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EXPERIMENTS IN TRANSPORT RELATED CHOICES: THE INFLUENCE OF RISK AND UNCERTAINTY IN DETERMINING COMMUTERS' BEHAVIOUR WITH RESPECT TO PARKING ALTERNATIVES.

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Abstract

The aim of this research is to analyse the trade-off between parking space availability and cost, in terms of time savings (considering time in terms of foregone earnings). 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 presents the preliminary outcomes of a laboratory experiment, 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 commuters' 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. In the follow up work, currently being completed, results of the quasi-experiment's outcome are compared with experimental evidence, in order to identify potential significant differences with existing revealed and stated preference results.

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1. Introduction

The importance of parking areas has always attracted the interests of urban mobility policies, but recently academic researches point their attention on the drivers' behaviour approaching the decision of parking. Literature's interest on the value of travel-time saving (Moses and Williamson, 1963; Becker, 1965; and Cherlow, 1981), an important element which reduction is seen as a benefit, and on the value drivers give to the possibility of having a definite information on the availability of parking slots.

In this paper, different aspects that can influence commuters' behaviour are analysed. Restricting the study only to one transport mode, own private vehicle (car), the research question, at which we would like to address, regards the definition of the price of parking for commuters in terms of willingness to pay in order to have information that neutralizes any form of risk or uncertainty[4].

The aim is to understand how individuals behave when they have to face a decision on where to park, the value that they give to the time-saving and to the information on the availability of parking areas nearby the working place.

The willingness to pay for certain information on the availability of parking opportunities is here pointed out throughout an experiment. In detail, we will obtain this information employing two complementary approaches: a natural field experiment[5] (survey) and a laboratory experiment[6]. The outcomes of these different, but complementary methodologies will help us to have a more complete and clearer idea of commuters' preferences when they face risky or uncertain parking decision.

In detail, commuters' attitude towards risky and uncertain situation can be explicitly revealed through a survey, thanks to which we collect socio-economic information and the propensity for risky or uncertain outcome, as respondents are asked to choose among different hypothetical scenarios that include slight variations of what is present in reality (Golias et al., 2002; Hensher, 2001; Axhausen and Polak, 1991; Peter and Polak, 1993). A secondary, but not less relevant, outcome is that of being able to compare the results from a natural experiment setting and a laboratory experiment (Holing-Veras et al., 2003; and De Jong, 2012) (or lab experiment as it is used in literature). In the follow up work we will use a field experiment, as it allows us to observe the choices that individuals make in a natural environment but we are unable to pick the behaviour in an uncertain situation, this leads us to elect a lab experiment, which even in a decontextualized context, still can give us appropriate results on the decisions under risk and uncertainty.

At this point in our work we will focus only on the results of the laboratory experiment, but for completeness it seems necessary to describe how we built both the experiments as they share the same characteristics and mostly the same scenarios.

Modelling the choice sets in this contexts means that we have to define which attributes and levels we take into account for the description of the parking activities and the risk/uncertainty related to them.

The parking slots are identified according to their nature, and the attributes that better identify them are: (i) the parking ticket, (ii) the time-related variables such as the in-vehicle time, (iii) searching time and (iv) walking time to the working place.

The purpose of the paper is to understand the role that certain-risky-uncertain information has on respondents, and to do that we introduce a new parking mode (actually not in use in the

[4]Risky event is defined as a situation in which individuals have a known or a knowable probability distribution, while as regard the uncertainty, individuals do not have a defined probability distribution.

[5] "Natural field experiment: it is an experiment which employs standard subject pool, but the environment is one where the subject naturally undertake these tasks and where subjects do not know that they are in an experiment." in Harrison and List (2004), pp.1013-1014.

[6] "Lab experiment: is one that employs a standard subject pool of students, an abstract framing and an imposed set of rules" in Harrison and List (2004), pp.1013-1014.

area we are considering), an SMS booking system for the parking slot that is an easy procedure that allows commuters to book in advance the slot in a particular parking area, avoiding the searching time for it and, removing any risk and/or uncertainty about its availability.
The trade-off between parking ticket and time-variant variables (as the walking time or the searching time) emphasizes the different degrees of uncertainty and risk. It is known that certain information, as long as the travel time variation is perceived as a cost for commuters (Axhausen and Polak, 1991; Peter and Polak, 1993). Comparing their combinations we are able to define different degrees of knowledge, from known certainty to unknowable uncertainty, essentially moving from a slot booked by a SMS to a metered slot the ticket price will decrease and simultaneously the risk and/or uncertainty of not finding an available parking will increase.
Commuters' behaviour under risky situations can be revealed using a survey, as the guaranteed degree of knowledge is the same among the respondents, even if the hypothetical scenarios might not realistically represent the daily conditions.
The survey we developed is divided into three parts:

1. the first part collects the socio-economic information about respondents as the age, gender, income, number of cars in the household.
2. the second part is related to the trip information, basically in this part we investigate on the reason of the trip, the duration of the trip (including the in-vehicle time, searching time for the parking and the egress time), the number of trips per week and the parking mode usually used;
3. the last part essentially describes the hypothetical scenarios that the respondent could face.

We model different scenarios for a set of three different parking types. The alternatives between the parking modes are: *technological parking type*, *non-technological parking type* and the *on-street option*. The scenarios are obtained through a factorial design. In our lab-experiment we propose the full factorial design[7] that based on the number of attributes and levels gives us 128 treatments, while in the SP experiment we adopt a fractional factorial design[8], which reduces the number of treatments to nine. More precisely, the attributes that change across these treatments are: the ticket price (according to the different parking mode), the searching time and the walking time to the working place.
We test the different degrees of certainty/uncertainty through the parking probability attribute. (the probability of finding the parking slot available in the alternative taken into account). Once the respondent makes his/her choice we can realize how the change in the ticket cost, jointly with the time-variant variables, had affected the final decision. The trade-off between ticket cost and time-related variables will be taken into account in our analyses.
The results of this survey are useful to segment commuters, along with their risk attitudes[9], as for example, into: commuters who prefer to pay a higher ticket with the certainty to find a slot closer to the working place; or commuters that prefer to pay a lower ticket incurring in higher searching and walking time (usually considered as costly). This underlines the propensity of commuters to rely on certain versus uncertain knowledge about the slot availability.

