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Preferences for sustainable mobility in natural areas: The case of Teide National Park

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Abstract:

We conducted a stated choice experiment with visitors to the Teide National Park (TNP), where a hypothetical park shuttle bus connecting its main points of interest was simulated. Using these data, we estimated a model focused on capturing systematic and random heterogeneity in the park visitors' preferences. We obtained visitors' willingness-to-pay (WTP) for saving time while searching for a parking space (when using cars), and also visitors' WTP for reducing the waiting time required to start the visit in the shuttle bus. Moreover, regarding the environmental impact of the visit, we obtained individuals' WTP for reducing CO_2 emissions.

Our results suggest that visitors would be willing to pay nearly 11€ for reducing the time spent finding a parking space and 9€ for reducing the waiting time to start the visit, in one hour; further, they would be willing to pay 3€ for reducing in 20gr the CO_2 emissions per occupant. These values are higher for females, for German visitors and for those who are regular bike riders at their home location. Moreover, we found that visitors aged between 55 and 60 had the highest WTP.

These results may be used to design transport management policies for relieving visitors' dependence on personal vehicles, helping to increase the visit quality and reduce the negative externalities associated with current mobility patterns in the park.

KEYWORDS: Stated choice experiment, mixed logit, individual preferences, willingness-to-pay, sustainable transport, Teide National Park

1 Introduction

Growing interest in nature-based tourism has led to a substantial increase in visitors to National Parks (Buckley, 2000; Balmford *et al*., 2009), which have become important tourist attractions worldwide. However, the exponential growth in the number of visitors has also brought negative impacts on park resources (such as traffic congestion, air and noise pollution, parking issues, etc.) and in the quality of the visitor's experience (Mace *et al*., 2004; Ament *et al*., 2008). These problems, fuelled by increasing vehicular travel demands, have highlighted the need to plan and implement alternative mobility systems at national parks.

For these reasons, transport management at national parks has emerged as a key issue and managers of natural areas around the world are seriously considering alternatives to the private car. In this sense, more sustainable transport modes, such as buses, trains, bicycles and cableways, allow to reduce the negative externalities associated with cars, but the implementation of sustainable mobility policies in natural spaces is relatively recent (Daigle and Zimmerman, 2004; Manning *et al*., 2014). This concern has manifested throughout the world in the application of different initiatives associated with the implementation of incentives for the use of such modes, together with applying dissuasive measures to the use of private vehicles, such as tolls and restrictions on car access (Holding and Kreutner, 1998; Orsi and Geneletti, 2014). Therefore, increased focus on the use of more sustainable modes across a substantial number of national parks has led to a greater need for improving the understanding of visitor behaviour (Taff *et al*., 2013).

To properly assess alternative management strategies, we need to carry out cost-benefit analyses. For this, we need to estimate a monetary valuation for, among others, the travel time and the negative externalities associated with car use. These constitute welfare improvements to be added in a cost-benefit analysis of park projects. Research on these values can help designing more efficient and equitable transport policies for natural parks.

According to microeconomic theory, the monetary valuation associated with changes in negative externality levels and/or transport mode attributes can be obtained from individual choices in both real and hypothetical markets; these requires the cost of each option to be included as one attribute of the choice scenarios. The welfare gain to visitors should be evaluated according to their willingness-to-pay (WTP), that is, the marginal rate of substitution between one attribute and money for a given level of utility.

In the past, WTP was usually obtained using the *Contingent Valuation* (CV) method; however, there is controversy regarding its ability to find reliable WTP, especially when applied to situations where multiple options and attributes are considered (Diamond and Hausman, 1994). *Stated Choic*e (SC) experiments are now preferred, particularly when it is necessary to value the characteristics describing a resource or service (Hanley *et al*., 1998). SC experiments involve hypothetical choice contexts where respondents have to make trade-offs between attributes and implicitly reveal their valuations of different attributes.

In SC experiments the response variable is represented by the choices made by respondents. SC experiments belong to a broader class of experiments referred to as *Stated Preference* (SP) methods, where responses may also be of a different nature (e.g. choices, rankings and ratings) but even, more generally, to other classes of experiments such as CV.

SC methods have been widely used in the transport field; however, the application to travel choices in natural spaces is scarce (Steiner and Bristow, 2000; Shiftan et al., 2006; Pettebone et al., 2011). Moreover, in national park contexts, few studies have evaluated the attributes of alternative transport modes using discrete choice models (Pettebone *et al.*, 2011; Shiftan *et al.*, 2006, Orsi and Geneletti, 2014). Finally, we are not aware of previous work considering the WTP for reducing CO_2 emissions from travel modes in national parks.

This paper contribues to filling a research gap in terms of exploring visitor preferences and WTP for several attributes of sustainable travel modes in a national park context. Specifically, a SC experiment was conducted at Teide National Park (TNP) in Tenerife (Spain), where cars are an integral part of the visitor experience (70% of visitors access and move through the park by car, mainly in rental cars).[1]

The participants of our travel choice experiment had to choose between using the car (that is, their current option) and a hypothetical shuttle bus connecting the main points of interest and the two main entrances to the park. The bus was assumed to be free and visitors would only have to pay for parking their cars at the park entrance. The bus could also be either electric or diesel powered, with different levels of greenhouse gas emissions (CO_2) in each case. Visitors using the bus would need to wait a certain amount of time to start the visit, depending on the frequency of the service. In contrast, car users would need to spend some time finding parking spaces at the various sites inside the park and pay an increased parking fee; also, their greenhouse gas emissions (CO_2) per passenger would be higher than those of the bus users. The inclusion of the cost of using each travel option allowed us to obtain the WTP for reducing the other attributes considered.

