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Economic valuation of street-level urban greening: A case study from an evolving mixed-use area in Berlin

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ABSTRACT

Although there have been many studies on the economic valuation of urban green (recreational value of urban parks, ecosystem services provided by green roofs), preferences for certain types of street-level greening measures, such as increasing street-level vegetation and trees or green initiative programming, are largely unknown. To begin to put a monetary value on these aspects of urban green, we use a discrete choice experiment to explore people's preferences and willingness to pay for green features in an urban Neighborhood Management development zone in Berlin. Data was collected through an online survey distributed in the neighborhood. While the resulting sample was not representative of Berlin as a whole, the results from a latent class logit model indicate that our respondents strongly value some of the green attributes presented in the survey, especially street greening. This analysis can be used to guide decision-making regarding urban greening and green building practices at both policy- and project-level.

1. Introduction

More than half of the world's population lived in cities by 2014. Migration forecasting by the United Nations places this number at 68% by the year 2050 when, combined with global population growth, a possible 2.5 billion people will be added to the already unprecedented 4.2 billion in urban areas in 2018 (United Nations, 2018). In North America and Europe, an even-greater 82% and 74% now live in urbanized areas (United Nations, 2018). To keep up with the growing demand for living space, open areas are consumed by infrastructure and existing urban centers are made denser, leading to high levels of soil sealing. At the same time, space for natural, non-built features in the urban landscape is becoming increasingly finite. Between 1990–2000, unsealed lands in Europe were converted to urban use at a rate of 1000 km^2 pe($\approx$275 ha per day) (European Commission, 2012). This trend has decreased in recent years ($\approx$252 ha per day) but does not show signs of stopping: in Germany for example, about 13% of total land area was urbanized in 2007. A significant proportion of this land is impermeable, bearing adverse effects for urban ecosystem services and the living conditions of urban dwellers. Although ecosystem responses to human land use involve many complex interactions that can affect a variety of ecosystem services (Grimm et al., 2008), changes to the surface can hinder the ability of ecosystems to provide some of the most important ecosystem services that people rely on: climate regulation, food provision, and freshwater cycling (European Commission, 2012). As a consequence, researchers, practitioners, and policy-makers on various scales have made efforts to maintain and improve the services of urban ecosystems by setting up agendas to create more urban green spaces (TEEB, 2011). Urban green spaces also offer the possibility for locals to engage in recreational activities and aesthetic appreciation or can act as inspiration for the arts or other transformational experiences, thereby supporting mental and physical health (TEEB, 2011).

The term 'urban greening' has been defined in various ways and contexts for use in a range of disciplines. From broad concepts of environmental sustainability (Jansson, 2013) to specific measures within green infrastructure planning (European Environment Agency, 2017; Young, 2011), urban greening can also take shape as initiatives or programs for a greener urban lifestyle. Kuchelmeister (1998) defines

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Table 1
Choice Attributes and Descriptions.

Attribute	Description	Scale	Levels
Green facades	*Green facades are the outward walls of a building covered by vegetation. They are created by placing plant-containing structures against the building or by growing climbing plants directly onto the building itself. They can provide an attractive look to the wall, although this can change seasonally. The plants can provide ecosystem services like insulating buildings against heat and cold, reducing air pollution, increasing biodiversity and reducing street noise levels. However, green facades can also damage walls, involve maintenance and attract unwanted wildlife.*	*Share of buildings with green facades*	*Status Quo: Currently the area of interest has only a few (less than 1 in 10) street-facing green facades.* *Green Facades 2: Increase to 1 out of 10 buildings with green facades.* *Green Facades 3: Increase to 2 out of 10 buildings with green facades.*
Street greening	*Street greening is the addition of trees, sidewalk gardens (planters), and* [a]*natural vegetation along Potsdamer Straße. Street greening measures are controlled by infrastructure planning and play a significant role in providing ecosystem services to communities such as creating shade, improving street-level air quality, lowering air temperature, absorbing noise, and reducing wind speed in streets. However, it can also obstruct footpaths and attract unwanted wildlife, as well as cause inconveniences as a result of fallen leaves or fruits.*	*Frequency of street trees and planters*	*Status Quo: Currently the study area has on average 1 tree every 20 m, no maintained vegetation, and a few small planters.* *Street Greening 2: Increase to mostly trees -trees every 10 m, no vegetation, few planters.* *Street Greening 3: Increase to mostly vegetation -trees every 20 m, vegetation, many planters.*
Green initiatives	*Green initiatives create opportunities for businesses and the community to learn about environmentally friendly behaviors in a recreational setting. These projects and programs encourage the street to "go green" while stimulating the economy and creating a sense of social cohesion. However, large events can also create unwanted noise, congestion of streets, and increase demand for street maintenance. Green initiatives can be broken down into two main categories: 1)* Eco-events and 2) Educational programming. *Eco-events are any free community-wide events that are considered environmentally focused. Potential events could include "Potsdamer Straße Green Week," a mass tree planting, or competitions to create "green" balconies or artworks. Educational programming is described as a variety of workshops and small group activities for all ages designed to inform respondents about the ecosystem services provided by urban green. Examples include: waste management programs for businesses and residences, urban gardening classes, environmental art/upcycling classes, workshops about sustainable foods, energy efficiency, environmental design and architecture, etc.*	*Frequency of programming*	*Status Quo: The community currently has irregular programs and events throughout the year.* *Green Initiatives 2: Increase to occasionally - eco-events once per year, monthly educational programming (occasional).* *Green Initiatives 3: Increase to often - eco-events once per season, weekly educational programming (often).*
Cost		*Yearly contribution to Urban Green Fund*	*Status Quo: No additional costs.* *€ 12.00* *€ 30.00* *€ 60.00* *€ 120.00* *€ 240.00* *€ 360.00*

[*a] In contrast to maintained vegetation (planters and street trees), natural vegetation is everything along the street growing naturally, without human interference (i.e. grasses, bushes, weeds, etc).

'urban greening' as "all urban vegetation management", including both urban forestry and farming. Urban greening is often conceptualized this way – as the planning, management, and implementation of specific interventions of 'urban green' itself, such as "tree planting or the creation of parks or green roofs" (Bowler et al., 2010) as well as "landscaped lots and streets" (Westphal, 2003), to "create or add value to the local community in an urban area" (Kuchelmeister, 1998).

With this in mind, it is important to define how we will be using the term 'urban greening' in this paper. We use 'greening' to refer to the planning, management, and implementation processes that underlie interventions of 'urban green'. Due to the limitations associated with a survey-based approach, we restrict 'urban green' to two specific types of vegetation – green facades and street greening (defined in Table 1) – and green initiatives (Table 1) aimed at teaching the community about the benefits of urban green and getting them involved in the planning and management aspects of greening. Since these initiatives can contribute to developing a more inclusive green and social infrastructure concept, we believe this expanded definition suits our study approach.