[7]"Full Factorial Design is a design in which all possible combinations of the attribute alternative are used" in Hensher D.A., Rose J.M., and Green W.H., "*Applied Choice Analysis*", Cambridge University Press (2007), pp. 109.
[8]"Fractional Factorial Design is a design in which we use only a fraction of the total number of treatment combinations" n Hensher D.A., Rose J.M., and Green W.H., "*Applied Choice Analysis*", Cambridge University Press (2007), pp. 115.
[9] Risk attitude is a mind-set towards taking or avoiding a risk when deciding how to proceed in situations with uncertain outcomes, it differs from risk propensity (the attitude towards taking risk) and from risk aversion (attitude towards avoiding risk).

In the literature it has been noticed that achieving results on the propensity of respondents making decisions under uncertainty levels through a stated preference approach, it is not always an easy task. The on-line booking system is usually known (Wang, 2011; Koulayev, 2009; Lee et al., 2007) as a service characterized by different levels of uncertainties of risk knowledge. The uncertainty can be of different types as: known uncertainty, when the risk probability is precise and specified; unknowable uncertainty, where the risk probability is unknown to everyone or we can face an unknown uncertainty in the case the risky probability is an information not available to one but may be possessed by others. Academics underlined (Wang, 2011) that certain information (known certainty) is costly (willingness to pay), and issues relate to the risk accepted by consumers are usually considered in works focused on on-line booking purchase (Koulayev, 2009). Taking into account these works, the second part of the research, focused on the uncertainty, is conducted through a laboratory experiment.
The reason why we introduce a laboratory experiment is due to the fact that the natural experiment (the survey with stated preference choices) is not always able to capture the degree of uncertainty and of respondents' risk attitude, while in a laboratory if subjects participate in a framework-free experiment, we can control for the level of risk the respondent can stand. The lab experiment has so far the peculiarity that the situation described is decontextualized from the reality. We set up an aseptic environment that is not correlated to the situation of the parking mode choice reported in the survey, and if this aspect can be seen as an issue, at the same time it is possible to look at it as a way to complete the results of our study. The two approaches give us two complementary results, the one obtained by the survey points out the behaviour of commuters, as when we vary the attribute of the parking mode in the nine different scenarios proposed, we model for different degrees of risks, on the other hand, the results obtained with the lab-experiment enable us to compare both risky and uncertain situations, giving then an exhaustive explanation of the problem we want to analyse.
The paper is divided into five sections, the following section will briefly review past papers on this topic. In section 3, the experimental design is described, then the preliminary results are analysed in section 4. And the last section reports our preliminary conclusions.

2. Literature review

The impact of a parking area has an important role in the urban planning and mostly in drivers' benefits, for this reason policy makers usually take advantage of different instruments to predict travel demand segment, and at the same time to improve the service guaranteed to consumers.
Understanding the elements able to influence travellers' behaviour is always been one of the key questions in literature. The first who focuses on the allocation of time issues across different activities is Becker (1965). He evaluates the cost of time, in particular among workers that commute from home to the workplace, underlining their preferences through the maximization of their utility function, strictly related to transport costs.
To collect and interpret information about travellers' behaviour, different methodologies are used in literature. Usually, studies are based on observed preferences (revealed preference RP) (Ben-Akiva and Polydoropoulou, 2001) or stated preferences (SP) (Golias et al., 2002; Hensher, 2001; Axhausen and Polak, 1991; Peter and Polak, 1993) experiment, where the main difference between the two relies on the way the information is captured. The former approach is based on observed traveller's choice, so mainly on statistics about consumers' preferences that not always are available. The observations obtained through a RP approach show a statistical correlation between the levels of the attributes present in a choice, making impossible to distinguish which attribute really affects respondent's decision. For this reason a SP experiment is often preferred as it enables to measure respondents' preferences under

hypothetical scenarios (which might not be present in the market). Thanks to this approach the problem of data's availability does not exist, but a risk of systematic bias can rise, as the alternatives proposed to respondents may not exactly reflect their preferences.
In this section of the paper we will focus on some works that examined a particular aspect of the urban transport i.e. the parking activity. Considering the urban transport, we take into account the trip from a starting point to a final destination.
Commuters' decisions, on the way to reach the final destination, and the starting time of the trip, are influenced by the duration of travel time and the transport mode.
Behaviour related to travel mode and parking type is slightly related to the presence of risk or uncertainty about the availability of slots. It seems necessary to remark the theoretical difference between the risky and uncertain decisions. As reported in Hey (2002), people can take decisions under risk and/or uncertainty in a static or dynamic scenario. As noticed, the behaviour risky decisions have been more explored in literature than the decisions taken under uncertainty in both dynamic and static situations. On this same topic, Wang (2011) points out that decisions under risk are driven by inconsistent perceptions, belief and emotions and they do not consider different degrees of uncertainties when the decision is made.
Our objective is to point out that very few has been done in the field of uncertainty about the parking activities, while a wide literature is present when considering decisions taken under risk. In parking activity (searching, decision of where to park, ticket fee, parking time duration, etc.) a key role is played by the time, which has been investigated under three different aspects: the time spent travelling (usually divided into in-vehicle time and out of vehicle-time), time spent in the parking activity (Axhausen and Polak, 1990, 1991; Thompson et al., 1998; Golias et al., 2002) (as searching time[10] and egress time[11]) and the travel time saving (Moses and Williamson, 1963; Becker, 1965; and Cherlow, 1981).
Previous works, on this topic, analyse the value of travel time saving. Cherlow (1981), for example, shows that information on travel time saving, extrapolated both by stated choice survey and by revealed preference, is necessary to demonstrate the trade-off between the willingness to pay and the reduction of time travelled (time-cost trade-off). To monetary quantify the value given by respondents to the travel time saving, academics inferred it from the average wage rate (Moses and Williamson, 1963) or from the average family income of the sample considered.
Marsden (2006) reviews works on the issue related to the parking choices, taking into account different subjects, as commuters, non-commuters and residents, and for most of them data have been collected through stated preference experiments, with a particular focus on commuters' behaviour and their perception of time. From the results we can infer that the out-of-vehicle cost has the highest influence on travellers rather than the in-vehicle cost (Feeney 1989). This result is confirmed, later on, in Axhausen and Polak's work (1991), where it is emphasized that respondents evaluate walk egress time two or three times more than in car searching time for a parking slot.
A brief description of driver's perception of parking availability is reported in Polak et al (1990), where drivers base their expectations on their knowledge of spatial and temporal distribution of parking opportunities and on the relative parking cost. Apparently, the nature of parking choice relies on the information and knowledge the driver has. It is predictable that no parking space would be selected before a round search has been conducted to test the availability of slots (free parking or parking slots that have a fee) in the area of interest. The parking process then is stressed by the importance given to: the searching time, the walking time to the final destination and the role of information. Some further interrogations on the nature of knowledge or information that could influence driver's choice are made. Results highlight that drivers consider more relevant the searching time and walking time than other