We aimed to make several contributions to the literature on management mobility for national parks. In particular, our research is unique in that we were able to estimate WTP for certain mode attributes affecting visitors' travel choices at TNP. Specifically, we obtained

[1] The TNP is the most visited of Spain's network of national parks, reaching a historic record in 2016 with a figure of over four million visitors (Data extracted from "Anuario de Estadística", Instituto Nacional de Estadística (INE), and "Memorias de la Red de Parques Nacionales", Ministerio de Agricultura y Pesca, Alimentación y Medioambiente)

visitors' WTP for saving time while searching for a parking space and for reducing the waiting time required to start the visit in the shuttle park bus. We also obtained, for the first time, individuals' WTP for reducing CO_2 emissions, finding in all cases that the estimated values depended on the factors and socioeconomic characteristics of the visitors.

To the best of our knowledge, no previous studies have used a *mixed logit* (ML) model focused on capturing systematic and random heterogeneity in park visitor's preferences. Moreover, instead of using *fractional factorial designs*, as the vast majority of previous studies, our choice scenarios were generated using an *efficient design* (Huber and Zwerina, 1996), a superior technique which had not been applied to analyse travel choices in national parks. Finally, we were able to estimate "individual values" for the parameters and not just the "population" means that are typical of the great majority of ML applications.

The rest of the paper is organized as follows. Section 2 reviews the current literature on the subject to put our contributions in context. In section 3, a descriptive analysis of the data obtained in the SC survey is presented, as well as the experimental design of the exercise. In section 4, we explain our modelling approach and in section 5 comment the most interesting results. Finally, the main conclusions drawn from the analysis are presented in section 6.

2 Brief Literature Review

The majority of studies related to transport management in national parks has used qualitative surveys and has been focused on visitors' responses to management policy changes (Harrison, 1975; Miller and Wright 1999; Sims *et al*., 2005). For instance, several authors have evaluated the visitors' acceptance of a park shuttle system in national parks: Denali National Park (Harrison, 1975; Miller and Wright, 1999); Great Smoky Mountains National Park (Sims *et al*., 2005); Zion National Park (Mace *et a*l., 2004, 2013); Acadia National Park (Holly *et al*., 2010). In general, results indicate significantly lower support of visitors for additional fee-based or mandatory systems (Holly *et al*. 2010; Sims *et al.* 2005; White 2007; White *et al*. 2011).

Other studies have examined the visitors' experience during movements through a park. For instance, Hallo and Manning (2009) point out that road management should be different in natural parks not only to encourage the safe and efficient travel of visitors, but also to improve the recreational experience.

Several authors (Eaton and Holding, 1996; Holding and Kreutner, 1998; Laube and Stout, 2000; Shiftan *et al*., 2006; White, 2007; Youngs *et al*., 2008; Pettebone *et al*., 2011; Mace *et al*., 2013; Taff *et al*., 2013, Wilson *et al.*, 2018) have found that the quality of service provided (cost, frequency, waiting time, bus comfort, etc.), the management measures adopted (e.g. road closures) and the conditions experienced by the visitors (e.g. traffic congestion, crowding, parking problems, easy access to different areas and viewpoints), are the main factors explaining the choice of more sustainable modes over cars. Additionally, the influence of environmental values associated with using such modes has been found to be a secondary reason to use, for example, a shuttle bus service (Holly *et al*., 2010; White, 2007).

Some authors have taken advantage of the benefits of using SP surveys, to study the attitudes of visitors towards different transport modes in/to natural and recreational areas (Steiner and Bristow, 2000; Shiftan *et al*., 2006; Pettebone *et al.,* 2011; Pettengill *et al*., 2013; Orsi and Geneletti, 2014)[2]. In particular, Steiner and Bristow (2000) analysed visitors' preferences between *park-and-ride* and driving, and considered fare, bus headway and journey time as the main attributes. Shiftan *et al.* (2006) identified the car entrance fee and bus fare, the car in vehicle and out of vehicle time, the bus headway and the availability of interpretative programs in the buses as the main variables affecting the choice of shuttle bus versus car. Pettebone *et al*. (2011) found that visitors preferred to use their private vehicles over other modes but were willing to change under certain conditions (i.e. trail crowding and road congestion). Orsi and Geneletti (2014) used a SP survey to predict mode choice as a consequence of various access policies. Pettengill *et al.* (2013) evaluated attitudes towards car, shuttle bus and bicycle, using SP questionnaire and discrete choice models, and found that visitors preferred segregated bike lanes, lower travel cost and levels of crowding, higher levels of convenience in the case of parking lots, and higher availability of bicycle and bus stops.

This review of literature about park visitors' preferences towards more sustainable transport modes shows that few studies have been designed to quantitatively model the influence of various factors on national park visitors' decisions about mode choice. Moreover, studies

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[2] *Stated Preference* methods have been widely used to estimate the economic value assigned to national parks by visitors (see, for example, Lee *et al*, 2013; Henderson-Wilson *et al.*; 2017). Other studies have used this technique to estimate destination choice models in natural spaces (Scarpa and Thiene, 2005: Thiene and Scarpa, 2009).

using SC models are relatively limited and no one has estimated the WTP for reducing CO_2 emissions from transport modes in national parks. Likewise, to the best of our knowledge, no studies published to date have used efficient designs to generate choice scenarios and none has estimated ML models allowing to capture systematic and random heterogeneity in park visitor's preferences. Models of this type can be powerful tools to aid the implementation of appropriate measures to disincentive private car usage in national parks.

3 Data and Choice Experiment

In this section, first, the characteristics of the Teide National Park (TNP) and the mobility patterns of park visitors are described. Second, the stated choice (SC) experiment is described. Third, data collection and sample description from the SC survey are shown.