Many urban planning decisions still do not properly account for environmental impacts even though they can have long-term effects on air pollution, greenhouse gas emissions, biodiversity, and water use. Understanding the value of urban green in neighborhoods can help contribute to better land-use planning and environment-oriented decision-making and budgeting, ultimately increasing a community's resilience to some of the stresses of climate change. Despite many studies agreeing that natural green spaces possess intrinsic value, these values are often difficult to monetize, leaving them overlooked in different levels of planning and policy-making. Thus, specific measurements of urban green's economic value – especially about the potential benefits to the local population – can help decision-makers understand the consequences and trade-offs of urban planning and land uses (Engström and Gren, 2017; Sander and Zhao, 2015). Davies and Lafortezza (2017) note that European policy and planning discussions surrounding urban green are largely focused on the benefits for biodiversity and health while benefits linked to the green economy and social cohesion are often absent.

Existing literature on the economic value of urban green space uses a variety of methods, including questionnaire or survey approaches (Derkzen et al., 2017; Kabisch and Haase, 2014; Mell et al., 2013), hedonic pricing (Saphores and Li, 2012; Czembrowski and Kronenberg, 2016), contingent valuation (Latinopoulos et al., 2016; Verbič et al., 2016), and discrete choice experiments (Arnberger and Eder, 2011; Vollmer et al., 2016). Some studies use actual or hypothetical residential choices to investigate the value of large-scale urban green features (Tu et al., 2016), while others looked at the value of rather small-scale urban green features like street trees (Ng et al., 2015; Giergiczny and Kronenberg, 2014), urban green walls (Collins et al., 2017), and green roofs (Vanstockem et al., 2018). Additional studies used discrete choice experiments to value larger-scale green areas like urban parks (Bertram et al., 2017; Lo and Jim, 2010).

Despite the knowledge generated in these studies, the information provided to policy-makers is still limited as the conclusions of individual studies are not always transferable to other sites (Brander and Koetse, 2011). Furthermore, some features of urban green, such as community-level greening projects and culturally focused urban green programming, have been neglected in economic valuation studies. Consequently, further research in various urban areas on specific features of urban green is required to gain a more thorough understanding of the economic value of urban green.

In the present study, we contribute to the emerging literature about the economic value of urban green by using results from a discrete choice experiment to quantify willingness to pay (WTP) for features that have been either infrequently valued or not at all: green facades, street greening, and green initiatives. Our study took place in a vibrant and evolving area in the center of Germany's capital city of Berlin. This neighborhood presents a unique opportunity for new and experimental policies, given its current state of change as well as the support of an ongoing citizen initiative for local improvement. The study emerged from discussions with the local initiative, "Boulevard Potsdamer", which is engaged in activities to improve the urban green in the area. The survey was exploratory in nature and operated on a small budget. This led to a modest sample of 128 respondents that is not representative of the case study area's demographics. However, our results provide initial insights about local users' willingness to pay for changes in the area's environmental assets which policy-makers and researchers can use in conjunction with follow-up valuation studies and non-monetary assessments to determine what changes would be most accepted and feasible amid public awareness limitations and budget constraints (Kabisch, 2015).

2. Methods

2.1. Choice experiments to assess the economic value of urban green

Various approaches to value ecosystem services have been discussed in the literature, also in the context of urban green (Pietrzyk-Kaszyńska et al., 2017). Not all approaches provide monetary values, but still give important insights into preferences and attitudes of the local population. Such approaches have advantages (a deeper understanding of the preferences and a more holistic picture of value) and disadvantages (absence of a unit that can be used in cost-benefit analyses), as discussed for example in Kenter (2016). A combination of both, monetary and non-monetary valuation can provide deeper insights into the true value of ecosystem services and thus inform policy makers more accurately (Czembrowski et al., 2016). Assessing the economic or monetary value of urban green is difficult because many of the diverse ecosystem services it provides are public goods, which are not traded on markets and thus lack data about the prices and quantities demanded. There are two types of monetary valuation methods which assess these social, environmental, and ecological values: revealed preference, where actual observations directly infer choices; and stated preference, where values are not observed directly but are rather elicited through hypothetical scenarios (Tinch et al., 2019). Within revealed preference methods there are direct valuation methods, such as market price and simulated markets; and indirect valuation methods, such as travel cost, hedonic pricing, and avoidance expenditures (ibid.). Stated preference can be direct, such as contingent valuation and choice modelling, or indirect, such as contingent ranking. In this study, the economic valuation of goods is elicited through a stated preference method, specifically discrete choice experiment (Bateman et al., 2002).

Among stated preference methods, discrete choice experiments (DCE) have gained momentum because they allow for the simultaneous estimation of the economic value of various features (herein "attributes") expressed via willingness to pay (WTP). Discrete choice experiments are questionnaire-based and provide respondents with a hypothetical market in which they can choose to "buy" the good or not. The good is defined by several attributes that vary in predefined levels according to an experimental design. The respondents choose between presented alternatives with varying attribute levels several times. The generated data consists of choices made by the respondents (the dependent variable) and attributes and socio-demographic characteristics (independent or explanatory variables). The advantage of using a DCE is its ability to estimate respondents' preferences for marginal changes to the attributes (Hanley et al., 2001; Train, 2009). Furthermore, it offers an insight into the order of preference for the attributes, a correlation that is difficult to measure with other valuation methods.

Discrete choice experiments are rooted in microeconomic theory and go back to the contributions of Thurstone (1927), Lancaster (1966), and McFadden (1973). The statistical analysis is based on the random utility model (RUM), which link the deterministic model of consumer choice with a stochastic component (McFadden, 1973). U_{ni} represents the utility that respondent n receives from alternative i, and is split into a deterministic observable component, V_{ni}, and a random unobserved term included additively, ε_{ni}.

$$U_{ni} = V_{ni} + \varepsilon_{ni} \tag{1}$$

In its simplest form, the specification of the deterministic part is given as:

$$V_{ni} = \beta_0 ASC + \beta a_i \tag{2}$$

where $\beta_0 ASC$ is the alternative-specific constant multiplied by an unknown, to-be-estimated parameter reflecting unobserved alternative-specific effects and $a_i = (a_{i1}, a_{i2}, \ldots, a_{ik}, a_{ic})$ is a vector of attribute levels present in alternative i. Of these attributes, a_{ic} reflects the price or the cost for the alternative. $\beta = (\beta_1, \beta_2, \ldots, \beta_k, \beta_c)$ is a vector of unknown, to-be-estimated parameters representing the utility "weight" of each attribute. As the parameters in β are unscaled in discrete choice models, it is common to express the utility weights in terms of monetary units, e.g. WTP. WTP values give the monetary compensation for a one-unit change in an attribute and are calculated as the marginal rate of substitution between the k^{th} attribute a_k and the cost attribute a_c, which, in the linear-in-parameters specification, boils down to:

$$WTP_k = -\frac{\partial\frac{V}{\partial} a_k}{\partial\frac{V}{\partial} a_c} = -\frac{\beta_k}{\beta_c} \tag{3}$$

Due to the stochastic elements in the utility function, results are expressed in terms of probabilities. The probability of choosing alternative j is the probability that the utility of alternative j is greater than that of all other alternatives.

$$Prob(j) = Prob(V_j + \varepsilon_j > V_i + \varepsilon_i, \forall\ i \neq j) \tag{4}$$

Assuming that ε are Extreme Value Type I independently and identically distributed (iid) over all alternatives and respondents, the specification leads to the conditional logit model, whereas the probability to choose alternative j is given as:

$$Prob(j) = \frac{exp(V_j)}{\sum_{i=1}^{I} exp(V_i)} \tag{5}$$

While this model is a first step towards modeling respondents' choices, there are significant limitations in the model, including the independence of irrelevant alternatives (IIA) identity and the inability to handle unobserved preference heterogeneity. Models allowing for correlation in the unobserved part of utility, such as random parameters logit and latent class logit models, relax these assumptions. In our analysis we estimated latent-class logit models to gain a better understanding of preference heterogeneity. This approach probabilistically classifies respondents into multiple preference classes (Boxall and Adamowicz, 2002).