[10] Search time is the time spent searching and queuing for the parking space.
[11] Egress time is the time spent walking to the final destination.

parking activities components. It is understandable that in this paper authors' aim is to test driver's choice in a risky situation, as decisions are basically based on the expectations or previous knowledge of the parking area that drivers have. The risk of not finding a parking slot is underlined by the round search necessary to have an idea of the slots' distribution. In this way drivers can lower the uncertainty about the situation and have a clearer comprehension of the dynamics related to her decision about where to park.
A different research question is carried out in Axhausen and Polak (1991) work, where the aim is to test driver's behaviour when she/he has to face a choice between three alternative parking types: free on-street parking, different types of off-street parking (lots and garages) and also the illegal parking. Parking type differentiation resulted useful in a second moment of the survey; information collected is used to segment the sample according to the willingness to pay. This experiment has been conducted through a computer-based survey, composed by three choice situations and has been tested in two different countries (German and UK), in order to understand differences across countries. The parking price per hours in the different cities of the UK , Birmingham, Sutton, and Coventry, are respectively on average, for the metered on-street equal to £1, £0.50 and £0.80 for Coventry, while as regard the multi-storey the ticket price is on average in Birmingham equal to £1.8, £0.6 for Sutton and £0.9 in Coventry.
Most of the results are consistent with the literature, as the egress time valuation, the access time (the ratio of access time is between 1 and 1.6 for Birmingham and between 1 and 2.7 for Karlsruhe) and drivers' decision of never illegally park that has on average a lower value of time. In particular with regard to the walking time, drivers that consider also the illegal park are more impatient during searching time (on average it is around 3 minutes against a free on street searching time that is between 4 and 15 minutes across the different cities scrutinised in the UK) and tolerate less long walks. In conclusion respondents consider illegal parking as an acceptable alternative that reduces the searching time and subsequently the egress time. These results show the attitude of commuters to risky situation as the illegal parking one is, and the idea that for some of them it is a considerable option emphasises the different levels of risks and uncertainties related to this kind of choice. Illegal parking can lead to a fine which range varies across the city considered, for example in Birmingham it is between 0 and £100, up to £50 in Sutton and a maximum of £24 in Coventry.
Thompson et al. (1998) and Golias et al. (2002) have a similar approach as Axhausen and Polak (1991) but they restrict the parking choice options. Both papers present: a focus on the choice between off-street and on-street parking slots, data are collected through a questionnaire-based survey distributed in Central Business District (CBD). The main difference between the two works is that, in the former paper, authors consider the evaluation of the parking space, which is based on previous experience and network knowledge (in particular regarding the off-street parking where it is assumed to be already known). In Thompson's paper it is considered a restriction on the duration of on-street parking and it has been noticed that, due to these new policies restrictions, drivers preferred to reduce the searching time (from 3.76 to 1.35 minutes on average) and an increase in the walking time (from 2.61 to 4.34 minutes on average). Golias et al. (2002)'s paper on the other hand, adds one more scenario to the two main ones (on-street and off-street), that is represented by the option of refusing the two previous type of car parking (for example the respondent will not use his car), and if this alternative is chosen, this value is not included in the analysis. The survey proposes three choices and four sets of different scenarios characterised by different levels of searching time, walking time and cost of the parking space per hour. As expected also this experiment shows that an increase in off-street cost leads to a decrease of its share. The time saving results more attractive if the on-street search time increases; the less important factor seems to be the duration of off-street parking, because its attraction increases as the parking duration does. Finally, evaluating the cost variable, an off-street parking is

preferred to an on-street one for a longer duration. To determine the level of risk and uncertainty, Golias et al. (2002) model the set of cards in a way that a variation of the time and cost attributes enable them to understand driver's patience and at the same time her willingness to pay for a certain parking type against a more uncertain choice. 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). These papers differ 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, as long 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) tried to explain parking pricing throughout user's attitudes (from user's behaviour it is possible to understand the effect that changes in parking price has on the travel demand, but this requires a wide range of information that not always is available and easy to obtain). 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. The goal is to find out the price at which travellers would give up parking and to which other transport mode they would likely shift. A higher percentage of them prefer to travel by car until a certain modal connection point (e.g. park and ride) and than switch directly to public transport, or to carpool. To conclude this work points out the expected parking price per hour (0.80€) between 7 am and 9 pm of the day that commuter would like to accept before giving up for another transport mode. The knowledge and information on the travel and on the availability of parking space assume an important role on the decision process of travellers. This problematic has been tackled by Polak and Jones (1993). They infer 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"[12]. Nowadays, we can not ignore the added value given by this pre-trip information and the other factor influencing travellers' behaviour. At the end this work gives us an idea of how important can be the pre-trip information for travellers and how they would behave if they could have a certain information on traffic congestion and so we think it might be useful to understand also how a commuter would behave if there was a real time service able to give him information on the parking slot's availability.

Decisions on the parking type can be also influenced by the presence of parking benefits towards drivers. Feeney (1989), Willson (1992) and Shoup (1997) underline how the possibility of benefit from parking subsidies can really influence commuters' decision. Feeney results (based on a literature review of academic papers) support the intuition that parking subsidies influence the transport mode choice, while both the last two works have analysed the sensitivity of worker's choice on the employer-paid parking. Willson (1992) interviewed both employers (118) and employees (5060) to point out how (mode choice) employees decide to reach the workplace (drive alone, carpool or transit) if the employer guarantees a

[12] In Peter J., Polak J., "The acquisition of pre-trip information: A stated preference approach", in Transportation, Vol. 20 (1993), pp. 196

