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INDIVIDUALS' BEHAVIOUR WITH RESPECT TO PARKING ALTERNATIVES: A LABORATORY EXPERIMENT*

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Abstract

The aim of this paper is to analyse the trade-off between parking space availability and cost, in terms of time saving. This information is pivotal when designing parking policies in terms of fares, investments and regulation. A relevant body of literature has focused on parking behaviour (e.g. travellers' choice of parking type and location). However, little attention has been devoted to understand how risk and uncertainty influence drivers' behaviours in parking decision. This paper address the parking choice problem by means of a laboratory experiments, which aims to collect disaggregate data on travellers' responses to changes in parking attributes and related information. Different components of the parking activity (e.g., general in-vehicle time, parking search time, egress time) are controlled for, in relation to the characteristics of the respondent. In order to avoid heterogeneity in relation to journey purposes we focus on individuals' mobility. The collected data is used to build simple model of consumer's choice related to parking decision, taking explicitly into consideration both risk and uncertainty.

Keywords: parking, risk, uncertainty, choice behaviour, laboratory.

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1. Introduction

The importance of parking areas has always attracted the interests of urban mobility policies, and, more recently, also academic researches have pointed their attention on drivers' behaviour approaching the parking decision.

The concentration of working activities, offices and institutions in the city centres influences the rising demand for parking slots, the viability of the cities (i.e. congestion issues) and the quality of life for citizens. In order to improve cities' mobility urban planners try to reconcile both citizens' and workers expectations, investing in environmental friendly travel modes (eg.: green buses, cycle paths), regulatory policies related to traffic management and new parking areas. The shortage of free urban spaces dedicated to *on-street* parking and the modern traffic management approaches, however, are favouring the creation of new *off-street* buildings in the downtown areas (Barter, 2010; Shoup, 2005; Arnott and Inci, 2006). Neither private parking managers nor policy makers carry out demand analysis to identify drivers' preference for specific parking characteristics, such as time-savings and/or risk of not finding a parking lot available or not knowing whether and how easily they might find one. Parking pricing strategies, in fact, are rarely based on consumers' preferences. Specialised literature on parking choices focuses on measuring different aspects connected with the parking activity itself, i.e. parking fees, value of travel time-savings (VTTS)[4] and, the value given to the information on the parking slots' availability[5]. Only a few of the relevant papers evaluate explicitly the role of uncertainty and risk associated to the availability of parking slot has on individuals' decision. Investigating subjects' behaviour towards risk and uncertainty is an interesting task as pointed out by Andersen et al. (2009). On one hand it is intuitive that decision-makers might have attitudes towards uncertainty just as they might have attitudes towards risk. On the other hand, it is only recently that this intuitive notion has been formalized and axiomatically characterized.

In the last decades the technological progress and the real-time information is playing an important role in the urban transport sector since individuals can be easily updated on a number of relevant issues such us, for instance, the traffic conditions, the presence of parking areas or of intermodal interchange areas, the availability of parking slots, etc. We believe that the combination of new technological tools and real-time information can influence individuals' approach to parking decision, since the perception of the risk and of the uncertainty connected to the parking alternatives can be mitigated. Clearly, the possibility of relying on real-time information, during the on/off-peak hours, seems extremely important when deciding and planning parking alternatives.

Our purpose is to assess whether investing in new technologies in parking area's managing might affect drivers behaviour.

In the paper we modelled this technological innovation through a laboratory experiment that elicits subjects' behaviour when facing different levels of risk and uncertainty that mimic parking alternatives involving different levels of technological endowment. In particular we design three different scenarios

[4] The reader is referred to Cherlow (1981), Becker (1965), Moses and Williamson (1963).
[5] The reader is referred to Jones and Polak (1993).

corresponding to three different parking alternatives: two more conventional – on street parking and non-technological off-street parking – and technologically advanced – off-street parking with an SMS booking system, which allows real-time communication between manager and drivers. These alternatives are characterised by different level of risk and uncertainty and also by different attributes such as tariff, searching time and walking time to destination. Although it is common knowledge that the probability of finding a parking place and its distribution play a significant role in travellers' decision process, literature on this topic is very limited and, to the best of our knowledge, this is the first paper that tries to study these aspects in a laboratory.

The paper is divided into five sections; in section 2 we present a brief review of the literature. Section 3 presents the experimental design; then the results are presented and analysed in section 4. Finally section 5 concludes.

2. Literature review

Understanding the elements that affects travellers' behaviour is one of the key issues in literature. Starting from the seminal work of Becker (1965) on the behaviour of workers commuting from home to the workplace the preference of travellers with respect to time saving has received growing attention. Scholars focused mainly on three aspects: (i) travel time saving in general (Moses and Williamson, 1963; Becker, 1965; and Cherlow, 1981); (ii) the time spent travelling (Hensher and Truong 1985, Hensher 2006, 2008), usually divided into *in-vehicle* time and *out-vehicle* time; and (ii) the time spent in the parking activity (Axhausen and Polak, 1990, 1991; Thompson and Richardson, 1998; Golias et al., 2002) as searching time[6] and egress time[7]. When considering parking choices *in-vehicle* time and *out-vehicle* time are perceived differently. The latter has a greater influence on travellers' behaviour with respect to the former. According to Feeney (1989) and to Axhausen and Polak (1991) drivers evaluate egress time two or three times more than searching time for parking slot[8].