Each class represents a separate conditional logit model with a different preference structure. The unconditional choice probabilities are calculated by multiplying the conditional logit distribution with the probability of class membership and are given as:

$$Prob(j) = \sum_{c=1}^{C} p_c \frac{exp(V_{j|c})}{\sum_{i=1}^{I} exp(V_{i|c})} \tag{6}$$

where p_c is the probability to belong to class c. This probability is estimated with a multinomial logit model as:

$$p_c = \frac{exp(\zeta_s X_n)}{\sum_{c=1}^{C} exp(\zeta_c X_n)} \tag{7}$$

where $\zeta_c X_n$ are parameters and case-specific variables such as socio-demographic variables. These variables explain the probability to belong to a specific class and thus identify some part of heterogeneity in preferences.

Our choice to use a latent class logit model over a random parameters logit model was driven by two factors. First, for the purposes of our analysis, we find a latent class model more appealing as it allows to identify discrete preference heterogeneity, expressed as different preference classes. Such information on preference heterogeneity is easier transferable to a wider audience (including practitioners and policy makers), which are not familiar with the methodology, than results from random parameters logit models, which model preference heterogeneity according to a continuous distribution (see Sagebiel, 2017 for more details). Second, the latent class model statistically outperformed the random parameters logit model in terms of model fit, i.e. the latent class model explains the data better than the random parameters logit model.[2]

2.2. Study area

The study was conducted along the main stretch of Potsdamer Straße (street) in the Tempelhof-Schöneberg district of Berlin, Germany. The street begins at Potsdamer Platz, a major tourist hub near the city center, and extends 2.5 km south. We focused on a central portion of the street since the area north of the Landwehr canal consists of mostly commercial zoning (Fig. 1).

Development of the study area is overseen by a neighborhood management project commissioned by the Berlin Senate that aims to create a "socially integrative city" with the objective of improving living conditions in deprived parts of the city (Senate Department for Urban Development Communication, 2010). The population of the immediate area is approximately 25,670 people with a large portion sharing a migrant background (Senate Department for Urban Development Communication, 2010). This number was derived by summing the population totals of two neighborhood management areas (Bülowstraße, Magdeburger Platz) that encompass the study area illustrated in Fig. 1.

Furthermore, the area was selected based on exchanges with the local green initiative Boulevard Potsdamer. The initiative seeks to transform Potsdamer Straße, which connects Berlin's center to residential neighborhoods, into an urban green corridor through further development of urban greening and ecological commerce activities in the area, and therefore enhancing diversity and quality of life, and increasing resilience in the neighborhood. The small-scale of this study supports the Boulevard Potsdamer initiative to decide which projects they will direct their funding to in the future. Conducting this type of small-scale study is also beneficial in that attributes are more relatable for the respondents and leave less room for interpretation (Johnston et al., 2017).

The study area includes some small, scattered green areas and two modest community gardens. Kleistpark marks the southern border and is the only park along this stretch of the street. In general, there is a noticeable lack of recycling bins, vegetation, and trees along the street. Current green programs such as urban gardening workshops, a small seed bank, and the local library, referred to as a "green library" due to its eco-centric catalogue and programming, all lack sufficient funding and would benefit from strategic planning and a development framework. This background makes the area a particularly interesting case study when considering the diverse factors that could play a role in the survey respondents' choices.

2.3. Attribute selection and choice design

Our discrete choice experiment focused on three aspects of urban greening, representing a diverse range of ecosystem services (Table 1). Street trees and green facades are included as they are among the most effective measures to mitigate urban heat waves and climate change (Schmidt, 2010). Further, the quantity of green on streets (green facades, vegetation, street trees) can be increased without using additional space, which is a more plausible option for a dense urban area like Potsdamer Straße. Green initiatives were included as a result of cooperation with the local community organization, Boulevard Potsdamer. They are interested in expanding educational programming which has been shown to increase community building, environmental literacy, and participation in communities (Volk and Cheak, 2003). In light of potential budget constraints of the city administration, these attributes were also selected considering that they can be enhanced without large-scale investments from the city. To this end, we excluded open areas like parks and urban gardens, as they require significantly more space, maintenance costs, and overall investment. The scenarios presented in our study thus provide a realistic and short-term perspective for the local population.

For the discrete choice experiment, we selected three attributes that seemed most visible and accessible to our respondents and were independent from each other in order to avoid potential confusion about correlations and unrealistic combinations: 1) the number of green building facades, 2) street green in the form of trees or planter boxes, and 3) green initiatives like eco-events and education programs. The three attributes were chosen by incorporating feedback from meetings with members of Boulevard Potsdamer, visiting the study area, and conducting expert interviews with local environmental organizations and municipal district offices to gauge demand for certain environmental features. The attributes and photos were pretested with students and scientists from Technische Universität Berlin as well as in a convenience sample of about 20 participants. Our literature review of current discrete choice experiments revealed a lack of research on small-scale street-level elements of urban green. To the best of our knowledge, these unique attributes had not been jointly investigated in other studies, implying that little information on the trade-offs between the attributes currently exists in the literature. Street greening and green facades were two of our focus points due to the extensive amount of vehicle and foot traffic on Potsdamer Straße, making these attributes very noticeable. With the presence of the green library and some small urban gardens in the study area, we sought to investigate the feasibility of using green initiatives as community-building activities that could connect groups of people who are already active and engaged in greener living with those who are less so.

Each attribute consisted of three levels. The first level reflected the present condition (status quo) in the study area; higher levels represented improvement to the attribute. The attributes were described in detail, including their potential positive and negative effects on the neighborhood. We did this intentionally in order to make the study as transparent as possible and to assure a common interpretation for the respondent. In addition to the three green attributes, we included a cost attribute to calculate WTP. The cost attribute was described as a mandatory annual payment from individuals to an "urban green fund" managed by the local government. It had six levels ranging from 12 € to 360 € and was zero for the status quo. The costs presented to our respondents did not correspond with the actual implementation costs for street greening, green facades, or green initiatives, instead serving as proxies to establish willingness to pay.

Table 1 overviews the attributes, including the description provided to the respondents, and their respective scales and levels. Note that the descriptions of attributes were complemented with photos. The whole questionnaire is available in the online supplementary material.

2.4. Questionnaire design

The questionnaire contained five sections (the English version of the questionnaire is found in the online appendix). The first section asked respondents about their use of Potsdamer Straße, including their preferred mode of transport and their familiarity with two environmental

[2] We provide the R code for both models and some additional analyses on code ocean, a cloud-based platform used to share scientific code (codeocean.com/capsule/3461933). The raw data files are published on Mendeley (dx.doi.org/10.17632/sjgr3w28n7.1).