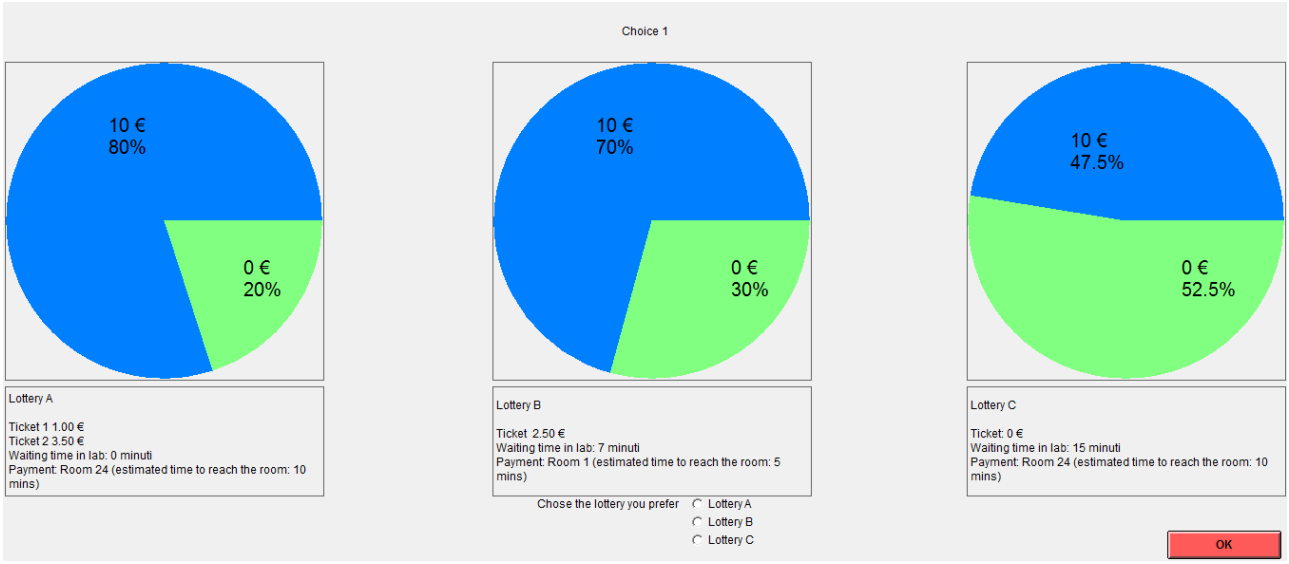
free parking or a daily parking cost. The number of solo drivers decreases as soon as the free park is not guaranteed any more and consequentially the number of carpooling increases. When commuters pay for the parking slot, then the transit increases more than carpooling, because carpooling still means that there is a fee to be shared. Different situation is pointed out in Shoup (1997), in which as a consequence of a Californian law, the author studies the shift of employee to different mode (drive alone, carpooling, transit, walking, bicycling) to reach the workplace if a cashing out program is implemented by the employer. The idea of the act is that employer has to offer commuters the option to choose a cashing out park subsidy. Eight case-study firms were analysed and results show that to a decrease of solo driver corresponds an increase of carpooling, transit and, not surprising, also of the number of worker that prefer to walk or to use the bike in order to obtain in cash the value of the subsidy. This new form of subsidy reduced the number of solo driver by the 17%, increases the carpooling by the 64% the transit of resident by the 50% and the number of walkers or riders by the 39%.
A recent paper of Habib et al. (2012), on the other hand, focuses on a different starting point, analysing how the activity-travel scheduling process can be influenced by the parking choice. The type of activities are distinguished by the purpose of the trip (work, study, leisure and shopping) and based on this activities, the start-time, the duration and the type of park preferred are collected. Using an origin-destination (OD) survey with parking inventory and choice information authors show that the start-time of activities (during a normal day) is influenced by the parking search and the duration of these activities themselves. As expected, workers prove how trip's final destination influences the two main variables (duration and parking choice), in particular in the situation of subsidized employer-parks (this alternative is attractive for employees because determine a different schedule of the travel activities during the day); while people who travel for study activities prefer to park in free-charge parking areas or, if not possible, can choose between park&ride or Kiss&ride options. A proper segmentation of the respondents was necessary to understand how characteristics strictly related to the purpose of the trip could influence respondent's behaviour. Obviously other factors determine respondent's choice, e.g. the income. People with higher wages prefer to park in places closer to the workplace and more expensive then who perceives a lower income. Other aspects that involves parking choice or decisions related to the behaviour of commuters are analysed in Hensher (2008), in which he focuses on the relationship between the driver and other passengers in the car, and in Plaut (2006), in which the behaviour of the households (two spouses) in commuting is scrutinised. Hensher notices how little attention was given by previous literature to the role of passengers in a vehicle. This is due to the fewness of available data such that results do not properly quantify how passengers' presence can affect the travel time saving of a driver. In order to obtain an idea of this phenomenon, the respondents of the computer based survey were non-commuting drivers that had a set of 16 (different level of travel time savings and different rood tools) of choices. To determine the influence of passenger presence a mixed logit model was used in order to capture the heterogeneity of preferences across the respondents, such that results showed that an increase in the number of passengers decreases the value of travel time saving from $19.99 to 13.22$ per hour, although the paper does not define the travel time saving for each passenger or for the vehicle, it gives just an idea of how it can change in the perception. Another interesting paper that regards the commuting decision of spouses related to the location of the house is reported in Plaut (2006) where the investigation not only compares the different attitudes of man and women when they have to commute, but the situation of renters or of home-owners is taken into account. Here to understand commuters behaviour the only car trip is considered and as regard the length of the trip has been noticed that workers who rent the house prefer to drive less while who is home-owner prefers to have a longer trip in order to gain a higher salary. Both these academic contribution help to realise that other factors can be considered,

but they did not explain if these are also able to influence the parking activities. According to us all these elements can contribute to the decision related to the parking choice as the presence of a passenger, the income level, the conjugal status as well as the status of renter of home-owner can lead to a more careful behaviour's interpretation.
Another research question that has not been scrutinised is about the role of the real time information during the trip. Commuters usually rely on the knowledge they have about the kind of slot they would be able to find, but there is no definition on the degree of certainty or of uncertainty about it. There is no evidence from the literature, in the urban transport sector, about the decisions taken under risk in a real time purchasing service.
Here we touch on the online booking service papers simply to understand how previous academics studied the reaction of consumers when they have to book in advance a service, as we consider the possibility to implement a new parking mode, an SMS booking system that allows drivers to "reserve" in advance the parking slot. Previous literature focused its attention on the online hotel booking (Koulayev, 2009), where the logic behind respondents' behaviour is similar to the one of commuters. Searching for a hotel is costly (this underlines the willingness to pay for a certain and immediate information), and at the same time it is based on previous knowledge or on the perception consumer has about this service. In our case study, however, there is no need to take into account the reviews or the impressions that other consumers had about the service, basically because this is not part of our study, but it can be seen as a further research topic. The existence of different degrees of uncertainty, related to the basic consumers' knowledge, is reported in Wang (2010) analyses, where decisions of online purchasing, under uncertain risk of phishing are showed. In our case we are not arguing about the quality of the service but we simply want to see and predict drivers' reaction to this new option. Other contributions show that the propensity of people to buy such a kind of service, in the online booking sector, strongly depends on their innate personal innovativeness (Lee et al., 2007), and so this explains why the attitudes of some consumers may lead them to make a choice, a more risky and innovative in its nature, than to a more traditional one, that in our case study may be the metered slot.
Further studies can start from these open questions: how the presence of other passengers influences parking decisions? Would be more likely that passengers prefer to choose a particular parking type in order to reach earlier the workplace or they prefer to endure a longer travel time (in-vehicle and out of vehicle) in order to find a free parking space? Is it possible that the personal innovativeness leads commuters to a more risky choice? Can the parking sector guarantee an online service as for the other transport modes e.g. airline booking system?