Thompson and Richardson (1998) and Golias et al. (2002) compared drivers' behaviour when facing off-street and on-street parking alternatives. In both papers data are collected through a questionnaire-based survey distributed in the Central Business Districts (CBD) of large cities. In the former paper, authors introduce a restriction on the duration of on-street parking and analyse the effect of this policy instrument. The result is approximately a threefold reduction in the time devoted to search and a just less than a doubling of the time invested in walking to the final destination. Golias et al. (2002) restricted their analysis to a sample analyse composed by drivers that are not discouraged to use the car by what they consider excessive costs. They present three choices and four sets of scenarios characterised by different levels of searching time, walking time and tariff of the parking space per hour. As expected they find that an increase in off-street tariff leads to a decrease of its share and that time saving associated with off-street parking is more

6 Search time is the time spent searching and queuing for the parking space.
7 Egress time is the time spent walking to the final destination.
8 For a comprehensive review see: Marsden (2006).

attractive if the on-street search time increases. The less important factor in the choice seems to be the duration of off-street parking.

Other interesting investigations have been conducted on the sensitivity of pricing regime and the supply of parking slots by the time of the day, using a stated preference approach (Hensher and King, 2001; Anderson et al., 2006; Anderson and de Palma, 2004, 2007) and permit schemes (Liu et al., 2014a,b). These papers differ from each other in the sample trip purpose: in the first paper the sample is composed by commuters (employees which parking fee is partially, totally or not guaranteed by the employers) and individuals who travel to the Central Business District, while in the second one respondents are only tourists. It is quite remarkable that both tourists and travellers to the CBD for different purpose have similar behaviours, in fact tourists, just as commuters, prefer cheaper transit alternatives and dislike spending long time in transit as long as congestion. More recent studies of Clinch and Kelly (2004, 2006, 2009) and Simicevic et al. (2012) try to explain parking tariff policy looking at user's attitude towards the parking. On one hand it is clear that looking at user's behaviour it is possible to understand the effect that changes in parking tariff has on the travel demand, on the other hand, it is equally clear that eliciting these information is not an easy task. Here the distribution of travellers, according to parking type choice, and their attitude towards the parking price is determined by a face-to-face interview. In these papers authors elicit a threshold price at which travellers change their preferences from private transport to some alternatives. In this decisional problem an important role is played by knowledge and information about the travel (trip) and parking space availability. An alternative approach to infer travellers' preferences is used by Jones and Polak (1993). They gather travellers' behaviour considering pre-trip information, based on a computer-based procedure that presented a credible simulation of an in-home pre-trip information system. Respondent can interrogate the system, obtain the information on the trip planned and finally rank the options obtained. This scenario gives an idea of the weight assigned to the pre-trip information by respondents, engaged in a work or non-work journey. As reported: "these findings emphasises to travellers of the timeliness and relevance of provided information and suggests that may be beneficial for pre-trip information system to be able to actively signal the occurrence of relevant network incidents as well as passively deliver descriptive information"[9]. Nowadays, we cannot ignore the added value given by this pre-trip information and the other factor influencing travellers' behaviour. Indeed they affect subjects' behaviour trough a reduction of risk and/or uncertainty. Jones and Polak (1993) show the importance of pre-trip information for travellers and how their behaviour change if they can realise on certain information on traffic congestion. It might be interesting to study how commuters behave if they have access to a real time service on parking slot's availability, that reduce the risky/uncertainty of their decision task. Guo et al., 2013 analysed uncertainty in relation with route choice of cruising traffic. Golias et al. (2002) study drivers' behaviour towards risk and uncertainty by varying time and tariff attributes such that this enables them to elicit drivers' patience and their willingness to pay for a certain parking type against a more uncertain choice.

Laboratory experiments are quite often employed to understand individual's behaviour in risky or/and

9 Jones and Polak (1993).

uncertain situations. Most of the time an unframed experiment is preferred to a framed one since attitudes towards some particular situations can influence individual's behaviour.

3. The laboratory experiment design

The computerized experiment was conduct in May and October 2013 at the ESSE Laboratory at the University of Bari. The experiment was programmed using the z-Tree software (Fischbacher, 2007). The 112 participants were first year undergraduate students.

The experiment was composed by three sessions; in each session subjects have to complete two treatments (i.e. a risky treatment and an uncertainty one) and a questionnaire (reported in Appendix 1).

The whole experiment[10], on average, took between 70-90 minutes to be completed, and it varied across subjects since they were asked to complete the three tasks at their own speed.

In the risky treatments and in the uncertain treatments, subjects were presented 128 scenarios (reported in Table A, see Appendix 2), each of them involving three lotteries (A, B, C). They were asked to state their preference among the three lotteries choosing the preferred one. Each lottery represents a particular parking type: (i) *technological parking*, (ii) *non-technological parking* and (iii) *on-street*.

The *technological parking* is characterised by high tariff, composed by the booking price (price 1) and the ticket cost (price 2). The tariff can vary on two levels: 3.5€, and 4.5€. In this particular parking type the searching time is fixed to 0, since subjects can reserve a parking area they do not have to search for it. On the other hand, since these parking areas are, normally, located not in the very city centre, it is reasonable to think that the walking time to reach the final destination is high (in the experiment we fix it equal to 10 minutes). The probability of parking if the technological type is chosen can vary on two levels: the first one that gives respondents the certainty, and the second (that represent rush hours) where the probability of finding an available parking slot drops at 80%. The difference in the parking probability captures the difference between off-peak and on-peak situation.