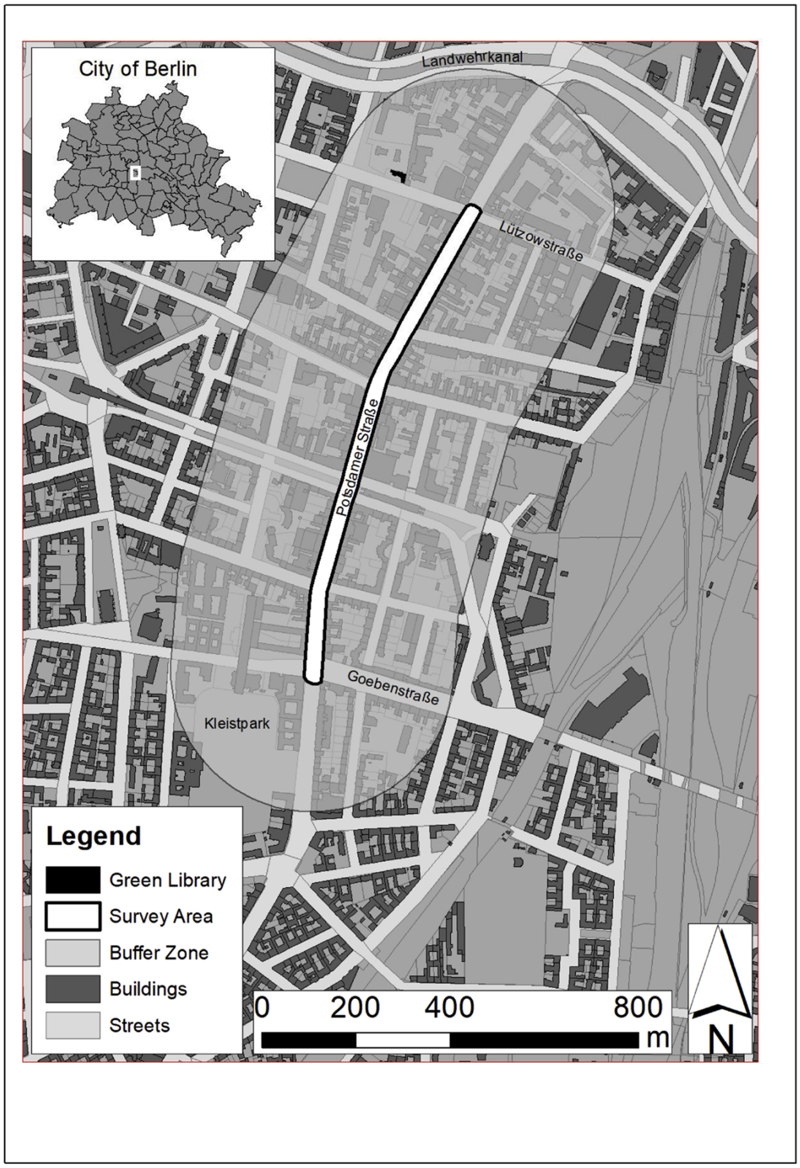


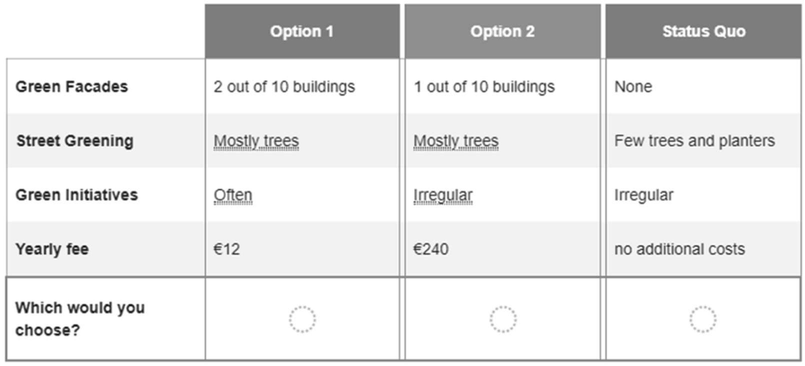
Fig. 1. Study Area.
Source: https://www.geodaten.tu-berlin.de/menue/downloads/berlin/

terms ("ecosystem services" and "biodiversity") used later in the attribute descriptions. Respondents not living in, working in, or frequently using the study area (i.e. not part of our target population) were identified using a screening question and directed to the end of the survey. The second section described the scenario in the discrete choice experiment. Respondents were asked to imagine that the local district office is interested in developing more green features in the area that would be funded via mandatory annual contribution to a fund for urban green in Berlin. We minimized the hypothetical bias in our approach by clearly defining the situation and the respondents' willingness and ability to pay the costs of these urban greening measures. To avoid strategic bidding, respondents were encouraged to consider what they would be willing to pay and their ability to pay for it if it were mandatory; they were also given the opportunity to opt out of payments. The third section contained an explanation of the choice experiment, each of the attributes, the status quo, and accompanying levels of improvement, including photos.

The fourth section contained the discrete choice experiment. Respondents were given nine randomly selected choice sets from an orthogonal array of 18 (Fig. 2). These choice sets included a mouseover option, where the respondent would be reminded of the description of the attribute levels as outlined in Table 1. In each choice set, respondents were asked to select their preferred alternative based on the levels of the attributes and yearly contribution to the urban green fund. The discrete choice experiment ended with a stand-alone question asking respondents if they would participate in eco-events, educational programming, both, or neither if the green initiatives were implemented. The survey concluded with socio-demographic questions on age, gender, employment status, and income, each containing a "prefer not to state" option.

2.5. Data collection

To administer the discrete choice experiment, a survey was created using a web-based tool from SurveyEngine, a market research company focusing on choice modeling research. The desktop and mobile-friendly online survey was open to respondents from January to March 2018. We chose to conduct our experiment using this online format to increase accessibility and inclusivity: it allowed respondents to access the survey at their convenience. These were important factors as some sections of the survey required careful reading and understanding from



	Option 1	Option 2	Status Quo
Green Facades	2 out of 10 buildings	1 out of 10 buildings	None
Street Greening	Mostly trees	Mostly trees	Few trees and planters
Green Initiatives	Often	Irregular	Irregular
Yearly fee	€12	€240	no additional costs
Which would you choose?			

Fig. 2. Example Choice Set.

the survey-takers. Yet, we acknowledge that the online format used for this study bears the potential to limit accessibility for specific groups of people such as non-internet users or those with technical limitations. To promote the online link to the survey, we distributed informational material (flyers and business cards) to residents and local businesses within the study area. Flyers containing a short description of the study and survey link were placed in mailboxes of residential buildings on randomly selected streets in the study area. To incentivize respondents to participate, each completed survey would receive a free hot beverage voucher from the neighborhood's green library. In addition to distributing flyers in the study area, the Boulevard Potsdamer initiative used its mailing list to distribute the survey via email, newsletter, and social media. The sample is not random: self-selection and non-response bias could occur with our sampling method, and it is not possible to aggregate our results to the whole study area. However, as detailed above, we tried to reduce the risk of selecting potentially biased urban green advocates by distributing flyers to the entire street evenly during normal business hours.