3. The laboratory experiment design

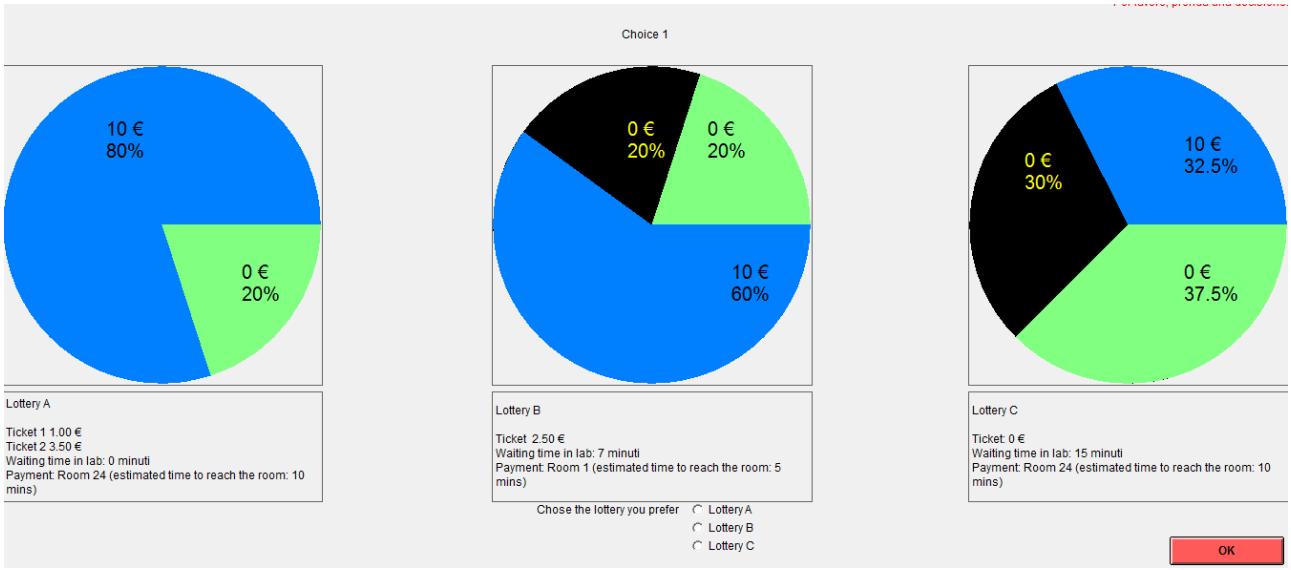
The laboratory experiment was conduct in May 2013 at the ESSE Laboratory at the University of Bari. 78 undergraduate students were recruited among first year students. The experiment was composed by four sessions; in each session subjects have to complete two treatments (i.e. a risky treatment and an uncertainty one) and a questionnaire.
The sample was composed by 64.58% of female students, while male students were about the 35,42% of the sample, with an average age of 20 years-old.
The whole experiment, on average, took more or less 50-60 minutes to be completed even if it varied across students 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 choices problems, each of them composed by three lotteries (A, B, C). Subjects then had to report their preferences among the three lotteries. A screen shot of the risky and the uncertain treatments are reported in figure 1 and 2 respectively.

Figure 1- Risky Lottery Choice in the Experiment.



Source: our elaboration using Z-tree software.

Figure 2 - Uncertain Lottery Choice in the Experiment.



Source: our elaboration using Z-tree software.

In order to design the lotteries (scenarios) we identify the attributes (e.g. ticket price, walking time etc.) allowing them to vary on two levels (e.g. ticket price in the on-street scenarios' could vary be 0 or 2 Euros), which were as close as possible to the real values respondents could face in everyday parking tasks. Basically, the ticket price was the result of the actual values of the different types of the parking area in the city centre of Bari, as well as the other attributes: the expected searching, and walking time necessary to reach the city centre. A new attribute necessary to distinguish between the parking types has been introduced: the parking probability. Thanks this attribute we are able to model for risk and uncertainty as this is the most important element, as well as the ticket price, that differentiate the parking slots from technological to non-technological and on-street.

The lottery, as represented in the lab experiment, can be lead back to the scenarios proposed in the field experiment, in particular lottery A represents the technological parking type. The

peculiarities of this lottery A (Technological parking type) are: higher ticket price divided into price 1 and price 2 (respectively the reservation price of 1 Euro and the parking price that could vary between 2.5, - 3.5 Euros) a waiting time before get paid of 0 mins (that represents the searching time), the payment into a specific room that requires 10 minute of walk to be reached (walking time). The probability of winning the lottery is between 80% or 100%.
The lottery B represents the non-technological parking type in which the ticket price is equal to 2.5 Euros, the waiting time before getting paid is 7 minutes (searching time) and then the time to reach the room for the payment was less the 5 minutes far from the lab (walking time). Here the probabilities to win the lottery are lower than in the previous lottery A, in fact there is at minimum one half of chances to win/lose or a maximum of 70% .
The last lottery (lottery C) represents the riskier one, as the chances to win/lose are much lower than in the lottery A and B. The lottery price in this case was equal to zero or at least subjects had to pay 2 Euros to play the lottery. This lottery represented the on-street slots and commonly it requires higher searching and walking time than in the parking type ascribable to the previous two lotteries. The same lotteries where reproduced in the last section of the experiment but in this case what changed were the probabilities to win/lose in Lotteries B and C. The only information available to the subject about the chances to win/lose the lottery is about the distribution of the probability.
A questionnaire was proposed at the end of the risky treatment before starting the uncertainty one. The aim of this questionnaire was to collect socio-economic information about respondents.
Once the experiment finished only one lottery 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 Euros and a minimum of 0 Euros, excluding the show up fee of 5 Euros, that each student received for sure. The average payment was around 9.80 Euros with a standard deviation of 1,41.
In the risky (uncertainty) treatment participants were presented with the same 128 choice problems (reported in Table A1 (Table A2), in Appendix 1), the presentation order varied between the two sessions.
Our aim, in the definition of the lotteries, was to reproduce exactly the parking tasks (e.g. the searching time, the walking time, the parking probability etc.), which we considered to draw the hypothetical scenarios, built in the SP experiment.