The *non-technological parking* involves a unique tariff with a ticket price equal to 2.5€. Since it is not possible to book a parking slot in the non-technological parking we assume that the searching time is positive (7 minutes). The walking time is also positive (5 minutes walking time), but since in a city there are more non-technological parking areas than technological one we assume that it will be less than the one of the technological parking. Also parking probabilities are lower than in the technological parking, we fixed the probability to find a free parking slot at 70%, and in the rush hour it drops at 50%.

The *on-street parking* represents the riskier parking possibility, as the chances to park are much lower than in the *technological parking*, and *non-technological parking*. We assumed two possible parking tariffs: free of charge, and a parking ticket of 2€. Concerning searching and walking time they are higher than in the *technological parking*, and *non-technological parking.* We assumed two different searching time, in the rush hour it is 30 minutes, otherwise 15 minutes. Lastly, the expected walking time to reach the final destination was assumed to be either 5 minutes or 10 minutes.

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10 Experimental instructions are reported in Appendix 3

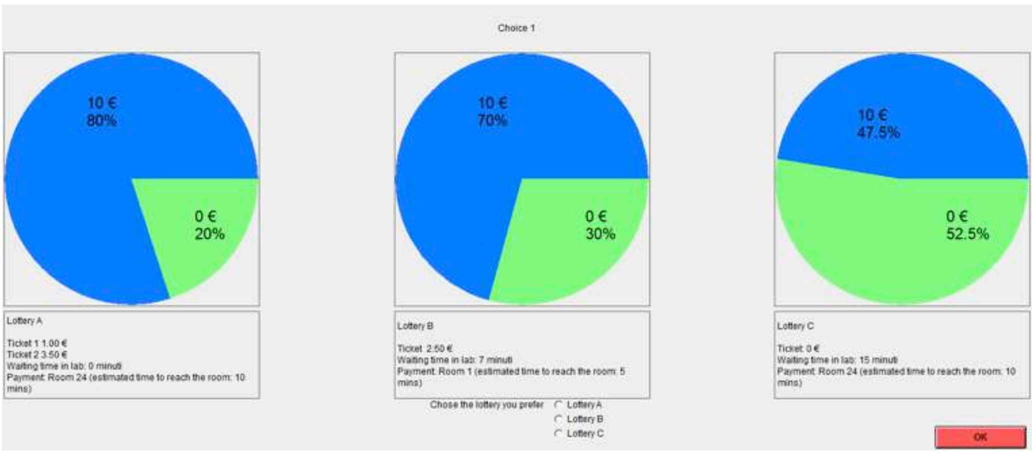
The scenarios are obtained through a factorial design. The 128 scenarios represent the full factorial design[11] based on the number of attributes and levels we used. More precisely, the attributes that change across these scenarios are three: the ticket price, the searching time, and the walking time to the final destination. Attributes and their possible levels are reported in the following Table 1.

Table 1: Attributes' levels

Parking type	**Technological**	**Non-technological**	**On-Street**
Ticket Price (Euro)	L:1+2.5 H: 1+ 3.5	Fixed:2.5	L: 0 H:2
Searching Time (mins)	Fixed: 0	Fixed: 7	L:15 H:30
Walking Time (mins)	Fixed: 10	Fixed: 5	L: 5 H:10
Parking probability (%)	L: 80 H: 100	L: 50 H: 70	L: 5 - 35 H: 35 - 65

In figure 1 and 2 are reported two examples referring to the risky treatment and the uncertainty one, respectively.[12]

Figure 1: Risky Lottery Choice in the Experiment



Source: our elaboration using Z-tree software.

In Figure 1 subjects face a risky problem, where they have to state their preference among the three risky lotteries.

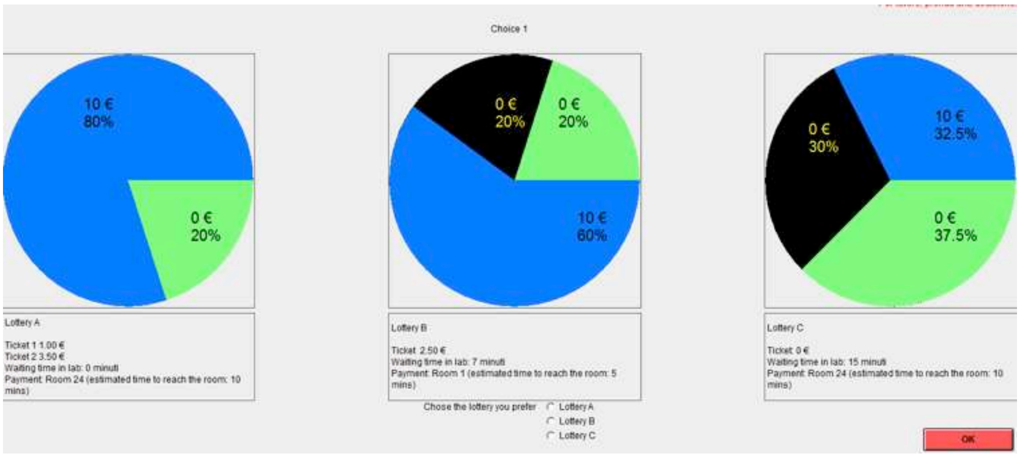
11 Hensher, Rose and Green (2007).