3. Results

3.1. Descriptive statistics

The survey garnered a total of 263 respondents from two language options, German or English. We decided to only analyze responses of frequent users of Potsdamer Straße who self-identified as citizens, workers, or regular visitors of the study area to ensure that the results accurately reflect the preferences of users of Potsdamer Straße. Additionally, questionnaires that were incomplete due to an early drop-out were removed, which resulted in 113 questionnaires being excluded from the final sample. This provided a subset of 128 completed and valid questionnaires for our regression analysis.

To understand how our sample differs from Berlin citizens as a whole, we compared our sample population to the 2016 socio-demographic data of Berlin (Table 2) available via the Amt für Statistik Berlin-Brandenburg (Amt für Statistik Berlin-Brandenburg, 2015; StatIS-BBB, 2016) and ran three non-parametric bootstraps to "scale up" our sample and analyze it in relation to the parent population (Appendix I).

The mean age of our respondents was approximately 53 years, while the mean age of Berlin residents over 18 is about 44 years. The standard deviation for the distribution of ages represented in the sampled data (17 years) was around three years smaller than that of greater Berlin, meaning the mean age of our sample fell within one standard deviation of the Berlin dataset. The gender distribution of respondents in our survey was predominantly female with a male:female ratio of 0.88. The Berlin dataset showed a more equal distribution of genders with a male:female ratio of 0.95. Our respondents had a mean household income that was slightly higher than the average household income in Berlin (58,875 € vs. 55,075 €) and a smaller standard deviation (25,382 € vs 29,016 €). These three descriptive statistics taken in tandem with the results of the bootstrap (Appendix 1) show that our sample was markedly older and wealthier and garnered more female respondents than the Berlin average.

Table 2
Descriptive Statistics of socio-demographic data of our sample and the Berlin population.

(N = 147)	Survey Data	Berlin
Age group (years)		
18-24	*9.50%*	*8.30%*
25-34	*21.10%*	*20.40%*
35-44	*15.60%*	*16.00%*
45-54	*21.10%*	*18.20%*
55-64	*23.80%*	*14.20%*
65+	*8.80%*	*22.90%*
mean	*52.50*	*43.60*
std. dev.	*17.30*	*19.10*
(N = 139)		
Gender		
Male	*46.76%*	*48.61%*
Female	*53.24%*	*51.39%*
Ratio (male:female)	*0.88*	*0.95*
(N = 128)		
Annual household income (€)		
< €7K	*10.16%*	*5.67%*
€7-15K	*16.41%*	*15.62%*
€15-30K	*19.53%*	*37.00%*
€30-45K	*20.31%*	*21.46%*
€45-60K	*16.41%*	*11.03%*
> €60K	*17.19%*	*9.22%*
mean	*€ 58,875.00*	*€ 55,075.72*
std. dev.	*€ 25,382.94*	*€ 29,016.70*

*Means and standard deviations were calculated using the median values of each age/income category, except for the oldest age group which was represented by the weighted average age of residents over 65.

Of the 128 complete responses, we report statistics of variables related to the usage of Potsdamer Straße in Table 3. We asked respondents which modes of transportation they commute with in the area (multiple answers possible), how they use the street (multiple answers possible), and if they would be willing to participate in green initiatives. 140 respondents (93%) stated that they commute by foot, 100 and 114 respondents (67% and 76%) stated that they use a bike and public transportation, respectively, and 58 respondents (39%) stated that the commute with car. Regarding neighborhood status, 76 respondents (50%) stated that they live in the area, 73 respondents (48%) stated that they work in the area, and 28 respondents (19%) stated that they visit the area regularly (e.g. for recreational purposes, bringing their children to kindergarten, etc.). Respondents who stated "none of these options" were excluded from the survey as they did not belong to our target population. Regarding green initiatives, 68 and 48 respondents (42% and 30%) stated that they would participate in eco-

Table 3
Respondent Characteristics.

(N = 150)	Count	%
Mode of transportation (multiple responses)		
Foot	*140*	*93*
Bike	*100*	*67*
Transit	*114*	*76*
Car	*58*	*39*
Neighborhood status (multiple responses)		
Resident	*76*	*50*
Worker	*73*	*48*
Visitor	*28*	*19*
Willingness to participate		
Eco-events	*68*	*42*
Educational programming	*48*	*30*
Would not participate	*45*	*28*

events and educational programming, respectively, and 45 respondents (28%) stated that they would not participate in any of those initiatives.

A closer look at the responses to the choice sets reveals that the status quo alternative was chosen 339 out of 1350 times (25%) and 12 respondents always chose the status quo alternative. Respondents who chose the opt-out in all choice occasions were retained in further analysis.

3.2. Estimation results

In this paper, we present results from two logit models that were developed to test hypotheses about users' preferences and assumptions of preference heterogeneity. The first model is a conditional logit model[3] . The ASC takes the value 1 for the status quo alternative and 0 otherwise. All attributes are coded as dummy variables with the status quo level as reference. We included two interaction terms with attributes and socio-demographic variables. The first interaction term was formed by multiplying age with the green initiatives dummy variables as we expected that differences in preferences for this attribute can be partly explained by the respondent's age. The second interaction term was formed by multiplying the cost attribute with the respondent's stated income. This interaction reflects economic theory stating that the marginal utility of money decreases with increased income (i.e. people with higher incomes have higher WTP values). We estimated various models with additional interaction terms, but no further socio-demographic variables could be identified to have a statistically significant impact on preferences for specific attributes. Thus, the first model is parsimonious in terms of socio-demographics as explanatory variables. The second model is a two-class latent class logit model. We included two additional socio-demographic variables in the membership function: resident status (selected 'I live in the neighborhood' when asked how they use Potsdamer Straße) and car usage (selected 'often' or 'always' when asked if they drive or carpool when commuting along Potsdamer Straße). Only these two variables were included in the class membership function because their inclusion resulted in statistically significant values and optimal goodness-of-fit measures. These variables are considered to influence one's preferences for certain urban green measures and explain the estimated probability to belonging to Class 1 (Class 2 is the reference class). A positive sign of the coefficient means a higher likelihood of being a member of Class 1 when the value of the variable increases.

We estimated all models with the R package 'gmnl' (Sarrias and Daziano, 2017). The results of the models are presented in Table 4. As indicated by AIC, BIC, and Pseudo R^2, the latent class model outperforms the conditional logit model in terms of model fit. Additionally, the Hausman test for testing the IIA assumption (Hausman and McFadden, 1984) rejected the Null hypothesis that IIA holds, i.e. a key assumption of the conditional logit model is violated. The latent class model successfully segments our respondents into two preference classes, which provides us with additional insights into heterogeneity in preferences. The latent class model is therefore our focus for the following interpretation.

