, +2% from actual rent, +5% from actual rent. Figures were presented in absolute values.

Table 2

Descriptive statisticsof the DCE attributes

Variable	Mean	SD	Min.	Max.
Naturalness	3.40	1.20	1.00	5.00
Walking distance (min)	11.50	17.26	0.1	240
Monthly rental payments (€)	590.13	309.06	55	4,000
Monthly utility costs (€)	192.40	178.6	1.00	3,000

Table 3

Mixed logit estimates basic models

	WTP Space						Preference Space	
	(Ia)			(IIa)			(Ib)	(IIb)
	WTP	SE	Share	WTP	SE	Share	Median WTP	
ASC (program 1)	-16.696***	(0.662)		-14.555***	(0.475)			
ASC (program 2)	-18.056***	(0.617)		-15.508***	(0.512)			
Naturalness	20.248***	(0.412)	90%				22.75	
Walking distance	-2.468***	(0.060)	6%				-3.03	
Rent	-2.648***	(0.032)		-2.404***	(0.037)			
Naturalness *Base: Nearly Natural (4)*								
Hardly natural (1)				-59.214***	(1.413)	8%		-62.35
Little natural (2)				-56.872***	(1.038)	6%		-62.19
Partly natural (3)				-25.213***	(0.677)	5%		-27.95
Very natural (5)				12.317***	(0.523)	92%		9.81
Walking distance (WD) *Piecewise*								
WD1 (<3 min.)				-5.788***	(0.344)	20%		-6.19
WD2 (3–6 min.)				-4.634***	(0.193)	10%		-5.30
WD3 (6–15 min.)				-2.602***	(0.079)	16%		-2.30
WD4 (>15 min.)				-1.743***	(0.038)	6%		-1.88
SD.ASC (program 1)	19.802***	(0.599)		9.969***	(0.198)			
SD.ASC (program 2)	20.937***	(0.697)		7.422***	(0.481)			
SD.naturalness	15.596***	(0.356)						
SD.walking distance	1.598***	(0.041)						
SD.rent	1.318***	(0.036)		1.479***	(0.038)			
SD.hardly natural (1)				42.911***	(1.252)			
SD.little natural (2)				37.515***	(0.877)			
SD.partly natural (3)				24.622***	(0.665)			
SD.very natural (5)				16.491***	(0.456)			
SD.WD (<3 min.)				7.005***	(0.603)			
SD.WD (3–6 min.)				3.650***	(0.184)			
SD.WD (6–15 min.)				2.645***	(0.082)			
SD.WD (>15 min.)				1.104***	(0.025)			
Observations	146,880			146,880				
Log-likelihood	-29,181.37			-28,474.05				

Note: Standard errors are in parentheses.

[a] Share indicates the calculated share of respondents lying on the positive domain of the normal distribution for each attribute parameter using the formula $100 * \Phi(\mu_k - \sigma_{b,k})$, where Φ is the cumulative standard normal distribution, and γ_k and $\sigma_{b,k}$ are the mean and standard deviation of the kth coefficient.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 4

Inter-city WTP comparison

Mean willingness to pay in € for Naturalness and Walking Distance

City	Naturalness	Walking Distance	No. of respondents
Berlin	22.13***	-2.40***	1017
Bremen	35.88***	-3.62***	139
Cologne	23.92***	-2.83***	396
Dortmund	19.61***	-1.94***	225
Dresden	12.44***	-1.63***	173
Düsseldorf	20.83***	-2.69***	230
Essen	22.56***	-3.09***	227
Frankfurt	23.58***	-3.10***	273
Hamburg	20.09***	-2.57***	692
Hanover	12.76***	-1.64***	206
Leipzig	15.64***	-1.75***	275
Munich	23.50***	-3.24***	422
Nuremberg	18.39***	-2.61***	204
Stuttgart	13.61***	-1.82***	166

Note: Data on the amount of green space are from Statista (2016), and data on population sizes and GDP are from the German federal statistical offices, available at www.statistikportal.de.

*** $p < 0.01$.

Figure 1

Graphical Likert scale for the naturalness of the closest and most often used UGS

Figure 2

Example of a Choice Set

Figure 3

Mean Willingness to Pay (€) for an increase in naturalness as continuous variable (by one) and dummy variables (compared to nearly natural UGS)

Figure 4

Mean Willingness to Pay (€) for walking distance by one minute as continuous and piecewise variables

Figure 5

Correlation between the offer of green space and willingness to pay for naturalness of green space in per capita terms (*left*) and absolute values (*right*)

[1] Unanimously the focus group participants agreed to the intended interpretation and ranking of the five degrees of "naturalness".
[2] Of all participants who did not complete the survey, 45.1% left the survey when they received the welcome message, 20.6% left when we asked for the address, 11% left when they had to upload a photograph, and 23.3% left at one of the other questions.
[3] For instance, we dropped if rental payments were reported as are smaller than €50 per month or unrealistic high considering the stated flat size as well as if the walking time to the next UGS is more than 450 minutes and daily window time exceeds 12 hours.
[4] According to Google Maps, a walking distance of 300 m is referenced to 4 walking minutes.

6 In order to investigate the impact of varying base levels of categorical random parameters on the model fit we first estimate an over-specified model (Walker, 2002). Therefore, we employed different randomly distributed alternative-specific constants (ASCs) for each alternative, as well as different random parameters for each level of the categorical variable. In model II, we selected the base level

for each attribute (or the ASC) based on the parameter with the smallest standard deviation. In our case, the base level for the ASC is the status quo, and the base level for naturalness is "near natural" (4). The output of the over-specied model is shown in Appendix Table A3.

7 The estimation results of the city level models are available upon request. Due to brevity, we just present the mean WTP.

				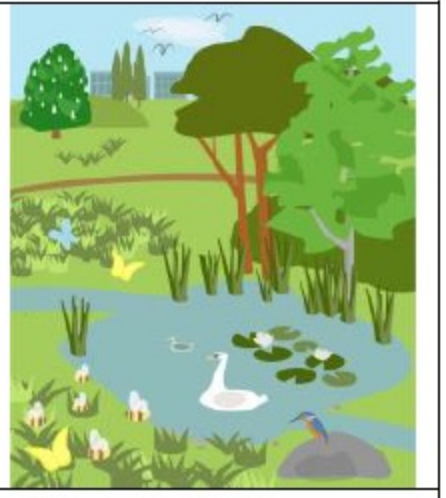
1	2	3	4	5
hardly natural	little natural	partly natural	near natural	very natural

Figure2

	Program 1	Program 2	My current situation
Naturalness of the closest UGS you use most often			
Walking distance to the closest UGS in minutes	**14.38 min (+25%)**	**5.75 min (-50%)**	**11.50 min**
Monthly rental payments in €	**€774.18 (-1%)**	**€778.09 (-0.5%)**	**€782**
I choose:	☐	☐	☐

[a] Only the absolute values have been shown to the respondents. These have been calculated as percentage changes (examples indicated in brackets) from the status quo values obtained from previous answers in the online survey.