12 Note that we are deliberately not allowing subjects to express indifference between lotteries. This simplifies our data analysis since, if subjects are given the opportunity to express indifference and take advantage of this opportunity, it is not obvious how one should treat such responses (see Hey, 2002). Moreover, this choice does not affect the value of the experiment to the subjects, since if subjects are truly indifferent it does not matter how they respond, given the adopted incentive mechanism.

If they choose Lottery A (i.e. the technological parking) the cost they have to pay is composed by two tickets; the first one to cover the booking cost, and the second one to cover the parking cost. The booking cost has to be paid irrespectively to the outcome of the lottery, in the example reported in figure 1 playing lottery A there is an 80% chance to win 10€ (i.e. find a parking slot) and 20% chance to get 0 (i.e. do not find a parking slot). The parking cost has to be paid only in the case they find a free park slot, i.e. the lottery's outcome is 10€. In order to get paid, since they choose a technological parking they do not have to wait in the laboratory (i.e. the searching time is 0), and they can immediately reach their final destination. Since we assume that technological parking are less common and may be not in the city centre we fixed a walking time of 10 minutes (i.e. 'root 1: estimated time to reach the payment's room 10 minutes').

If they choose Lottery B (i.e. the non-technological parking) they have a 70% chance to win 10€ (i.e. find a parking slot) and a 30% chance to get 0 (i.e. do not find a parking slot). Only in the case they find a free park slot they will pay the parking ticket. In order to get paid, since they choose a non-technological parking they have to wait in the laboratory (i.e. the searching time is 7 minutes), and then they can go to their final destination. Since we assume that non-technological parking are quite common and located also in the city centre we fixed a walking time of 5 minutes (i.e. 'root 2: estimated time to reach the payment's room 5 minutes'. Finally, if they choose Lottery C (i.e. the on-street parking) they have a 47.5% chance to win 10€ (i.e. find a parking slot) and 52.5% chance to get 0 (i.e. do not find a parking slot). In the particular case of Figure 1, irrespectively to the outcome of the lottery, subjects do not have to pay any cost (they are parking in a free slot). Although searching time and walking time are higher than in the previous alternatives, respectively 15 and 10 minutes.

Figure 2: Uncertain Lottery Choice in the Experiment.



Source: our elaboration using Z-tree software.

In Figure 2 subjects face an uncertain problem. In the Lottery A (i.e. the technological parking) there is no uncertainty. If individuals choose this lottery they will pay the booking price irrespectively to the outcome of the lottery, and get an 80% chance to win 10€ and, 20% chance to get 0. Only in the case they win the lottery (i.e. find a free park slot available) they will pay the parking ticket. In order to get paid, since they choose a technological parking they do not have to wait in the laboratory (i.e. the searching time is 0), and they can immediately reach their final destination (10 minutes walking). Lottery B (i.e. the non-technological parking) involves uncertainty. If individuals choose this lottery they have a 60% chance to win 10€ and a 20% chance to get 0. The black area representing the uncertainty leads subjects to a lack of information on the chances of winning the 10€ or not. This means that the probability of winning 10 is between 60% and 80%, conversely the probability of getting 0 is between 20% and 40%. Only in the case they win the lottery they have to pay the ticket's cost. In order to get paid, before going to collect their money they have to wait in the laboratory for 7 minutes and then walk for 5 minutes to reach the final destination and get paid. Finally, if they choose Lottery C they have a 32.5% chance to win 10€ and 37.5% chance to get 0 and a 30% probability of uncertain outcome (10€ and/or 0€). This will end up with a probability between 32.5% and 62.5% of getting 10€ and a probability ranging between 37.5 % and 67.5% of getting 0€. In case they choose this lottery C irrespectively to the outcome of the lottery they do not have to pay any cost, but the searching time, and walking time are higher than in the previous lotteries, respectively 15 and 10 minutes.

A questionnaire was proposed between the end of the risky treatment and the uncertainty treatment task. The aim of this questionnaire was to collect socio-economic information about respondents.

Once the experiment finished only one lottery, for each subject, was randomly chosen by the computer and played out for real. According to the choice stated in the lottery randomly played, the student received the payment, which amount was between a maximum of 10€ and a minimum of 0€, excluding the show up fee of 5€, that each student received for sure. The average payment was around 9.80€ with a standard deviation of 1.41.

4. The econometric strategy

4.1. Sample characteristics

In total data obtained are 28,672 observations, as we administered 128 choice problems for both risky and uncertain scenarios.

In Table 2 the descriptive statistics, concerning the socio-economic characteristics of the students involved in the laboratory experiments, are reported. The sample is composed by 112 students – 45% male and 55% female[13] – that are on average 20 years old.

Table 2: Descriptive statistics of sampled students.

Variable	Mean	Std. Dev.	Min	Max
Male	0.446	0.499	0	1
Household size	4.143	0.758	2	6
Hometown	0.580	0.496	0	1
Distance Uni-home (km)	23.650	25.399	0	150
*Average Income**	0.679	0.922	0	5
*Family average-income***	2.803	1.186	1	5

13 The percentage of female and male is consistent with the percentage of students (male and female) enrolled in the courses of the Department of Economics, Management and Law, from where they have been recruited.

Driving licence	0.902	0.299	0	1
Cars in the household	1.973	0.729	0	5
Weekly trip frequency	4.277	1.050	1	6
Vehicles-Uni	5.125	2.519	1	8
Commuting time	1.688	0.978	1	5
Searching time	0.946	0.889	0	4
Parking duration	1.366	1.208	0	4

* Individual's monthly income classes: not worker= 0; 0€=1; less than 500€ =2; between 500€ and 1000€=3; between 1000€ and 1500€=4; more than 1500€=5;

** Individual's family average monthly income classes: less than 1,000€=1; between 1,000€ and 2,000€ =2; between 2,000€ and 3,000€=3; between 3,000€ and 4,000 € =4; more than 4,000€=5.