4. The estimation model

In this section of the paper we attempt to specify the models and discuss about the preliminary results we get from the data collected through the lab-experiment.
The sample is composed by 78 undergraduate students, but in this part of our model we focus our attention only on 48 individuals for a total of 12287 observations.
In the table 1 below there is a quick recap of the scenarios proposed during the experiment, while in table 2 the descriptive statistics of the monthly expenditure on different categories and on transport sector are reported.
The aim of the paper is to test the presence of heterogeneity in the sample and in order to analyse it we propose first a simple multinomial logit model and then we move to a more sophisticated mixed model (McFadden and Train 2000). To test for the heterogeneity, an alternative specific variance was conduct, and then a random coefficient model has been estimated, in this section however we report only the preliminary results.

Table 1 - Descriptive statistics on the lab-experiment scenarios.

Name	Mean	Min	Max
Technological:			
Parking Probability (%)	90	80	100
Searching time (min)	0	0	0
Ticket price (€)	4.0	3.5	4.5
Walking time (min)	10	10	10
Non-Technological:			
Parking Probability (%)	60	50	70
Searching time (min)	7	7	7
Ticket price (€)	2.5	2.5	2.5
Walking time (min)	5	5	5
On-Street:			
Parking Probability (%)	33.8	20	47.5
Searching time (min)	22.5	15	30
Ticket price (€)	1.0	0	2
Walking time (min)	7.5	5	10

Table 2 - Descriptive statistics on monthly expenditure

	Mean	Standard Deviation
Monthly expenditure for categories (€):		
Spare Time (restaurants, pubs etc)	75.73	42.50
Clothes	62.05	122.06
Holidays/Trips	62.06	32.92
Mobile Phone	22.73	10.18
Interent	11.56	49.57
Presents	26.25	39.01
Sport	24.46	10.81
Others	8.19	45.17
Monthly expenditure for transport (€):		
Total	45.89	52.76
Fuel	44.29	41.01
Monthly ticket	36.28	44.24
Urban/extra-urban transport	26.91	44.28
Others	17.60	1.21

We use the BIOGEME econometric software (Bierlaire, 2009) in order to have our estimations. Starting from the multinomial logit model in the systematic part of the utility function we consider the alternative attributes that, determined the choice, as: the ticket cost, the value of time (here expressed in terms of searching time and walking time) and then we take into account the parking probability. We include a dummy variable, which takes value 1 in the case of uncertain lottery and 0 for the risky lottery.
In the Multinomial Logit Model (MLN) the utilities are expressed as follows:

$$V_{\text{tech}} = \text{ASC}_{t} + \beta_{\text{t-ticket}}\ \text{t-ticket} + \beta_{\text{t-wt}}\ \text{t-wt} + \beta_{\text{t-st}}\ \text{t-st} + \beta_{\text{t-pp}}\ \text{t-pp}$$
$$V_{\text{non-tech}} = \text{ASC}_{nt} + \beta_{\text{nt-ticket}}\ \text{nt-ticket} + \beta_{\text{nt-wt}}\ \text{nt-wt} + \beta_{\text{nt-st}}\ \text{nt-st} + \beta_{\text{nt-pp}}\ \text{nt-pp}$$
$$V_{\text{on-street}} = \text{ASC}_{os} + \beta_{\text{os-ticket}}\ \text{os-ticket} + \beta_{\text{os-wt}}\ \text{os-wt} + \beta_{\text{os-st}}\ \text{os-st} + \beta_{\text{os-pp}}\ \text{os-pp}$$

where the subscripts are defined as follows t = technological parking type, nt = non-technological parking type, os = on street, wt = walking time, st = searching time and pp = parking probability. Here we assume that the coefficient of the explanatory variables are alternative specific and for estimation purpose we normalize the alternative specific constant (ASC) of On-Street to zero.
The ASC are respectively positive, this could mean that the two alternatives technological and non-technological are positively perceived but in this case they are not significantly different from zero.
The estimated ticket price coefficients show, as we expected, a negative impact on the utility function and the perception is higher in the technological than in the on-street parking. This means that in absolute value people are more sensitive to the technological parking price ticket than in the other two parking types.

Table 3 - MNL estimation.

Parameter number	Parameter Name	Parameter Value	Robust Std error	Robust t-test	p-value
1	ASC_t	0.0249	0.672	0.04	0.97
2	ASC_nt	0.00335	1.2	0	1
3	β_t-ticket	-0.783	0.0415	-18.85	0
4	β_os-ticket	-0.235	0.0324	-7.24	0
5	β_t-pp	0.0389	0.00209	18.66	0
6	β_nt-pp	0.0317	0.00218	14.53	0
7	β_os-pp	0.0415	0.0026	15.95	0
8	β_os-st	-0.00836	0.00425	-1.97	0.05
9	β_os-wt	-0.00578	0.0127	-0.45	0.65

Summary Statistics:

N. of obs.:	12288
L(0) =	-13499.748
L(β)=	-10623.818
Adjusted ρ^2 =	0.212

The parking probability coefficients on the other hand are significant and positive implying that the probability of finding an available slot has a non-negative impact on the perception of respondents. As expected also the searching time coefficient in the on-street case has a

negative sign because perceived as a dis-utility. The walking time too is negatively perceived but in the on-street it is not significant[13].
In the second model (table 4 below) we introduced some socio-economic variables, such as age which is negative and significant reflecting a preference for the on-street parking as long as respondents get older, while variables such as gender and the number of people in the family seem not be significantly relevant in the choice of the kind of parking slot.

Table 4 - MNL model with socio-economic variables.