Class 1 represents respondents who are generally not willing to pay for improvements in green attributes, as indicated by the significant and positive ASC coefficient indicating a large proportion of respondents choosing the status quo alternative, and the large number of non-significant attribute coefficients. In contrast, Class 2 represents respondents who have strong preferences for improvements: the ASC coefficient is significant and negative (i.e. people prefer the hypothetical alternatives of the status quo), and most attribute coefficients are significant and positive. The probability of being a member of either class is relatively equally distributed. For a randomly selected respondent, the probability of belonging to Class 1 is 45%, while the corresponding probability for Class 2 is 55%. We estimated several latent class models with different variables in the class membership function. Income and resident status were not found to be significant predictors of class membership, but income is now included as an interaction term with price in the preference function and resident status remained in the class membership function because its inclusion resulted in better goodness-of-fit measures overall. However, car usage was found to be a significant determinant of class membership: the probability of belonging to Class 1 decreases if the respondent frequents the area with car (negative sign for car coefficients). Thus, a respondent is more likely to be a member of Class 2 and, by extension, more willing to pay for green attributes if the respondent uses a car always or often.

The positive and mostly statistically significant attribute coefficients in the latent class logit model show that respondents value implementing green attributes along Potsdamer Straße. The most important attribute is increasing the amount of trees and planters, followed by green building facades, and then by regularly occurring eco-events and education. The negative coefficient of the price attribute in both latent classes shows that higher prices increase the likelihood of choosing the status quo scenario. In the following section, we discuss these values in more detail in terms of WTP, making it easy to interpret and compare preferences for the attributes. Table 5 presents the WTP values for the conditional logit model (for the reader's reference) as well as for each class in the latent class logit model with confidence intervals (CIs) calculated using the Delta Method (Greene, 2002). Weighted average WTP values are also included. These are calculated as the sum of the product of the choice probability for the respective class and the class-specific WTP value (Scarpa and Thiene, 2005), in this case:

$$WTP_{av} = 0.45 * WTP_{class1} + 0.55 * WTP_{class2} \quad (8)$$

In the following we report WTP values with their respective CIs. Generally, CIs were comparatively large and its magnitude should be taken into account when interpreting WTP. For all attributes, WTP values in Class 1 were lower than values in Class 2. Class 2 showed a high WTP for more trees (143 €) and for more planters (173 €), with relatively large and overlapping CIs ([104,212] and [91,194]). Subsequently, WTP for more planters is statistically not significantly higher than for more trees (Wald Test p-value 0.15). In contrast, WTP in Class 1 were only 34€ ([12,56]) for more trees and 21 € ([-1,43]) for more planters (not significantly different, Wald test, p-value 0.22). The WTP for improvements in green facades on Potsdamer Straße was similarly large in Class 2 (109 € for an increase to 1 out of 10 buildings and 158 € for 2 out of 10 buildings), with large and overlapping CIs ([63,156] and [105,212], respectively) In contrast, WTP for green facades in Class 1 was significantly lower (18 € [3,40] and 28 € [7,38]). In Class 2, WTP for an increase to 2 out of 10 buildings was statistically higher than WTP for 1 out of 10 buildings (Wald test, p-value 0.02),

[3] As some people responded more quickly to the choice experiment questions, we performed a robustness check by excluding stepwise respondents who took less than 0.5 minutes, 0.6 minutes, …, 2 minutes. It turned out that willingness to pay values were hardly affected. Therefore, we used the model with all respondents included. The results of the robustness check are part of the R code.

Table 4
Results.

	Model 1			Model 2					
	Conditional Logit			Latent Class 1			Latent Class 2		
	β		z-score	β		z-score	β		z-score
ASC	0.488	**	3.080	0.561	.	1.886	−0.890	***	−3.604
Green Facade 2	0.551	***	4.790	0.423	.	1.719	0.708	***	4.728
Green Facade 3	0.762	***	6.676	0.656	**	2.674	1.026	***	6.644
Street Greening 2	0.816	***	7.073	0.788	**	3.215	0.924	***	6.218
Street Greening 3	0.829	***	7.096	0.492	.	1.940	1.122	***	7.352
Green Initiatives 2	0.243	*	2.186	0.122	n.s.	0.519	0.313	*	2.174
Green Initiatives 3	0.143	n.s.	1.276	−0.467	.	−1.689	0.467	**	3.143
*Green Initiatives 2*Age*	−0.179	**	−3.042	−0.430	***	−3.698	−0.162	.	−1.795
*Green Initiatives 3*Age*	−0.215	***	−3.648	−0.672	***	−4.974	−0.180	.	−1.953
Price	−0.069	***	−13.592	−0.230	***	−8.767	−0.065	***	−8.498
*Price*Income*	0.006	**	2.662	0.014	n.s.	1.044	0.003	n.s.	0.727
Class Membership (Reference Class 2)									
Constant				0.2	n.s.	1.021			
Resident				−0.069	n.s.	−0.553			
Car				0.605	***	5.607			
Observations			1152			1152			
Respondents			128			128			
Share						45%			55%
AIC			2192.23			1772.90			
BIC			2247.77			1899.13			
Pseudo R^2			0.14			0.32			
Log-likelihood			−1085.12			−861.45			
Log-likelihood (null)			−1262.05			−1262.05			

Significance: *** p < 0.001; ** p < 0.01; * p < 0.05; p < 0.1; . n.s. p > 0.1 See Table 1: Green Facade 2 is 1 out of 10 buildings with green facades; Green Facade 3 is 2 out of 10 buildings with green facades; Street Greening 2 is mostly trees - Trees every 10 m, few planters; Street Greening 3 is mostly vegetation - Trees every 20 m, many planters; Green Initiatives 2 is occasionally - Eco-events once per year, monthly educational programming; Green Initiatives 3 is often - Eco-events once per season, weekly educational programming.

Table 5
Marginal willingness to pay for urban green (€ per year).

	Model 1		Model 2				
	Conditional Logit		Latent Class 1		Latent Class 2		*weighted*
	Mean [95% Confidence]		Mean [95% Confidence]		Mean [95% Confidence]		
ASC	70.19	**	24.38	.	−137.39	***	−64.56
	[21.83, 118.55]		[-3.31, 52.06]		[-214.19, -60.60]		
Green Facade 2	79.37	***	18.36	.	109.29	***	68.35
	[45.67, 113.06]		[-3.16, 39.87]		[62.60, 155.97]		
Green Facade 3	109.64	***	28.49	*	158.43	***	99.93
	[74.94, 144.34]		[6.60, 50.38]		[104.76, 212.10]		
Street Greening 2	117.45	***	34.24	**	142.65	***	93.84
	[81.87, 153.03]		[12.44, 56.04]		[90.97, 194.33]		
Street Greening 3	119.37	***	21.39	.	173.28	***	104.9
	[83.91, 154.82]		[-0.62, 43.40]		[119.83, 226.73]		
Green Initiatives 2	35.00	*	n.s.		48.39	*	28.99
	[3.41, 66.6]		[-14.75, 25.34]		[4.31, 92.48]		
Green Initiatives 3	n.s.		−20.27	.	72.14	**	30.53
	[-11.1, 52.23]		[-44.18, 3.63]		[26.16, 118.12]		
*Green Initiatives 2*Age*	−25.78	**	−18.70	***	−24.97	.	−22.15
	[-42.54, -9.03]		[-29.02, -8.38]		[-52.34, 2.40]		
*Green Initiatives 3*Age*	−31.00	***	−29.20	***	−27.77	.	−28.41
	[-47.94, -14.06]		[-41.68, -16.72]		[-56.10, 0.57]		