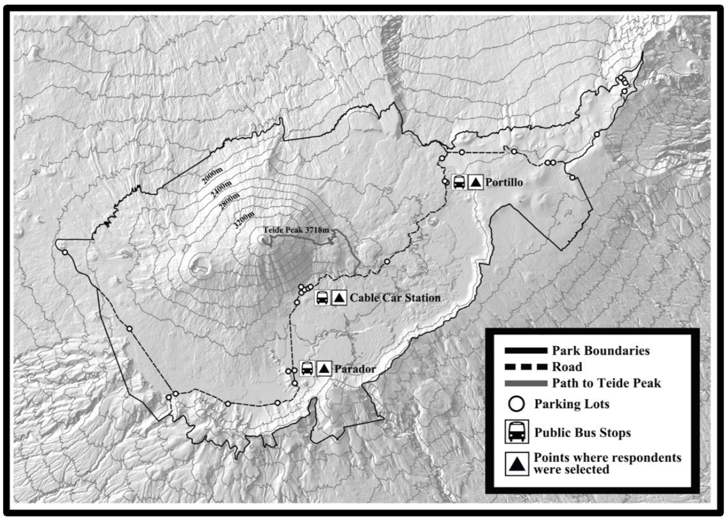
3.1 Characteristics of the park and visitor mobility patterns

The TNP is located in the centre of the island of Tenerife (Canary Islands, Spain). The park was created in 1954 in recognition of its volcanic and biological singularity, and was declared a World Heritage Site by UNESCO in 2007. Its main attraction is the Teide-Pico Viejo volcanic complex, which reaches 3718 meters and is the highest peak in Spain. Likewise, the park has a great visual impact due to its atmospheric conditions that generate constant changes of tones and textures on the landscape and form an impressive sea of clouds as a backdrop to the mountain (UNESCO, 2007). The park covers an area of 190 km^2 and has four road accesses; two from the north of the island (La Orotava and La Laguna) and two from the south (Vilaflor and Chio). It is crossed by three roads totalling around 50 km. However, the section that runs through the TF-21 brings together most visitors because the main landmarks of the area are concentrated along it (Figure 1).

The park is heavily exposed to the pressures of mass tourism due to its attractiveness and location in a popular tourist destination; in fact, it is the most visited natural park in Spain and in 2016 received over four million visitors[3]. This volume is concentrated in certain months and peak hours, showing strong seasonal behaviour, with the maximum influx occurring in the summer months, especially August, and Easter.

[3] Data extracted from "Anuario de Estadística", Instituto Nacional de Estadística (INE), and "Memorias de la Red de Parques Nacionales", Ministerio de Agricultura y Pesca, Alimentación y Medioambiente.

Figure 1. Teide National Park



According to the information provided by the park authorities, in 2015 the TNP received a daily average of over 9,000 visitors, concentrated mainly between 11 and 12 in the morning. Also, 70% of visitors travelled to the park by car, mostly rental cars, 28% by tour bus (organized excursions) and only 2% by public bus services (see González *et al*., 2017; 2018). The high volume of traffic (2,400 cars per day) has to use the only road (see Figure 1), about 20 km in length with 700 parking spaces distributed in 22 car parks. Therefore, at peak hours the number of vehicles usually exceeds the load capacity of the park. This causes a wide range of negative externalities such as high noise levels in certain areas, traffic congestion, crowding in car parks, air pollution, and so on (González *et al*. 2016a). This situation demonstrates the need to implement transport management policies for relieving visitors' dependence on personal vehicles, helping to improve the use and conservation of such a unique natural area.

3.2. Stated choice experiments

SC experiments are an effective method to analyse individuals' preferences. Their main purpose is to determine the independent effects of different attributes upon certain observed outcomes, for example, the choices made by a sample of respondents (Rose and Bliemer, 2009). Therefore, a typical SC experiment requires a sample of individuals to complete different choice tasks (i.e. choose the preferred alternative among a finite set of options). The alternatives are characterized by the different values, or levels, taken by the attributes included in the experiment. All the information about the experiment is represented in a design matrix **X**, the columns and rows of which are normally associated with the alternative attributes and choice situations, respectively. The way in which these levels are arranged in **X** determines the ability of the experiment to measure the independent effect of every attribute and to obtain statistically significant parameter estimates (Ortúzar and Willumsen, 2011, Chapter 3).

There are many types of SC experiments. For decades, *orthogonal designs* (i.e. those where column vectors in **X** are uncorrelated), were widely used by researches in many fields, mainly because of their simplicity in both, construction and use (see Louviere et al., 2000 for a good review of different SC methods). However, more recent literature has questioned their suitability when using nonlinear models, such as discrete choice models, mainly because the orthogonality property does not ensure the minimization of the standard errors of the parameters estimates (Huber and Zwerina, 1996; Kanninen, 2002; Sándor and Wedel, 2002). In addition, as pointed out by Rose and Bliemer (2009), orthogonality is a statistical property related to the correlation structure of **X** and not a behavioural property imposed on the experiment. Therefore, *orthogonal designs* would not be theoretically appropriate when attributes are cognitively perceived as correlated in the minds of the respondents (e.g. price and service quality attributes). For these reasons, many researchers have focused on the construction of *efficient designs*, which are fractional factorial experiments based on certain efficiency criteria. Although the use of designs based on the minimization of the asymptotic standard errors has become a more attractive strategy for researchers wishing to estimate nonlinear choice models, their use is not free of criticism (Walker *et al*. 2018).

One of the most widely used efficiency measures is the D-error, defined as:

$$D - \text{error} = (\det \Omega_1)^{1/K} \tag{1}$$

where, K is the total number of parameters to estimate and $\mathbf{\Omega_1}$ is their asymptotic covariance matrix, defined as the inverse of the Fisher information matrix $\boldsymbol{I_1}$ (Train, 2009, Chapter 8). In turn, the latter is represented by the inverse of the negative of the expected Hessian of the log-likelihood function as follows:

$$\Omega_1(X,Y,\beta) = I_1(X,Y,\beta)^{-1} = \left(-E\left(\frac{\partial^2 \log L(X,Y,\beta)}{\partial\beta\partial\beta'} \right) \right)^{-1} \tag{2}$$

where **Y** are the outcomes of the survey and β a set of parameters representing the coefficients accompanying X in the utility function. As the elements of β are unknown, prior information about them is required to generate the design. In fact, the D-error measures the inefficiency of the experiment; thus, the idea behind its construction is to find a design matrix with sufficiently small D-error.

