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The effect of parking charges and time limit to car usage and parking behaviour

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ABSTRACT

Parking policies are considered a powerful tool for solving parking problems as well as problems of the transportation system in general (traffic congestion, modal split, etc.). To define parking policy properly, its effects must be estimated and predicted. In this paper, based on stated preference data and using a logistic regression, a model to predict the effects of introducing or changing the parking price and time limitation was developed. The results show that parking prices affect car usage, while time limitations determine the type of parking used (on-street or off-street). A positive finding for policy makers is that users with work are more sensitive to parking measures than are other users, so parking measures can be used to manage user categories. Although there is a concern that parking policy can jeopardise the attractiveness and efficiency of a zone, the results show that a very small number of users would give up travelling into the zone.

1. Introduction

The main objective of parking management is to balance the parking supply with the parking demand. However, parking policy has a strong impact not only on the operation of the parking subsystem but also on the entire transportation system and the city in general. Possible driver responses to parking policy (primarily to the parking charge and time limitation) are complex and varied. These include a change in the parking type, parking location, transportation mode, car occupancy, destination, travel frequency, travel time (with possible consequences on the parking duration) and route (Scholefield et al., 1997). This mechanism of influence allows parking policy to be used to achieve objectives beyond this subsystem. For example, studies have shown that the most important factor in reducing car usage is the parking price (Higgins, 1992). Thus, parking policy can be the most effective policy for achieving the desired modal split (Victorian Competition and Efficiency Commission (VCEC), 2006). Furthermore, the parking charge is considered to be the second best measure for solving traffic congestion after congestion charging (Albert and Mahalel, 2006; Kelly and Clinch, 2006), but it is used far more often because of its relatively simple implementation (Marsden, 2006; Verhoef et al., 1995).

Although good parking policy has many positive implications for sustainable transportation, poor parking policy can have the opposite effect. For example, analysing 16 studies from 11 international cities showed that approximately 30% of the traffic volume are vehicles cruising for parking, i.e., result of poor parking management (Shoup, 2005). In addition, recently, there is concern that parking policy could negatively impact the competitiveness and business efficiency in an area (D'Acierno et al., 2006).

To properly set the parking policy and define the appropriate measures, i.e., to ensure that the objectives are met without adverse impact on the transportation system and other systems of a city, the effects of the policy must be predicted.

Originally, models for the prediction of parking policy impacts were aggregate, i.e., based on group behaviour. Conventional models were later replaced by disaggregate models because it was recognised that the individual impact must be examined and included (Kelly and Clinch, 2006).

The user response to time limitation can be relatively easily predicted; it depends on the parking duration and the possibility of shortening the duration (which is associated with trip purpose (Transit Cooperative Research Programme (TCRP), 2005)). However, the prediction of the user response to the parking price is very complex and not accurately known.

It is particularly complex to determine the impact of several measures (the time limitation and parking price of on-street parking and the parking price of off-street parking) because of their synergistic effect. For this reason, it is not appropriate to estimate the impacts of the measures individually; instead, this should be performed simultaneously (see for example Ibeas et al., 2011).

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To investigate the parameters of significance for parking decision making, a logistic regression of the stated preference data is usually conducted (Hess, 2001; Shiftan and Burd-Eden, 2001; Tsamboulas, 2001; Shiftan and Golani, 2005; Albert and Mahalel, 2006; Khodaii et al., 2010; Simićević et al., 2012a). Thus, some of the socio-economic and trip characteristics significant for decision making are identified.

Lately, more and more researchers are interested in this topic. In a review paper on parking policy, Marsden (2006) noted that "We do not understand nearly enough about how individuals respond to parking policy interventions nor how these responses interact with local circumstances, the availability of alternative transport modes or alternative destinations," and among parking topics that require further research, he highlighted "the importance of out-of-vehicle costs and in particular walk-times on parking behaviour".

This paper is testing the hypotheses: (1) that time limit and parking price influence parking behaviour (2) that these influences differ for specific user subgroups (depending on certain characteristics of users and trips). The aim of this paper is to forecast user behaviour in the conditions of change in price and/or time limit of parking, and further to forecast direct effects of such measures. The forecast was made by using multinomial logit model fitted with the data gathered by approaches of revealed and stated preferences.

The structure of the paper is as follows: in Section 2, the state of parking in the central area of Belgrade is described. In Section 3, the problem this paper addresses is presented, and the procedure for its solution is described. To test this procedure, necessary data were gathered as shown in Section 4, while the collected data are presented in Section 6. In the 7th and final section, final considerations are summarised.