On average individuals commute four days per week for 24 km (average distance from home to university), with a commuting time is higher than 30 minutes and less than an hour, and an average searching time for parking between 5 and 10 minutes.

Almost all the individuals in the sample hold a driving licence (i.e. 90%) and, being the car available, they frequently use it for daily trips. Thus students habitually face parking issues.

4.2. Model specification and estimation

In this section we present the models used to analyse the data and we report the results.

4.2.1 The model

We start the model development process with the multinomial logit (MNL) model and move to more complex models, in order to define the best specification. The estimation procedure is carried out using BIOGEME econometric software (Bierlaire, 2003).

The systematic utility functions are defined by the following equations:

$$V_t = ASC_t + \beta_t\, ticket_t + \beta_t\, pp_t \quad (1)$$

$$V_{nt} = \mathrm{ASC_{nt}} + \beta_{\mathrm{nt}}\, pp_{nt} \quad (2)$$

$$V_{os} = \mathrm{ASC_{os}} + \beta_{\mathrm{os}} ticket_{os} + \beta_{\mathrm{os}}\, wt_{os} + \beta_{\mathrm{os}}\, st_{os} + \beta_{\mathrm{os}} pp_{os} \quad (3)$$

where *t* indexes the *technological* parking type, *nt* indexes the *non-technological* parking type, *os* indexes the *on street* parking type. The alternative's attributes that might determine the choice are the parking ticket cost **(***ticket*), the walking time (*wt*), the searching time (*st*) and the parking probability (*pp*).

It should be noted that for the *technological* parking type, waiting and searching time are equal to zero, thus they do not enter the equation (1). For the *non-technological* parking type, besides the waiting and searching time, also the parking ticket cost is equal to zero, hence they do not appear in the equation (2).

4.2.2 The estimation process

The model development process started with the estimation of two MNL models: one with generic coefficients (MNL 1) and the other with alternative-specific coefficients (MNL 2), in order to test whether the attributes are perceived differently for the different alternatives[14]. Thereafter we perform the likelihood ratio (LR) test to assess the best performing model. The next step is to detect the presence of systematic heterogeneity in the data. Hence, we extend the best performing model between MNL 1 and MNL 2 by adding interaction terms between the parking attributes and some socio-economic variables (MNL 3). In the MNL models all alternatives are considered independent.

4.2.3 The estimation results

In Table 3 we report the estimations' results, comparing the different models estimated. The tests indicating the performances of the different models are reported at the bottom of the table. First, we focus on the comparison between the MNL model with generic coefficients (MNL 1) and the MNL with alternative-specific coefficients (MNL 2). LR test results provide sufficient evidence to support a more sophisticated model (MNL 2). Given the LR test's results, in the discussion we focus on the MNL model with alternative specific coefficients, notwithstanding that the results of MNL model with generic coefficients are, overall, consistent with the former ones.

The specific constant of the technological alternative (ASCt) is positive and significant. This implies that, *ceteris paribus,* there is a preference for this alternative rather than for the *on-street* one. Instead, the specific constant of the non-technological alternative (ASC_{nt}) is not statistically significant.

The coefficients of the ticket of both *technological* and the *on-street* parking type are negative and highly significant. As expected, individuals perceive a higher disutility when the ticket price increases. This would lead to a higher probability of choosing an *on-street* slot. Moreover, the magnitude of the coefficient of the *technological* alternative is more than twice the coefficient of the *on-street* one; this result confirms Golias at al. (2002) results.

The *on-street* searching time (*st*) for the parking slot is negative and significant, suggesting that the higher the searching time, the lower the perceived utility of the alternative parking lot. The coefficient of parking probability is positive and significant for all the alternatives as expected: as the probability of finding an available slot rises, the perceived utility strengthens. Actually, in line with previous literature, moving from an *on-street* to an *off-street* alternative, the coefficient decreases, indicating a greater value assigned to an increase in parking probability for the more risky and uncertain alternative. It is puzzling that in all models, in contrast with previous findings, the coefficient of walking time is not statistically significant, as if the respondents haven't assigned to this attribute any relevance in their choice process.

We introduce a scale parameter to capture individuals' behaviour when facing the uncertain lotteries. This scalar parameter tests the hypothesis that individuals' behaviour in the risky treatment is different from their behaviour in the uncertainty one. The uncertainty scalar coefficient is positive and significant. This implies that individuals do have different perceptions of risky lotteries when uncertainty is added. Moreover uncertain lotteries' coefficients have a higher magnitude: they are roughly 13% higher than the coefficients associated to the risky lotteries.

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[14] Although alternative specific coefficients are generally best used for variables that do not vary with the specific choice (income, sex, etc.), having a very large database, and thus, no problems with the degrees of freedom, we choose to investigate the alternatives.

Table 3. Discrete choice models.