There are different strategies to generate *efficient designs*. In this paper, we used the program Ngene which specializes in their generation for discrete choice experiments (see ChoiceMetrics, 2009 for a detailed reference guide).

Before conducting our choice experiment, we carried out two pilot surveys and focus groups with experts in the field of electric and conventional vehicle mobility. This preliminary information allowed us to define the main elements of the experimental design, that is, alternatives, attributes and levels. The results from the pilot survey data models, helped us in determining a set of parameter priors that were used in the generation of the D-efficient design.

The choice experiment was aimed at visitors of TNP, in Tenerife, who accessed the park by private or rental car. People who hired organized excursions were excluded from the study because they did not have the possibility of visiting the park using another mode. To analyse preferences for more sustainable transport in their visit to the TNP, individuals participating in the experiment were faced with the choice between using car (i.e. their current option) and a hypothetical shuttle bus connecting the main points of interest inside the park with its two main entries. Specifically, the experiment considered a hypothetical situation where visitors had the option of leaving their cars in a low-cost parking lot at the park entrance, and make the visit using the internal shuttle bus. Likewise, they could decide to continue the visit in their own vehicles.

The park bus would make an internal circuit acting as a shuttle service stopping at the main places of interest in the park; the bus would be free and visitors would only have to pay for using the parking space at the entrance. The bus could also be either electric or diesel powered, with different levels of greenhouse gas emissions in each case. Visitors using the bus would have to wait a certain amount of time to start the visit, depending on the frequency of the service. In contrast, car users would need to spend some time finding parking spaces at the different sites and pay an increased parking fee; also, their greenhouse gas emissions per passenger would be higher than those of the bus users. The attributes and levels as well as the parameter priors considered in the choice experiment are shown in Table 1.

Once the attributes and levels were defined, an *efficient design* consisting of 12 hypothetical choice scenarios between the car and bus alternatives was generated. Although, in general, *efficient designs* require less choice scenarios than *orthogonal designs*, the number of choice situations may still be large, leading to increased respondent burden, jeopardizing the quality of the provided information (Caussade *et al*., 2005). Thus, to reduce respondent burden and gain reliability in the responses, the experiment was divided into three blocks of four scenarios each. In this way, each respondent had to process a less demanding amount of information (i.e. only four choice situations), depending on the block assigned to him/her. To preserve the efficiency of the experiment, the sample size was tripled considering that the number of interviews for each block should be balanced. The different choice scenarios generated by the experiment are presented in Table 2. An example of choice scenario, as shown to respondents in the survey, is presented in Table 3. In all these choice situations, there is a trade-off between the attributes considered in the analysis. Thus, for example, if the bus alternative is chosen in the first choice scenario, the individual would be revealing that s/he is willing to spend 30 min of waiting time to start the visit to avoid paying 30 € of parking, an emission of 45 gr of CO_2/km and 20 min finding a parking space.

3.3 Data collection and sample description

A total of 604 visitors who accessed the TNP by car, as driver or companion, were interviewed. Of these, 218 always chose the same option in the four proposed scenarios, so they were eliminated. Thus, the final sample consisted in 386 individuals yielding a total of 1544 choice observations.

Table 1. Attributes and levels

<table>
<tr><th rowspan="3">ATTRIBUTES</th><th rowspan="3">Priors</th><th rowspan="3">Level</th><th colspan="4">ALTERNATIVES</th></tr>
<tr><th colspan="2">PARK BUS</th><th colspan="2">CAR</th></tr>
<tr><th></th><th></th><th></th><th></th></tr>
<tr><td rowspan="3">COST:
BUS (Parking cost at Park entrance)
CAR (Parking cost within the park)</td><td rowspan="3">-0.136</td><td>0</td><td>High</td><td>10 €</td><td>High</td><td>30 €</td></tr>
<tr><td>1</td><td>Medium</td><td>5 €</td><td>Medium</td><td>15 €</td></tr>
<tr><td>2</td><td>Low</td><td>0 €</td><td>Low</td><td>0 €</td></tr>
<tr><td rowspan="2">CO_2 EMISSIONS
(gr CO_2/km and occupant)</td><td rowspan="2">-0.05</td><td>0</td><td>High
(conventional diesel bus)</td><td>20 gr/km per occupant</td><td>High
(medium size gasoline car)</td><td>45 gr/km per occupant</td></tr>
<tr><td>1</td><td>Low
(electric bus)</td><td>0 gr/km occupant</td><td>Low
(medium size diesel car)</td><td>35 gr/km per occupant</td></tr>
<tr><td rowspan="3">WAITING TIME TO FIND A PARKING SPACE</td><td rowspan="3">-0.04</td><td>0</td><td rowspan="3">Low</td><td rowspan="3">0 min</td><td>High</td><td>30 min</td></tr>
<tr><td>1</td><td>Medium</td><td>20 min</td></tr>
<tr><td>2</td><td>Low</td><td>10 min</td></tr>
<tr><td rowspan="3">WAITING TIME TO START THE VISIT</td><td rowspan="3">-0.066</td><td>0</td><td>High</td><td>40 min</td><td rowspan="3">Low</td><td rowspan="3">0 min</td></tr>
<tr><td>1</td><td>Medium</td><td>30 min</td></tr>
<tr><td>2</td><td>Low</td><td>15 min</td></tr>
</table>