Significance: *** p < 0.001; ** p < 0.01; * p < 0.05; . p < 0.1; n.s. p > 0.1 95% confidence interval: lower limit followed by upper limit, confidence intervals calculated with the Delta Method. WTP in € is not representative of the actual or perceived costs of implementing Urban Greening but used only as an indicator of preference/willingness toward attributes in the survey sample. See Table 1: Green Facade 2 is 1 out of 10 buildings with green facades; Green Facade 3 is 2 out of 10 buildings with green facades; Street Greening 2 is mostly trees - Trees every 10 m, few planters; Street Greening 3 is mostly vegetation - Trees every 20 m, many planters; Green Initiatives 2 is occasionally - Eco-events once per year, monthly educational programming; Green Initiatives 3 is often - Eco-events once per season, weekly educational programming.

while this was not the case in Class 1 (Wald test, p-value 0.29). WTP for green initiatives diverged the most between the two classes. While in Class 2 WTP was 48 € [4.3,92.5] and 72 € [26.2,118.1] for more green initiatives (no statistically significant difference between 'occasionally' and 'often', Wald test, p-value 0.27), WTP in Class 1 was not statistically significant for 'occasionally' and had negative mean for 'often' (-20 € [-44,4]), indicating no WTP for green initiatives.

The interaction term between age and green initiatives revealed decreasing WTP for green initiatives with increasing age for both classes. Moving one age category higher (see Table 3) resulted in a decrease of

WTP between 19 € [8,29] to 25 € [2,52], i.e. older people are less willing to pay for green initiatives than younger people. The interaction term with income is significant only in the conditional logit model. The positive sign means that increasing income reduces the impact of increasing costs, which is in line with our expectation that higher income people are less sensitive to increases in costs. We could not provide evidence for an income effect in the latent class model and therefore do not discuss the influence of income on willingness to pay further.

The weighted averages of the WTP values from the latent class model reveal an overall positive WTP for improvements on Potsdamer Straße and a preference toward the higher level of improvement for all three green attributes. On average, improvements in street greening (94 € and 105 €) and green facades (68 € and 100 €) are larger than those of green initiatives (29 € to 31 €).

4. Discussion

In general, the findings from our study are in line with other studies focusing on the valuation of urban green space. Our discrete choice experiment showed that respondents are, on average, willing to pay for improved urban green attributes. We found strong differences in preferences between respondents. The latent class model revealed that about half of the respondents are willing to pay comparatively large amounts for improvements, while the other half is hardly willing to pay at all and, if so, only for more trees and planters.

In the following subsections, we discuss the results for each of the three green attributes as well as policy implications and recommendations.

4.1. Green facades

We observed strong heterogeneity in the WTP values for green facades between the two classes. Class 2′s WTP (109 € and 158 €) contrasted sharply with the WTP of Class 1 (18 € and 28 €). This marked contrast in WTP between the classes could indicate differences in perception about green facades, perhaps related to aesthetics or benefits to urban socio-ecological health. Although we observed broad confidence intervals, a trait echoed across all the attributes. The findings indicate that respondents were generally willing to pay to increase the share of facades made green on Potsdamer Straße. This conclusion is partially supported by other research on the topic, although many studies focused on different aspects of green facades: their value to biodiversity (e.g. Collins et al., 2017), energy saving benefits (e.g. Haggag et al., 2014), or their general potential (Francis and Lorimer, 2011). In contrast to our findings, a study on a newly installed living wall at a hospital in Spain found that respondents were not willing to pay for such a feature themselves but believed that there were positive benefits and supported the hospital's decision (Urrestarazu et al., 2017). In general, it is difficult to compare our findings to prior studies because they were conducted differently, observed different socio-cultural and economic contexts, and had different objectives than our study on Potsdamer Straße. However, our results confirm a trend that people are willing to pay more for physically larger investments.

4.2. Street greening

Among our attributes, street greening was the most widely agreed-upon: both classes showed significant WTP for improvements in street trees (though much higher for Class 2). Our findings for the street greening attribute are in line with previous studies that show a positive willingness to pay for street green among respondents. A discrete choice experiment on street trees in Lodz, Poland revealed a positive WTP concluding that programs with larger upgrades were more likely to be selected (Giergiczny and Kronenberg, 2014). Similarly, a study in Manchester, UK observed increased WTP for both larger and physically greener investments (Mell et al., 2013). Derkzen et al. (2017) elicited preferences between various green infrastructure measures in Rotterdam and showed that, at the street level, respondents opted for trees over shrubs and grass strips, which shows a preference for larger green measures, an effect that we could not identify in our study.

4.3. Green initiatives

Our respondents showed strong interests in green facades and street greening while green initiatives received the least amount of attention. WTP values were only 48 € and 72 € for Class 2 and were either negative or not significantly different from zero for Class 1. In contrast to street greening, green initiatives was the most divisive attribute studied. It was the only attribute to return negative WTP values and showed a high level of disagreement between the two classes. Additionally, the interaction between green initiatives and age adds a layer of complexity; we observed that respondents from both classes were less willing to pay for green initiatives when age increased. Only a quarter of the respondents in our sample reported that they would not participate in either environmental education or eco-events if they were implemented – possibly indicating some interest in the concept as long as the initiatives meet their accessibility criteria (time, location, physical layout, etc.) for participation. So despite the growing popularity of urban gardens and civic greening initiatives in Europe and the USA in recent years (Bendt et al., 2013; Kaźmierczak, 2012; Krasny and Tidball, 2009), our results suggest that, for the respondents of our survey, a disconnect might exist between interest in green initiatives and willingness to pay for them. Low WTP values could be the result of several reasons (including a lack of time to participate or an unwillingness to sacrifice time), but the potential disconnect between interest and willingness to pay might signal that there are barriers to participation that affect populations that are interested in green initiatives but aren't willing to pay for them to occur unless the details of the initiative are specified and fit their individual requirements. More research on this attribute is needed.

4.4. Policy implications and recommendations

In contrast to previous similar studies, our study offers a comparison of preferences between different types of urban green. A simultaneous valuation of several urban greening features is useful for prioritizing the various options for urban greening in policies and plans. For example, respondents showed that they value an increase in the number of planters, a very low-cost alternative, just as much as an increase in the number of street trees, a higher-cost alternative. It is thus much more cost-effective to increase the number of planters rather than street trees. Similarly, respondents were willing to pay for green facades. An increase to 1 out of 10 buildings with a green facade leads to a WTP of 68 € and a further increase to 2 out of 10 buildings with a green facade increases WTP by only 32 €. This can be explained by decreasing marginal utility and implies that people already benefit a lot from a few green facades. An increase to even more green facades produces much less additional benefit.

Our results demonstrate that respondents are indeed willing to pay for urban greening, which is a valuable conclusion for decision-makers working on urban ecosystem services and urban or landscape planning. For planners with concerns about how to fund urban green features, this study provides evidence that frequent users of the study area might be willing to pay to improve their local trees, facades, and eco-initiatives or support public investments and other mechanisms to do so. However, our analysis also showed that preferences are heterogeneous and a large share of people are not willing to pay. So, while respondents showed a positive WTP on average, their intragroup heterogeneity would likely make it difficult to implement any payment scheme to fund urban greening that does not account for those nuances.