2. Parking in Belgrade

Belgrade is the capital of Serbia. The urban part of the city occupies an area of about 77,000 ha and has approximately 1.5 million inhabitants. About 96,000 inhabitants live in the city centre, which has an approximate area of 440 ha.

Based on the traffic survey, the inhabitants of Belgrade make approximately three million trips per day. In the modal split, passenger cars account for 22% and public transport for 52% of all daily trips. Coverage with the public transport network is approximately 2.1 km/km^2; headways are between 6 and 20 min. Public transport users assess the quality of service as very good (mark near 4 out of a maximum of 5) (Jović and Djorić, 2009).

The parking problem in Belgrade is present in almost all its urban area. The parking problem arises as a result of the disproportion between the parking demand and the number of available parking spaces. The disproportion is a result of historically formed city structures, flows or omissions in the planning and a lack of good parking supply management.

The basic characteristic of Belgrade is the insufficient off-street public parking capacity, so the majority of vehicles are parked on the streets. All parking spaces are owned by and under the jurisdiction of the city administration, which is, therefore, responsible for making the appropriate parking policy.

A restrictive parking element is implemented within the central area for on-street parking spaces. The area is divided into three zones (red, yellow and green) that differ in the following regime attributes: time limitation (1, 2 and 3 h, respectively) and parking price (56 RSD (0.53 EUR), 38 RSD (0.36 EUR) and 31 RSD (0.30 EUR) per commenced hour, respectively). Most visitors pay parking by mobile phone, although other technologies are in use, such as parking metres, parking tickets and electronic tickets. The period of regime validity is every day from 7 a.m. to 9 p.m. and on Saturdays from 7 a.m. to 2 p.m.

Residents and businesses in the area are entitled to a parking permit (PP), which does not guarantee a vacant parking space to its holder; however, once the user finds a vacant parking space, the user can park there without any time limitation. The price of PP for residents is 480 RSD per month (5.05 EUR), while the price for businesses depends on the zone the company is located in (9,130 RSD (86.95 EUR), 6,176 RSD (58,82 EUR) and 4,106 RSD (39.10 EUR) per month, respectively).

Disabled persons can park at specially marked parking spaces (3% of the total number of parking spaces (Milosavljević et al., 2009)), which the parking regime does not take into account.

On-street parking spaces can be reserved for state institutions, city institutions, public services, diplomatic and other foreign representatives, businesses and entrepreneurs. The city administration approves reservations based on previously prescribed conditions. Approximately 10% of the total number of parking spaces in the central area is reserved (Milosavljević et al., 2009).

Parking at parking lots and garages is charged every day for 24 h. The parking price varies from facility to facility and is 2–3 times higher than the on-street parking price. In addition to paying for parking per commenced hour, it is possible to pay for parking per month (types and fees vary among facilities, but they are also far higher than those for on-street parking).

During increased area attractiveness, all on-street parking spaces are occupied, and even illegal parking occurs, making it hard to find a vacant parking space. On the other hand, off-street car parks and parking garages are never 100% occupied, and it can be assumed that at every moment, a vacant parking space can be found.

3. Problem statement and proposed solution

As already mentioned, the aim of this paper is to predict the effects of the introduction or change of the parking policy, namely, time limitation and the parking price.

These policies refer only to users who park at public, non-reserved parking spaces and who are subject to the parking regime (so-called visitors). It is therefore necessary, in the first step, to isolate this demand and use it for the study.

To survey visitors' responses to parking policy changes, the stated preference method is used, where through interviews, various hypothetical situations are presented to the respondents, and they declare how they would behave in such situations. This implies that there are scenarios with different combinations of the time limitation and parking price levels. If the number of all possible scenarios (full factorial) is so great that it is impractical to examine them all, it is possible to examine only a subset, chosen to represent a full set with certainty (fractional factorial) (Hensher and King, 2001; Wong, 2006). The possible choices for visitors are as follows: no change in behaviour, driving to the zone and changing the type of parking space (on-street instead of off-street or vice versa), parking at the fringe of the zone and continuing the journey by public transport or on foot, using other transport modes, and so on.

To better explain the response visitors faced with parking policy changes, it is necessary to gather a wide set of parameters that are assumed to have a strong impact on the travel decision. These are some socio-economic characteristics of the visitors and trip characteristics.

All data will be used to fit the multinomial logit (MNL) model, which will predict the probability of choosing each of the stated alternatives for each visitor for any parking price and time limitation. At the end of the modelling process, it is necessary to