	MNL 1		MNL 2		MNL 3	
	Coeff.	*T-test*	*Coeff.*	*T-test*	*Coeff.*	*T-test*
Bpp	0.037***	40.97	0.033***	26.10	0.0427***	14.98
			0.037***	28.06	0.0373***	11.49
			0.043***	28.49	0.0451***	9.97
βticket	-0.560***	-32.24	-0.838***	-31.94	-0.625***	-9.12
			-0.386***	-20.24	-0.414***	-3.24
Bst	-0.015***	-6.38	-0.015***	-6.38	-0.017***	-6.8
Bwt	0.005	0.69	0.005	0.69	0.005	0.70
βpp-male					0.005***	3.40
					0.004***	2.26
					0.011***	4.56
β pp-licence					-0.006***	-2.37
					0.001	0.32
					-0.007	-1.58
β pp-mh-inc.					-0.007***	-4.20
					0.001	0.30
					-0.007***	-2.76
β ticket-male					-0.042***	-1.01
					-0.094***	-2.34
β ticket-licence					-0.202***	-2.97
					-0.171***	-2.51
β ticket-mh-inc.					-0.150***	-3.77
					-0.135***	-3.47
off-peak					-0.050	-0.86
on-peak					0.287***	3.57
free-os					0.530***	4.17
out-city					0.069	0.76
ASC_{nt}	0.77***	9.12	-0.06	-0.49	-0.88***	-6.68
ASC_t	0.85***	8.49	2.31***	13.91	1.62***	10.29
Uncertainty	1.13***	4.61	1.14***	4.87		
Obs	28,672		28,672		28,671	
L(0)	-31,499.41		-31,499.41		-31,498.31	
L(β)	-25,719.45		-25,585.25		-25,480.55	
ρ^2	0.183		0.188		0.191	
AdJ ρ^2	0.183		0.187		0.190	

Once defined that MNL model with alternative-specific coefficients (MNL 2) is the best performing, we extend it by adding interaction terms between the parking attributes and some socio-economic dummy variables, to understand whether they influence individuals' behaviour:

- *male*, taking value 1 for male, 0 for female;
- *licence*, taking value 1 if individuals hold the driving licence, 0 otherwise;

- *mh-income*, taking value 1 if individuals' family average income is higher or equal than 2000 - 3000 €, 0 if individuals' family average income is lower than 2000 € ~~otherwise~~.

We also introduce four dummy variables to test whether individual behaviour changes, according to the scenarios characteristics. The dummies are defined as follows:

- *Off-peak* takes value 1 for scenarios in which individuals faced the highest parking probabilities in all the three alternatives, 0 otherwise.[15]
- *On-peak*: takes value 1 for scenarios in which individuals faced the lowest parking probabilities in all the three alternatives, 0 otherwise. [16]
- *Free on-street* takes value 1 if the *on-street* is free, 0 if the *on-street* ticket is equal to 2 Euros.
- *Out-city* takes value 1 if in the scenario the parking probability of the *technological* type is equal to 100% and for the other two alternatives the parking probability assumes the lowest value (*non-technological* type equals to 50% and *on-street* type equals to 20%), otherwise.

Generally, *technological* parking areas are mostly located outside the city centre, while *non-technological* areas and *on-street* slots are closer to the centre. Introducing these dummies in the model, we aim at understanding whether individuals prefer to take the risk of being in the congestion (opt for the *non-technological* and the *on-street* parking types which are closer to the centre) or if they prefer to avoid congestion and enjoy a less stressful and longer walking time (choose the technological alternative which we assume being located in a more decentralised zone of the city).

Estimations from MNL 3 would suggests that on the one hand individuals prefer the *off-street* parking rather than the *on-street* one (ASC_t is positive and significant). On the other hand individuals prefer the *on-street* alternative to the *non-technological* one (ASC_{nt} is negative and significant).

The sign and the significance level of the parking attributes' coefficients obtained from MNL 2 still hold for MNL 3. Regarding the interaction terms, we find that the interaction between parking probability and the dummy variable *male* is positive and significant for all the alternatives. This indicates that, when the parking probability increases, men perceive a higher utility than women.

The interaction between parking probability and the dummy variable *driving licence* is significant only for the *non-technological* parking alternative and it has a negative sign. This suggests that, differences in the perceptions of parking probability between driver licence holders' and the rest of the sample exist only in relation to the *non-technological* parking and that, individuals holding a driving licence perceive a lower utility than individuals which do not hold the driving licence.

The interaction between parking probability and the dummy variable *medium-high income* is significant for the *non-technological* and the *on-street* parking alternative and it has a negative sign.

[15] The probability of finding a slot for the *technological* parking type is equal to 100%, for the *non-technological* parking type is equal to 70% and for *the on-street* parking type is nearly 50%.
[16] The probability of finding a slot for the *technological* parking type is equal to 80%, for the *non-technological* parking type is equal to 50% and for *the on-street* parking type is 20%.

This suggests that, when the parking probability increases for the *non-technological* and the *on-street* parking alternative, individuals whose family has a medium-high average income perceive a lower utility than individuals whose family has a low income.

The interaction between parking ticket and the dummy variable *male* is negative and significant for all the alternatives.[17] This means that, when the parking ticket increases, men perceive a higher disutility than women. The interaction between parking ticket and the dummy variable *driving licence* is negative and significant for all the alternatives. When the parking ticket increases, individuals holding the driving licence perceive a greater disutility than individuals who do not hold the driving licence.

Finally, the interaction between parking ticket and the dummy variable *medium-high income* is negative and significant for the *non-technological* and the *on-street* parking alternative, suggesting that individuals whose family has a medium-high average income perceive a higher disutility than individuals from a low income family. Although this result might appear peculiar, it can be a result of the fact that the *non-technological* and the *on-street* parking are less valuable services for the high-income groups which are thus less prone to spend more for those services as opposed to lower income subjects.