Table 2. Scenarios of the discrete choice experiment

Scenario	PARK BUS				CAR			
	Parking cost (€)	**Emissions (gr CO2/km**	**Time to find parking (min)**	**Waiting time to start the visit (min)**	**Parking cost (€)**	**Emissions (gr CO2/km**	**Time to find parking (min)**	**Waiting time to start the visit (min)**
Block 1								
1	0	0	0	30	30	45	20	0
2	0	20	0	30	30	35	20	0
3	5	0	0	30	15	45	10	0
4	10	20	0	15	0	35	30	0
Block 2								
1	10	0	0	15	0	45	30	0
2	10	20	0	40	15	35	30	0
3	5	20	0	40	15	35	10	0
4	5	0	0	40	0	45	10	0
Block 3								
1	10	0	0	15	0	45	20	0
2	5	20	0	40	30	35	10	0
3	0	20	0	30	15	35	30	0
4	0	0	0	15	30	45	20	0

Table 3. Example of choice scenario

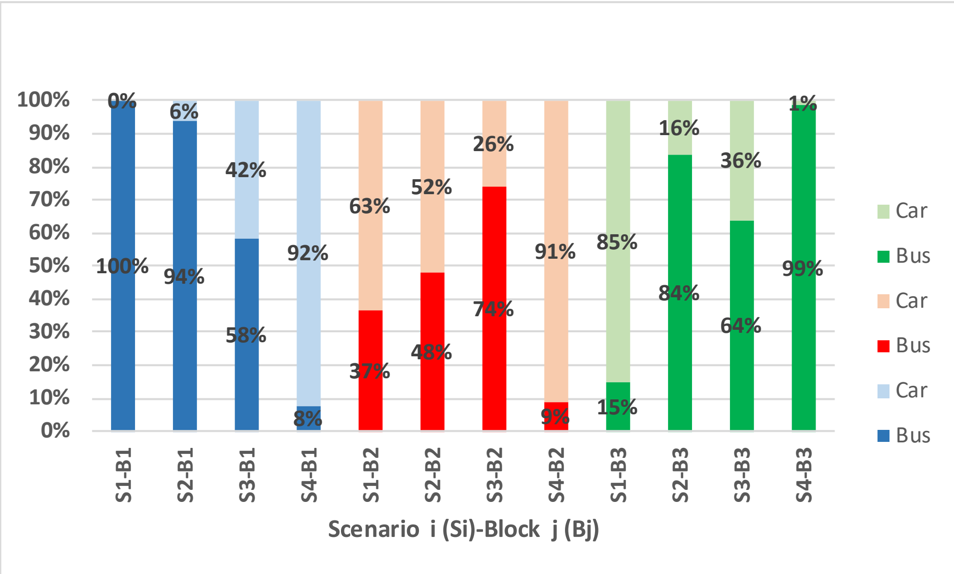
ATTRIBUTES	CHOICE SET 1	
	ELECTRIC BUS	**CAR**
Parking cost	0 €	30 €
Emissions per km and occupant	0 gr CO_2	45 gr CO_2
Waiting time to find parking	0 min	20 min
Waiting time to start the visit	30 min	0 min

Respondents were randomly selected at different points of interest along the park, such as El Portillo, El Parador and the Cable Car Station (see Figure 1). These places were chosen because visitors usually stop there and stay for a relatively long amount of time, so they could spend a few minutes completing the questionnaire. Information was collected through face to face interviews conducted by a well-trained group of interviewers and the questionnaire consisted of the following sections: (i) socioeconomic information about the respondent, (ii) information about the trip, (iii) intention of using sustainable transport modes inside the park and (iv) the discrete choice experiment.

Figure 2 shows the distribution of choices made by respondents across the different scenarios. Note that in all blocks there is at least one scenario where the car alternative is preferred by the majority of individuals: scenario 4 in block 1 (S4-B1) and in block 2 (S4-B2), and scenario 1 in block 3 (S1-B3). In such cases, the parking cost for the car was zero. Similarly, we note that the bus alternative is mostly chosen in scenarios 1 and 2, in block 1 and scenarios 2 and 4 in block 3, which are those where the cost of the bus was zero. These results highlight the importance of the cost variable in the choice of transport mode in this context.

Regarding sociodemographic profiles, 74% of respondents were men, foreigners (53%), German residents (33%), traveling for holidays (99.7%), staying in the tourist areas of Playa de las Américas and Puerto de la Cruz (51%), visiting the TNP for the first time (87%), travelling in a group of three people on a rental car (93%), mainly due to their comfort (90%), and not considering another transport alternative for the trip (93%). Most of them declared knowing how to ride a bicycle (77%) although they were not regular users of that mode (57%). However, they would be willing to use electric bicycles to visit the park if these were available (36%). Also, most respondents did not experience problems finding a parking space (82%), as the survey was conducted outside the peak hours. In this sense, it is important to highlight that the main congestion problems as well as the competition for parking spaces occur during the peak periods.

Figure 2. Distribution of choice alternatives in the different scenarios



4 The Demand Model

The most widely used theoretical framework underpinning discrete choice models is random utility theory (Domencich and McFadden, 1975). It is based on the hypothesis that decision makers are rational utility maximisers who apply a compensatory decision process to determine their preferred alternatives. The inability of the analyst to account for all factors influencing the choices made by individuals is modelled through the introduction of a random error term, that is added to the systematic or measurable (by the analyst) component of utility. The latter is expressed in terms of the alternatives' attributes, the socioeconomic characteristics of the individual and a set of unknown of parameters that represent individual preferences.