Parameter number	Name	Value	Robust Std err	Robust t-test	p-value
1	ASC_t	0.0246	0.494	0.05	0.96
2	ASC_nt	-0.00586	1.80e+308	0	1
3	β_t-ticket	-0.785	0.0416	-18.88	0
4	β_os-ticket	-0.235	0.0325	-7.23	0
5	β_t-pp	0.039	0.00209	18.69	0
6	β_nt-pp	0.0318	0.00218	14.55	0
7	β_os-pp	0.0416	0.00261	15.92	0
8	β_os-st	0.0416	0.00261	15.92	0
9	β_os-wt	-0.00579	0.0128	-0.45	0.65
10	β_age	-0.0483	0.0158	-3.06	0
11	β_family	0.0584	0.0332	1.76	0.08
12	β_gender	0.0913	0.0673	1.36	0.18

Summary Statistics:

N. of obs:	
L(0) =	-13499.748
L(β) =	-10616.086
Adjusted ρ^2 =	0.212

In order to understand if there is variability in the taste of the respondents regarding the different types of parking slots, we run an alternative specific variance model, allowing the variances of the different alternatives to assume different values. The results, reported below, show that the parking type is not perceived differently by consumers, because all the variances (ASC-t -std and ASC_nt-std) seems to be not significantly different to zero.

[13]In our treatments, some attributes such as ticket price, walking time and searching time in the non-technological parking type and the searching time and walking time in the technological parking type are always constant by construction and so they have not been introduced in our estimations.

Table 5 - Alternative specific variance model

Parameter number	Name	Value	Std err	t-test	p-value
1	ASC_t	1	7.51e-09	133223477. 1	0
2	ASC_t-std	0.000102	0.314	0	1
3	ASC_nt-std	0.00907	0.147	0.06	0.95
4	β_pp	0.0372	0.00131	28.44	0
5	β_st	-0.00992	0.00331	-3	0
6	β_ticket	-0.444	0.0219	-20.3	0
7	β_wt	-0.00423	0.0124	-0.34	0.73
8	ASC_nt	0.781	0.0563	13.87	0

Summary Statistics:	
Nof obs:	12288
L(0) =	-13499.748
L(β)=	-10685.81
Adjusted ρ^2=	0.208

In the last table (table 6 below) we report the preliminary results of the random coefficient model, accounting for the random distribution of the ticket price across the sample. It is noticeable that the mean and the standard deviation of both technological and on-street parking types are negative significantly different from zero, implying that there is variation in respondents' taste.

Table 6 – Random coefficient model

Parameter number	Name	Value	Std err	t-test	p-value
1	ASC_t	1	1.80e+308	0	1
2	ASC_nt	-0.717	0.162	-4.44	0
3	β_t-ticket	-0.592	0.0373	-15.86	0
4	β_t-ticket_std	-0.187	0.0656	-2.85	0
5	β_os-ticket	-0.653	0.18	-3.62	0
6	β_os-ticket_std	-0.789	0.21	-3.75	0
7	β_pp	0.044	0.00263	16.76	0
8	β_st	-0.0256	0.00427	-6.01	0
9	β_wt	0.00919	0.0137	0.67	0.5

Summary Statistics:	
N. of obs:	12288
L(0) =	-13499.748
L(β)=	-10655.426
Adjusted ρ^2=	0.21

The results commented until now are only preliminary results. We are going to understand consumers' behaviour when we allow each coefficient to be randomly distributed and through a mixed logit model, then, we will be able to test the presence of heterogeneity in the sample.

5. Conclusions

In this paper we have analysed the commuters' behaviour when they have to chose a parking slot using a laboratory experiment, based on a full combination of the three alternatives (technological, non-technological and on-street parking type) and attributes (ticket price, walking time, searching time and parking probability).
A dataset of 12288 has been used to run our estimations. The results show that respondents' behaviour is consistent with our expectation, as most of the time the ticket price together with the time-related variables are negatively perceived. In particular we notice that the technological parking slot is not perceived differently from the others if simply considered as a parking area (not accounting for its peculiar attributes, as for example zero searching time, higher parking probability than the other two parking types, etc.). When we allow the ticket price to be randomly distributed across the sample, then there is a different perception of the three alternatives showing a significant taste variation across the sample we observed.
In our follow up work we are going to improve these results, accounting for more observations, and to compare these results with the one obtained from a field experiment, in which we will use fewer treatments than we have used here, but still able to let us discuss about the possible outcome obtained with these two complementary but different approaches.

Appendix 1

Table A1 -Risky lotteries

Treatment number	Lottery A p_a	Lottery B p_b	Lottery C p_c
1	0.800	0.700	0.475
2	0.800	0.500	0.475
3	1.000	0.700	0.475
4	0.800	0.700	0.200
5	1.000	0.700	0.475
6	1.000	0.700	0.200
7	0.800	0.500	0.475
8	0.800	0.500	0.200
9	0.800	0.500	0.475
10	0.800	0.500	0.200
11	0.800	0.700	0.475
12	0.800	0.500	0.475
13	0.800	0.700	0.475
14	0.800	0.700	0.200
15	1.000	0.500	0.475
16	1.000	0.500	0.475
17	0.800	0.500	0.475
18	0.800	0.500	0.475
19	1.000	0.500	0.200
20	1.000	0.700	0.200
21	0.800	0.700	0.475
22	1.000	0.700	0.475
23	0.800	0.500	0.200
24	1.000	0.500	0.200
25	0.800	0.500	0.475
26	1.000	0.700	0.475
27	0.800	0.500	0.200
28	0.800	0.700	0.475
29	1.000	0.500	0.200
30	1.000	0.500	0.475
31	1.000	0.700	0.475
32	0.800	0.500	0.475
33	0.800	0.700	0.200
34	0.800	0.700	0.475
35	1.000	0.500	0.200
36	0.800	0.700	0.200
37	0.800	0.500	0.475
38	0.800	0.700	0.475
39	1.000	0.700	0.200
40	1.000	0.700	0.200
41	0.800	0.700	0.200