Thus, policy-makers and planners should use payment mechanisms that discern between those who are willing to pay more for the benefits of urban green and those who are not. We therefore recommend a mix of different street-greening measures rather than a focus on one specific green attribute. In the examples described above, respondents' utility will be strongly increased if more planters are present in the street and

1 out of 10 buildings has a green facade. Increasing the number of trees and green facades will lead to smaller additional net benefits. We also urge decision-makers to seek out and use valid sources of information about the reasons why certain attributes are valued more than others. While our results showed that green initiatives are somewhat divisive in terms of how much respondents were willing to pay, interest in them and a desire to participate in them could very well exist on Potsdamer Straße – planners should take that into account and seek to understand hidden barriers that affect people's willingness to pay rather than assume that low WTP is a proxy for low interest in the attribute.

The crafting of these targeted interventions and the payment schemes to fund them could be facilitated by including the results of the present study in discussions between local stakeholders and policymakers on urban greening plans.

4.5. Limitations

Our study does, however, have some limitations that should be accounted for when using the results in policy and planning exercises. Due to the survey's exploratory nature and small budget, the respondent sample is not representative of the study area's demographics and the sample size of 128 responses is rather small. Moreover, the socio-demographic variables explored in our models offered only a modicum of significant information about respondents' preferences, making it difficult to derive policy recommendations targeted at specific demographic groups based on the WTP results. We found some indication that car-users in our sample are willing to pay more for improvements in street greening and that willingness to pay for green initiatives decreases with age. Regression results show that there is only a slight correlation between car-users and the variables of income and age. We also found that respondents with higher incomes are less affected by increasing costs, but this effect was only significant in the conditional logit model. Although it would be highly useful to investigate the (in)direct causal influences of socio-demographic variables on the WTP for the three attributes of urban green, our survey was not designed to study those linkages.

Our study also lacked follow-up questions to validate the choice experiment (as described by Johnston et al., 2017). For example, many stated preferences studies include questions on protest responses. Protest responses come from people who are generally willing to pay but object to the choice task for a specific reason. These respondents, once identified, are usually excluded from the analysis. In our case, we did not include any such follow-up questions as we aimed at keeping the questionnaire as short as possible to maximize response rate and minimize drop-outs. Only 12 respondents always chose the status quo alternative and excluding them did not significantly change the results. Although information on protest responses would give additional insights, we can safely say that the omission of this question does not invalidate our results.

As is potentially the case in any stated preference study, our WTP values are likely higher than real WTP. This hypothetical bias is due to the speculative nature of the survey task (Carson and Czajkowski, 2014) – respondents are not obligated to perform their choices in reality and thereby might be more willing to report choices that they would not actually make. Additionally, the high dropout rate of 43 percent should be taken into consideration. Previous studies (Bateman et al., 2006) suggest that respondents dropping out of stated preference studies may be treated as zero-bidders, which would decrease the WTP values significantly. In this regard, the risk of exceedingly high WTP should be acknowledged when using our results for further analyses.

5. Conclusion

In light of rising urbanization and the resultant decrease of urban natural amenities, this study sought to measure the utility derived from components of the urban landscape that could collectively contribute to urban greening. Greening of urban areas can help increase climate resilience at a community level by providing habitat for biodiversity as well as support physical and mental health by helping regulate air quality levels and giving opportunities for recreation and aesthetic appreciation.

To obtain an economic valuation of urban greening, we used a discrete choice experiment to reveal monetary values for a unique variety of street-level greening measures that are important for urban planning. The statistical analysis of the collected choices revealed that frequent users of the study area are willing to pay for urban greening; the results also establish an order of preference for which attributes would be most appreciated in the neighborhood. It is important to note that the willingness to pay values obtained in the study are not interpreted as actual monetary values, but rather indicators of preferences between various options. Since the values are presented through hypothetical payments to an "urban green fund," they should not be interpreted as a reflection of people's *actual* willingness to pay, which would likely be different in a real-world setting. However, for the purposes of the study, we can interpret the varying levels of willingness to pay as an indication of respondents' preferences between the options (Hanemann, 1994; Kahneman and Knetsch, 1992; Kahneman et al., 1999). Notably, respondents' WTP values were at maximum 0.4% of income, which is comparable to raised property taxes in Berlin (Senatsverwaltung für Finanzen, 2019a; Senatsverwaltung für Finanzen, 2019b). The results could be valuable to decision-makers in the fields of urban ecosystem services and landscape planning and is especially pertinent to those in central Berlin.

Several economic studies have been published on citizens' experiences and preferences regarding urban green. However, due to varying and disparate results, such studies are not particularly transferable between regions and thus might only remain accurate for their specific location. That said, many of our findings are in line with other studies focusing on urban green space valuation and we would recommend using the discrete choice experiment in conjunction with non-monetary methods for other small-scale studies seeking to value urban ecosystem services and uncover an order of preferences for various urban green goods that can be assessed for feasibility and implemented as individual interventions. We found positive willingness to pay for street greening and green facades as well as higher willingness to pay for higher levels of provision, indicating preference for a greener neighborhood. Of the survey's three green attributes, two (street greening and green facades) showed higher WTP values while the third attribute (green initiatives) received less interest, i.e. WTP values were much lower than for the physical greening features.

The present study identified topics for continued research that could be appropriate for a qualitative study. For example, a qualitative survey about causation might be useful to determine why age had a negative effect on WTP for green initiatives and why this preference was distinctive in Class 2 respondents that otherwise showed a high WTP for other attributes. Extending the breadth of our study to include future research on larger-scale greening interventions as well as its depth to include the nuances of preference differences between stakeholder groups and the effects of sociodemographic variables may offer additional valuable contributions to policy-making in the area. Future studies could combine DCEs with other valuation methods, such as hedonic pricing, or non-monetary qualitative methods, such as satisfaction surveys and targeted focus group discussions, to provide more robust and holistic guidance to policy-makers about which urban greening interventions could provide optimal social benefits in context.

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Appendix A. Bootstrapping of socio-demographic variables

The mean age of the respondents was non-parametrically bootstrapped across 20,000 new vectors to approximate the 2.9 million respondents from the Berlin dataset (Amt für Statistik Berlin-Brandenburg, 2015); this produced a very concentrated distribution with a standard deviation of less than half a year. Although the bootstrap's minimum mean age was about seven years higher than the Berlin average and the mean ages of both the original and bootstrapped datasets were about nine years higher than the parent population (Berlin data), both of these statistics fell within the Berlin dataset's third quartile.

The distribution of bootstrapped gender ratios (R = 21,000) overlapped with the gender ratio from the Berlin dataset (Amt für Statistik Berlin-Brandenburg, 2015): the ratio of the Berlin dataset fell within the fourth quartile of the bootstrapped distribution.

When the mean income was bootstrapped across 20 new vectors to approximately equal the parent population (2311 respondents) (Amt für Statistik Berlin-Brandenburg, 2015), it produced a relatively concentrated distribution with a minimum value that was still about 2.500 € larger than the mean income of the Berlin sample. The bootstrapped mean fell within the Berlin sample's fourth quartile.

Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.landusepol.2019.104237.

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