Two important concerns have been raised when dealing with SC data. One is the potential correlation that may exist among the choices made by the same respondent. The other is that preferences could vary between individuals but not within, recognising the pseudo-panel nature of SC data (Ortúzar and Willumsen, 2011; Bliemer and Rose, 2010; Train, 2009). This dependency can be managed by the panel formulation of the ML model, where the utility of alternative *i* for individual *q* in choice situation *s* can be expressed as:

$$U_{iqs} = V_{iqs} + \xi_{iq} + \varepsilon_{iqs} \tag{3}$$

where ε_{iqs} distributes iid extreme value, ξ_{iq} are random terms with zero mean, varying across individuals, and $V_{iqs} = V_{iqs}(X_{iqs}, S_q, \beta_i)$ is the systematic component of utility, where X_{iqs}, is the vector of attributes for alternative *i* and individual *q* in choice scenario *s*; S_q represent the socioeconomic characteristics of individual *q* (see Table 4), and β_i is a vector of unknown parameters that can be either fixed or vary according to some probability distribution between respondents. In this regard, the standard deviation of ξ_{iq} accounts for the degree of correlation among the choices made by a given individual, whereas the possibility of random coefficients in the parameter vector account for random heterogeneity in individual tastes.

Following this scheme, the utility estimated in our models was specified as follows:

$$\begin{aligned} V_{iqs} = {} & \underbrace{\underbrace{\alpha_i + \left(\sum_k \beta_{S_k} S_{qk}\right)}_{\text{Constant: preference for alt i}} + \beta_E E_{iqs} + \beta_{WT} WT_{iqs} + \underbrace{\left(\beta_{TP} + \left(\sum_m \beta_{TP \cdot S_m} S_{qm}\right)\right) TP_{iqs}}_{\text{Systematic heterogeneity}}}_{\text{Fixed coefficients}} + \\ & + \underbrace{\underbrace{\left(\mu_C + \left(\sum_r \mu_{C \cdot S_r} S_{qr}\right) + \sigma_C \eta_C\right)}_{\text{Random heterogeneity in mean}} \cdot C_{iqs} + \sigma \tau_{iq}}_{\text{Random coefficients}} + \varepsilon_{iqs} \end{aligned} \tag{4}$$

where *E* are grams of CO_2 emissions per km and vehicle occupant, *WT* is the waiting time to start the visit for the bus alternative, *TP* is the time spent by car users finding parking spaces inside the park, *C* are parking costs; η_c and τ_{iq} distribute N(0,1) varying between but not within individuals, and ε_{iqs} distributes iid extreme value; finally, α_i, the set β, μ_c, σ_c and σ are parameters to estimate.

Table 4. Socioeconomic variables used in estimation

Socioeconomic Variable	Name	Description (value/units)
Parking problems	$S_{Parking\ problems}$	1 if the individual declared having had problems finding parking space, 0 otherwise
Use of bike in the park	$S_{Use\ bike\ in\ the\ park}$	1 if the individual declared that would be willing to use the bike in the park if this mode of transport were available for visitors, 0 otherwise
Size of the group	$S_{Group >3}$	1 if the size of the group is greater than 3, 0 otherwise
Bike user	$S_{Bike\ user}$	1 if the individual declared himself as a egular user of the bike in their home destination, 0 otherwise
$Gender_s$	S_{Gender}	1 female, 0 male
Age	S_{Age}	Age of the visitor (continuous)
Nationality	S_{German}	1 German, 0 other nationality

Systematic heterogeneity (taste variations) in preferences may be analysed by specifying interactions of socioeconomic variables and service attributes (Ortúzar and Willumsen, 2011, pp 179). This is the case of the time spent finding a parking space and the alternative specific constant (ASC) for the car alternative. In contrast, random heterogeneity (in our case of parking cost) was modelled by specifying Normal distributed coefficients, allowing for heterogeneity in the mean of the distribution. Other coefficients, such as those for emissions and waiting time to start the visit, were specified as fixed (after finding that their variation was very low in the sample).

Estimation results at the population (mean) level are presented in Table 5. Columns in the table include, the parameter name and attribute accompanying it, its point estimate, t-test, p-value, and also the lower and upper bounds for the parameter's confidence interval. Most parameters had the correct sign and were significant at the 95% confidence level; the only exceptions were the coefficient of *time spent finding a parking space* and the interactions of the *size of the group* and the ASC of car, as well as that of the *German nationality* and the mean of the *parking cost*.

The main findings from this analysis focus on the marginal effect that each attribute has on the utility of the alternatives and, consequently, on the choice probability, allowing us to characterize preferences in the context under analysis. Our results suggest that there exists a preference for the car alternative that is not explained by the attributes considered. This is represented by the interactions of socioeconomic variables and the car ASC, and is higher for those who travel in groups of more than three people. In contrast, it is lower for those who experienced problems finding parking spaces and those who declared that would be willing to use an e-bike, if this alternative was available for visiting the park. Also, the disutility produced by the time spent finding parking spaces was higher for females as well as for those who declared that they were bike users at their home destination.