The coefficient of the *off-peak* dummy is not significant, whereas the coefficient of the *on-peak* dummy is positive and significant, underlining that the probability of choosing an *off-street* alternative is, as expected, preferred in the rush hours. The dummy variable *free-os* has a positive and significant coefficient, implying that when the *on-street* slot is free then the *off-street* alternatives are less preferred. The estimated coefficient of *out city* dummy is not statistically significant.

5. Conclusions

In this paper we have analysed individuals' behaviour facing parking activities. Differently from previous contribution, in this work we collected data on travellers' behaviour in response to changes in parking attributes through a laboratory experiment, comparing risky and uncertain scenarios.

Estimations are carried out using different econometric model, in order to test the robustness of the results and define the best performing specification. In fact, we started with the multinomial logit model and we proceeded to more complex model making different hypothesis on the correlation among the alternatives proposed to the individuals and accounting for the non-systematic heterogeneity in the data.

Our results are consistent with the literature. Indeed, individuals negatively perceive an increase in the ticket price as well as in the searching time. On the contrary, the walking time does not seem to influence individuals' behaviour. We believe this is due to the experimental design we adopt. In our unframed experiment, individuals might not exactly perceive the meaning of this time-related variable.

Moreover, results show that people prefer the *technological* parking slot to the other parking

[17] Note that for the non-technological parking type the parking ticket is zero.

alternatives, if they have the chance. This highlights the relevance of having real time information. A simple SMS booking system can make parking activities easier and help to alleviate congestion's issues in the CBD.

Appendix 1 – Table A

Treatment	Risky Lotteries			Uncertain Lotteries		
	Lottery A	Lottery B	Lottery C	Lottery A	Lottery B	Lottery C
	p_a	p_b	p_c	p_a	p_b	p_c
1	0.800	0.700	0.475	80	60 – 80	35 – 65
2	0.800	0.500	0.475	80	40 – 60	35 – 65
3	1.000	0.700	0.475	100	60 – 80	35 – 65
4	0.800	0.700	0.200	80	60 – 80	5 – 35
5	1.000	0.700	0.475	100	60 – 80	35 – 65
6	1.000	0.700	0.200	100	60 – 80	5 – 35
7	0.800	0.500	0.475	80	40 – 60	35 – 65
8	0.800	0.500	0.200	80	40 – 60	5 – 35
9	0.800	0.500	0.475	80	40 – 60	35 – 65
10	0.800	0.500	0.200	80	40 – 60	5 – 35
11	0.800	0.700	0.475	80	60 – 80	35 – 65
12	0.800	0.500	0.475	80	40 – 60	35 – 65
13	0.800	0.700	0.475	80	60 – 80	35 – 65
14	0.800	0.700	0.200	80	60 – 80	5 – 35
15	1.000	0.500	0.475	100	40 – 60	35 – 65
16	1.000	0.500	0.475	100	40 – 60	35 – 65
17	0.800	0.500	0.475	80	40 – 60	35 – 65
18	0.800	0.500	0.475	80	40 – 60	35 – 65
19	1.000	0.500	0.200	100	40 – 60	5 – 35
20	1.000	0.700	0.200	100	60 – 80	5 – 35
21	0.800	0.700	0.475	80	60 – 80	35 – 65
22	1.000	0.700	0.475	100	60 – 80	35 – 65
23	0.800	0.500	0.200	80	40 – 60	5 – 35
24	1.000	0.500	0.200	100	40 – 60	5 – 35
25	0.800	0.500	0.475	80	40 – 60	35 – 65
26	1.000	0.700	0.475	100	60 – 80	35 – 65
27	0.800	0.500	0.200	80	40 – 60	5 – 35
28	0.800	0.700	0.475	80	60 – 80	35 – 65
29	1.000	0.500	0.200	100	40 – 60	5 – 35
30	1.000	0.500	0.475	100	40 – 60	35 – 65
31	1.000	0.700	0.475	100	60 – 80	35 – 65
32	0.800	0.500	0.475	80	40 – 60	35 – 65
33	0.800	0.700	0.200	80	60 – 80	5 – 35
34	0.800	0.700	0.475	80	60 – 80	35 – 65
35	1.000	0.500	0.200	100	40 – 60	5 – 35
36	0.800	0.700	0.200	80	60 – 80	5 – 35
37	0.800	0.500	0.475	80	40 – 60	35 – 65
38	0.800	0.700	0.475	80	60 – 80	35 – 65
39	1.000	0.700	0.200	100	60 – 80	5 – 35