42	1.000	0.500	0.200
43	0.800	0.700	0.200
44	0.800	0.700	0.200
45	0.800	0.700	0.475
46	1.000	0.500	0.200
47	0.800	0.700	0.200
48	1.000	0.700	0.475
49	0.800	0.500	0.475
50	1.000	0.700	0.475
51	1.000	0.700	0.200
52	0.800	0.700	0.475
53	0.800	0.500	0.200
54	1.000	0.500	0.475
55	1.000	0.700	0.200
56	1.000	0.700	0.475
57	1.000	0.700	0.475
58	0.800	0.500	0.200
59	1.000	0.700	0.200
60	0.800	0.500	0.475
61	1.000	0.500	0.475
62	1.000	0.700	0.475
63	1.000	0.500	0.475
64	1.000	0.500	0.200
65	1.000	0.500	0.475
66	0.800	0.700	0.200
67	1.000	0.500	0.200
68	1.000	0.700	0.200
69	1.000	0.700	0.200
70	1.000	0.500	0.200
71	1.000	0.500	0.200
72	0.800	0.500	0.475
73	0.800	0.500	0.475
74	0.800	0.500	0.200
75	1.000	0.500	0.475
76	0.800	0.500	0.200
77	1.000	0.700	0.200
78	0.800	0.500	0.200
79	0.800	0.700	0.200
80	1.000	0.700	0.475
81	1.000	0.500	0.200
82	0.800	0.500	0.200
83	1.000	0.500	0.475
84	0.800	0.700	0.475
85	0.800	0.500	0.200
86	1.000	0.500	0.475
87	1.000	0.500	0.475
88	1.000	0.700	0.475

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

Table A2 – Uncertain lotteries

Treatment number	Lottery A p_a (%)	Lottery B p_b (%)	Lottery C p_c (%)
1	80	60 - 80	35 - 65
2	80	40 - 60	35 - 65
3	100	60 - 80	35 - 65
4	80	60 - 80	5 - 35
5	100	60 - 80	35 - 65
6	100	60 - 80	5 - 35
7	80	40 - 60	35 - 65
8	80	40 - 60	5 - 35
9	80	40 - 60	35 - 65
10	80	40 - 60	5 - 35
11	80	60 - 80	35 - 65
12	80	40 - 60	35 - 65
13	80	60 - 80	35 - 65
14	80	60 - 80	5 - 35
15	100	40 - 60	35 - 65
16	100	40 - 60	35 - 65
17	80	40 - 60	35 - 65
18	80	40 - 60	35 - 65
19	100	40 - 60	5 - 35
20	100	60 - 80	5 - 35
21	80	60 - 80	35 - 65
22	100	60 - 80	35 - 65
23	80	40 - 60	5 - 35
24	100	40 - 60	5 - 35
25	80	40 - 60	35 - 65
26	100	60 - 80	35 - 65
27	80	40 - 60	5 - 35
28	80	60 - 80	35 - 65
29	100	40 - 60	5 - 35
30	100	40 - 60	35 - 65
31	100	60 - 80	35 - 65
32	80	40 - 60	35 - 65
33	80	60 - 80	5 - 35
34	80	60 - 80	35 - 65
35	100	40 - 60	5 - 35
36	80	60 - 80	5 - 35
37	80	40 - 60	35 - 65
38	80	60 - 80	35 - 65
39	100	60 - 80	5 - 35
40	100	60 - 80	5 - 35
41	80	60 - 80	5 - 35
42	100	40 - 60	5 - 35
43	80	60 - 80	5 - 35

44	80	60 - 80	5 - 35
45	80	60 - 80	35 - 65
46	100	40 - 60	5 - 35
47	80	60 - 80	5 - 35
48	100	60 - 80	35 - 65
49	80	40 - 60	35 - 65
50	100	60 - 80	35 - 65
51	100	60 - 80	5 - 35
52	80	60 - 80	35 - 65
53	80	40 - 60	5 - 35
54	100	40 - 60	35 - 65
55	100	60 - 80	5 - 35
56	100	60 - 80	35 - 65
57	100	60 - 80	35 - 65
58	80	40 - 60	5 - 35
59	100	60 - 80	5 - 35
60	80	40 - 60	35 - 65
61	100	40 - 60	35 - 65
62	100	60 - 80	35 - 65
63	100	40 - 60	35 - 65
64	100	40 - 60	5 - 35
65	100	40 - 60	35 - 65
66	80	60 - 80	5 - 35
67	100	40 - 60	5 - 35
68	100	60 - 80	5 - 35
69	100	60 - 80	5 - 35
70	100	40 - 60	5 - 35
71	100	40 - 60	5 - 35
72	80	40 - 60	35 - 65
73	80	40 - 60	35 - 65
74	80	40 - 60	5 - 35
75	100	40 - 60	35 - 65
76	80	40 - 60	5 - 35
77	100	60 - 80	5 - 35
78	80	40 - 60	5 - 35
79	80	60 - 80	5 - 35
80	100	60 - 80	35 - 65
81	100	40 - 60	5 - 35
82	80	40 - 60	5 - 35
83	100	40 - 60	35 - 65
84	80	60 - 80	35 - 65
85	80	40 - 60	5 - 35
86	100	40 - 60	35 - 65
87	100	40 - 60	35 - 65
88	100	60 - 80	35 - 65
89	100	40 - 60	5 - 35
90	80	60 - 80	35 - 65

91	100	40 - 60	35 - 65
92	80	60 - 80	35 - 65
93	80	60 - 80	35 - 65
94	100	40 - 60	5 - 35
95	80	40 - 60	5 - 35
96	80	60 - 80	5 - 35
97	80	60 - 80	5 - 35
98	100	60 - 80	35 - 65
99	100	40 - 60	35 - 65
100	100	60 - 80	5 - 35
101	100	40 - 60	5 - 35
102	80	40 - 60	5 - 35
103	100	60 - 80	35 - 65
104	80	60 - 80	5 - 35
105	100	40 - 60	35 - 65
106	80	60 - 80	35 - 65
107	100	60 - 80	5 - 35
108	80	60 - 80	35 - 65
109	100	40 - 60	35 - 65
110	80	40 - 60	5 - 35
111	100	60 - 80	35 - 65
112	100	40 - 60	5 - 35
113	100	40 - 60	5 - 35
114	80	60 - 80	5 - 35
115	100	60 - 80	5 - 35
116	80	40 - 60	35 - 65
117	80	40 - 60	5 - 35
118	80	60 - 80	5 - 35
119	80	60 - 80	5 - 35
102	80	40 - 60	35 - 65
121	100	60 - 80	5 - 35
122	80	40 - 60	5 - 35
123	100	60 - 80	35 - 65
124	80	60 - 80	35 - 65
125	100	60 - 80	5 - 35
126	80	40 - 60	35 - 65
127	100	60 - 80	5 - 35
128	100	40 - 60	35 - 65

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