Table 5. Estimation results

Parameter	Attribute	Coefficient	t-ratio	p-value	Lower C.I.	Upper C.I.
		Fixed parameters				
α_{Car}	ASC_{CAR}	1.411	1.986	0.047	0.019	2.803
$\beta_{Spark\text{-}prob}$	$S_{Parking\ problems}$	-0.443	-2.211	0.027	-0.836	-0.050
$\beta_{Sbike\ in\ park}$	$S_{Use\ bike\ in\ the\ park}$	-0.616	-3.713	0.000	-0.941	-0.291
$\beta_{Sgroup>3}$	$S_{Group\ >3}$	0.270	1.677	0.093	-0.045	0.585
β_E	E (Emissions)	-0.022	-2.689	0.007	-0.037	-0.006
β_{PT}	PT (Time finding parking)	-0.013	-1.137	0.255	-0.037	0.010
β_{WT}	WT (Waiting time)	-0.023	-1.914	0.056	-0.046	0.001
$\beta_{PT*Sgender}$	$PT*S_{Gender\ 1=female}$	-0.024	-3.133	0.002	-0.040	-0.009
$\beta_{PT*Sbike\ user}$	$PT*S_{Bike\ user}$	-0.021	-2.109	0.035	-0.041	-0.001
		Random parameters (estimated mean)				
μ_c	C (Cost)	-0.296	-8.443	0.000	-0.365	-0.227
		Random parameters (estimated standard deviation)				
σ_C	C (Cost)	0.062	5.026	0.000	0.038	0.087
		Systematic heterogeneity in mean (interactions)				
$\mu_{C*Sgender}$	$C*S_{Gender\ 1=female}$	0.059	3.939	0.000	0.030	0.089
μ_{C*Sage}	$C*S_{Age}$	0.003	3.627	0.000	0.001	0.004
$\mu_{C*Sgerman}$	$C*S_{German}$	0.028	1.724	0.085	-0.004	0.061
$\mu_{C*Sbike\ user}$	$C*S_{Bike\ user}$	0.052	2.777	0.005	0.015	0.089
σ	Standard deviation EC	0.005	0.068	0.946	-0.139	0.149
l*(0)	-1070.2192					
l*(θ)	-637.1525					
ρ^2	0.4047					
Observations	1544					

Regarding the impact of parking costs, the mean of this coefficient was higher (i.e. less negative) for females, older people, German visitors and bike users. The negative sign obtained for the emissions' coefficient reveals a certain concern on the part of car users for the environmental impact of this mode when used in natural areas. Finally, it is interesting to highlight the low significance of the standard deviation of the error component $\sigma\tau_{iq}$, suggesting the absence of correlation among the choices made by each respondent. In this regard, it is worth remembering that as a block design was used, each individual responded only to four choice scenarios.

An individual specific parameter for cost was also estimated using Bayes' rule to obtain a distribution of its random coefficient conditional on the sequence of choices made by each respondent (Train, 2009; Sillano and Ortúzar, 2005). Individual estimates were obtained by computing the mean of this conditional distribution using simulation.

5 Model Application

5.1 Willingness to pay for sustainable transport

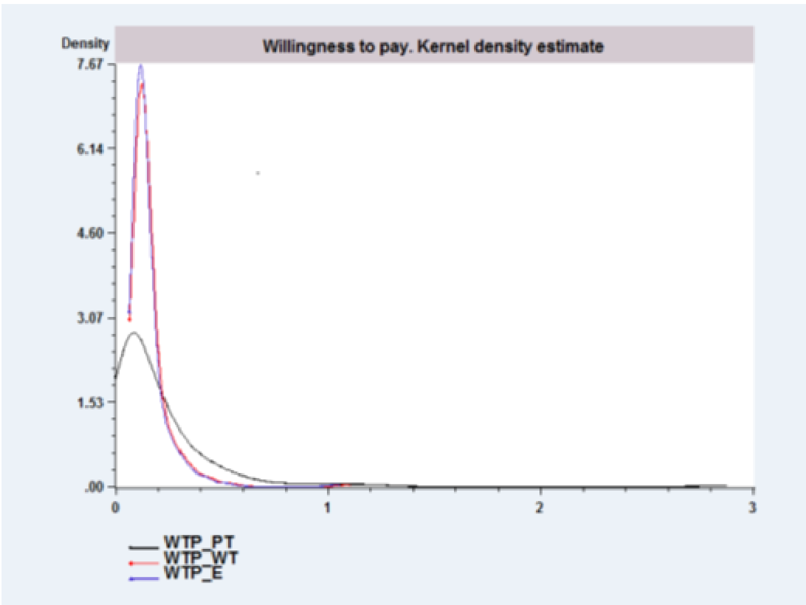
The willingness to pay (WTP) figures for the attributes considered in the experiment are essential for the evaluation of policies promoting sustainable mobility. The WTP for improving a particular attribute is typically derived as the ratio between the marginal utility of the attribute and the marginal utility of the cost (Gaudry *et al.*, 1989). The specification of random coefficients may pose problems in characterizing the distribution of the WTP for policy purposes as, in general, the ratio of two random coefficients may yield an unknown distribution (see the discussion by Sillano and Ortúzar, 2005). In this sense, the estimation of individual level parameters is of great aid in tackling this problem.

Individual level cost parameter estimates were used to obtain individual level WTP for the remaining attributes. The WTP distribution is characterized by the kernel density plots shown in Figure 3. Note that the WTP for saving parking and for waiting time present a similar distribution, with less dispersion than the WTP for reducing CO_2 emissions.

Table 6 presents a summary of WTP figures, averaged for different socioeconomic groups and for the whole sample. Individuals are willing to pay nearly 11€ for reducing in one hour the time spent finding a parking space; whereas the value of waiting time to start the visit is slightly higher than 9€/hour. According to these results, both the parking search time as well as the time waiting for the shuttle bus are trip elements that generate disutility for TNP visitors. However, the travel time inside the park is not a relevant attribute in our case study (as it is probably a pleasurable element), in opposition to urban trips where any component of travel time is a key source of disutility. Although, choice decision-making in the context of a natural park is different to that in an urban context, we compare our results with those obtained in the same geographical area. Specifically, with urban studies conducted in the islands of Tenerife and Gran Canaria

In Tenerife, Amador *et al*. (2005), found a generic travel time value close to 7.5 €/hour for university students. On the other hand, Espino *et al*. (2006), reported WTP values around 3.8 €/hour for non-working car users and of 2.4 €/hour for non-working bus users in suburban trips in Gran Canaria island. More recently, González *et al.* (2016b) obtained values ranging from 3.3 €/hour to 2.8 €/hour for car and bus university student users in Tenerife. They also reported a value of bus waiting time of 8,7€/hour, a value of bus access time of 7,07€/hour and a value of tram access time of 8€/hour. The magnitudes of the travel time values estimated in our case study are in line with the results for travel time outside the vehicle of González *et al.* (2016b).