40	1.000	0.700	0.200	100	60 – 80	5 – 35
41	0.800	0.700	0.200	80	60 – 80	5 – 35
42	1.000	0.500	0.200	100	40 – 60	5 – 35
43	0.800	0.700	0.200	80	60 – 80	5 – 35
44	0.800	0.700	0.200	80	60 – 80	5 – 35
45	0.800	0.700	0.475	80	60 – 80	35 – 65
46	1.000	0.500	0.200	100	40 – 60	5 – 35
47	0.800	0.700	0.200	80	60 – 80	5 – 35
48	1.000	0.700	0.475	100	60 – 80	35 – 65
49	0.800	0.500	0.475	80	40 – 60	35 – 65
50	1.000	0.700	0.475	100	60 – 80	35 – 65
51	1.000	0.700	0.200	100	60 – 80	5 – 35
52	0.800	0.700	0.475	80	60 – 80	35 – 65
53	0.800	0.500	0.200	80	40 – 60	5 – 35
54	1.000	0.500	0.475	100	40 – 60	35 – 65
55	1.000	0.700	0.200	100	60 – 80	5 – 35
56	1.000	0.700	0.475	100	60 – 80	35 – 65
57	1.000	0.700	0.475	100	60 – 80	35 – 65
58	0.800	0.500	0.200	80	40 – 60	5 – 35
59	1.000	0.700	0.200	100	60 – 80	5 – 35
60	0.800	0.500	0.475	80	40 – 60	35 – 65
61	1.000	0.500	0.475	100	40 – 60	35 – 65
62	1.000	0.700	0.475	100	60 – 80	35 – 65
63	1.000	0.500	0.475	100	40 – 60	35 – 65
64	1.000	0.500	0.200	100	40 – 60	5 – 35
65	1.000	0.500	0.475	100	40 – 60	35 – 65
66	0.800	0.700	0.200	80	60 – 80	5 – 35
67	1.000	0.500	0.200	100	40 – 60	5 – 35
68	1.000	0.700	0.200	100	60 – 80	5 – 35
69	1.000	0.700	0.200	100	60 – 80	5 – 35
70	1.000	0.500	0.200	100	40 – 60	5 – 35
71	1.000	0.500	0.200	100	40 – 60	5 – 35
72	0.800	0.500	0.475	80	40 – 60	35 – 65
73	0.800	0.500	0.475	80	40 – 60	35 – 65
74	0.800	0.500	0.200	80	40 – 60	5 – 35
75	1.000	0.500	0.475	100	40 – 60	35 – 65
76	0.800	0.500	0.200	80	40 – 60	5 – 35
77	1.000	0.700	0.200	100	60 – 80	5 – 35
78	0.800	0.500	0.200	80	40 – 60	5 – 35
79	0.800	0.700	0.200	80	60 – 80	5 – 35
80	1.000	0.700	0.475	100	60 – 80	35 – 65
81	1.000	0.500	0.200	100	40 – 60	5 – 35
82	0.800	0.500	0.200	80	40 – 60	5 – 35
83	1.000	0.500	0.475	100	40 – 60	35 – 65
84	0.800	0.700	0.475	80	60 – 80	35 – 65

85	0.800	0.500	0.200	80	40 – 60	5 – 35
86	1.000	0.500	0.475	100	40 – 60	35 – 65
87	1.000	0.500	0.475	100	40 – 60	35 – 65
88	1.000	0.700	0.475	100	60 – 80	35 – 65
89	1.000	0.500	0.200	100	40 – 60	5 – 35
90	0.800	0.700	0.475	80	60 – 80	35 – 65
91	1.000	0.500	0.475	100	40 – 60	35 – 65
92	0.800	0.700	0.475	80	60 – 80	35 – 65
93	0.800	0.700	0.475	80	60 – 80	35 – 65
94	1.000	0.500	0.200	100	40 – 60	5 – 35
95	0.800	0.500	0.200	80	40 – 60	5 – 35
96	0.800	0.700	0.200	80	60 – 80	5 – 35
97	0.800	0.700	0.200	80	60 – 80	5 – 35
98	1.000	0.700	0.475	100	60 – 80	35 – 65
99	1.000	0.500	0.475	100	40 – 60	35 – 65
100	1.000	0.700	0.200	100	60 – 80	5 – 35
101	1.000	0.500	0.200	100	40 – 60	5 – 35
102	0.800	0.500	0.200	80	40 – 60	5 – 35
103	1.000	0.700	0.475	100	60 – 80	35 – 65
104	0.800	0.700	0.200	80	60 – 80	5 – 35
105	1.000	0.500	0.475	100	40 – 60	35 – 65
106	0.800	0.700	0.475	80	60 – 80	35 – 65
107	1.000	0.700	0.200	100	60 – 80	5 – 35
108	0.800	0.700	0.475	80	60 – 80	35 – 65
109	1.000	0.500	0.475	100	40 – 60	35 – 65
110	0.800	0.500	0.200	80	40 – 60	5 – 35
111	1.000	0.700	0.475	100	60 – 80	35 – 65
112	1.000	0.500	0.200	100	40 – 60	5 – 35
113	1.000	0.500	0.200	100	40 – 60	5 – 35
114	0.800	0.700	0.200	80	60 – 80	5 – 35
115	1.000	0.700	0.200	100	60 – 80	5 – 35
116	0.800	0.500	0.475	80	40 – 60	35 – 65
117	0.800	0.500	0.200	80	40 – 60	5 – 35
118	0.800	0.700	0.200	80	60 – 80	5 – 35
119	0.800	0.700	0.200	80	60 – 80	5 – 35
120	0.800	0.500	0.475	80	40 – 60	35 – 65
121	1.000	0.700	0.200	100	60 – 80	5 – 35
122	0.800	0.500	0.200	80	40 – 60	5 – 35
123	1.000	0.700	0.475	100	60 – 80	35 – 65
124	0.800	0.700	0.475	80	60 – 80	35 – 65
125	1.000	0.700	0.200	100	60 – 80	5 – 35
126	0.800	0.500	0.475	80	40 – 60	35 – 65
127	1.000	0.700	0.200	100	60 – 80	5 – 35
128	1.000	0.500	0.475	100	40 – 60	35 – 65

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