Figure 3. Distribution of willingness to pay values



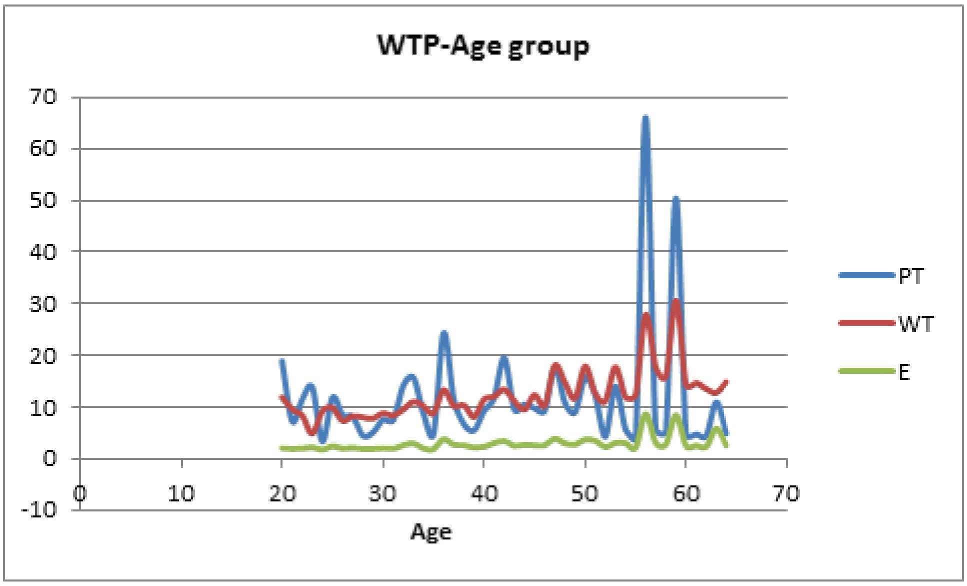
Regarding the environmental impact of the vehicle, individuals are willing to pay nearly 3€ for reducing in 20gr the CO_2 emissions per occupant. In general, we observe that the WTP figures are higher for females, for German visitors and for those who are regular bike riders at their home location.

Table 6. Willingness to pay estimates

SE Group	WTP for sustainable mobility		
	Time finding parking (PT) (€/hour)	Waiting time (WT) (€/hour)	CO_2 Emissions (20 gr CO_2/occupant)
Gender of the driver			
Male	5.78	7.94	2.52
Female	**25.06**	**12.88**	**4.10**
Nationality German			
No	10.42	8.83	2.81
Yes	**12.54**	**11.18**	**3.56**
Bike users			
No	7.92	8.44	2.69
Yes	**30.86**	**14.69**	**4.67**
Average	**10.77**	**9.22**	**2.93**

Figure 4 plots the distribution of WTP for the different age groups considered in our sample, showing that the highest figures are obtained for those aged between 55 and 60.

Figure 4. Willingness to pay for age group



There are interesting policy implications that can be drawn from our analysis. Consumers' WTP represent an essential input for the cost-benefit analysis, the theoretical underpinnings of which are grounded in welfare economics. Thus, the monetary value of the net benefits resulting from the application of different policies can be obtained. In this regard, the evaluation of a policy consisting in building parking facilities at park entrances should consider the visitors WTP for saving waiting time to start the visit and to reduce CO_2 emissions. In the same fashion, a policy consisting in charging for parking inside the park should consider the visitors WTP for saving time finding a parking space. Therefore, an appropriate pricing system could be created with the objective of reducing the environmental impact produced by the massive entrance of vehicles into the park.

6 Summary and Conclusions

The high volume of visitors received by TNP and their mobility patterns, characterized by high seasonality, high share of the private car, significant amount of CO_2 emissions per visitor, as well as lack of enough facilities to accommodate a high volume of vehicles, justify the implementation of measures to promote more sustainable mobility inside the park. The goal is to guarantee the conservation and quality of the visit and this is essential to ensure the leading position of TNP within the Spanish network of National Parks.

Knowledge about the relative preferences of transport mode attributes affecting visitors' travel choices in national parks and their willingness-to-pay for various improvements, are key information to design transport management policies aimed at relieving visitors' dependence on personal vehicles.

In this paper we analysed visitors' preferences for more sustainable mobility at the TNP. A stated choice experiment was conducted and mixed logit models were estimated. Our results suggest that:

(i) Park visitors are concerned about reducing the environmental impact of their visit (in this case, in terms of CO_2 emissions).

(ii) There exists a certain preference, or inertia, for using the car that is not explained by the attribute's values in the experiment. This inertia is obviously higher for those who travel in groups of more than three people and lower for those who experienced problems finding parking spaces; it is also lower for those who declared to be willing to use an e-bike, if this alternative was available for visiting the park.

(iii) Time variables associated with waiting and searching are negatively perceived. Moreover, the disutility produced by the time spent finding a parking space was higher for females as well as for those who declared that they were bike users at their home location.

WTP estimates provide interesting policy ammunition to implement some measures. In this case, individuals' WTP for reducing CO_2 emissions and for reducing the waiting time required to start the visit, may be used to determine the parking fee at the entrance of the park; this fee should be attractive enough to encourage car users to leave their cars there. In contrast, drivers' WTP for saving time while searching for a parking space, may be used to determine parking fees inside the park. These fees should be set to represent a real deterrent for private vehicles entering the park.

Regarding the environmental impact of the vehicle, individuals are willing to pay nearly 3€ for reducing in 20gr the CO_2 emissions per occupant. In general, we observe that these figures are higher for females, for German visitors and for those who are regular bike riders at their home location. We also found that the highest WTP corresponded to visitors aged between 55 and 60.

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