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The impact of the parking situation in shopping centres on store choice behaviour

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Abstract

The article discusses the effects of changing the parking situation in the surrounding of shopping centres on consumers store choice behaviour. To get insight into these effects a hierarchical logit model of parking lot and store choice behaviour is estimated and validated. The research is based on before-and-after data of supermarket visitors collected in a major regional shopping centre in a suburban area in The Netherlands.

The model is estimated using the before data. At the level of the supermarkets the estimated hierarchical logit model performs very well. The model is less accurate at the level of parking lots but still performs satisfactory. Significant attributes are a constant representing the characteristics of the supermarket, the distance between supermarket and parking lot, the number of parking spaces per parking lot, the location of the parking lot vis-à-vis the origin of the consumer, and the availability of supermarket trolley facilities at the parking lot. Validating the model by reproducing the after data yields less satisfactory results. Especially the model does not perform very well on predicting parking lot choice.

Introduction

Nowadays, in many European cities the major retail areas (especially inner-cities) suffer from congestion due to an ever increasing car use. Congested urban network and urban parking facilities surrounding business areas lead to a decrease of accessibility for residents, employees, customers and visitors, and for service and delivery traffic (Topp, 1991). A recurring issue in the definition of transportation policies to alleviate the congestion problem is how to maintain or improve the accessibility of the urban retail areas. Planners try to control the accessibility with a variety of infrastructural and regulatory measures, including parking measures. Parking measures are related to the number of available parking spaces, parking costs, maximum parking duration, the location of parking spaces, and the diversity of parking supply (Axhausen and Polak, 1991; Matsoukis, 1993). In order to be able to select the most optimal set of parking measures, planners need to anticipate their effects.

One of those effects concerns the impact of the parking situation on retail trade. Parking measures may affect shopping and travel behaviour of consumers at two different levels. The first level (macro level) concerns the effects related to shopping destination, mode, route, and parking lot choice. Examples of effects at this level are changing shopping destination choice and mode of travel, changing the parking lot choice and route to this location, and changing start times and frequency of the shopping trip (Feeney, 1989; Coombe et al., 1997). Effects on the choice of individual stores to visit and the choice of routes through the shopping area form the second level (micro level). This micro level focuses on the effects of changes in parking location on the micro shopping behaviour of consumers.

The ways in which consumers react to parking policies will not only affect the performance of the urban transportation network and the parking facilities but also the economic performance of shopping areas and individual stores. Consequently, these effects should be the major concern to different parties. Managers of parking facilities may expect a decrease of revenues as a consequence of the decrease of demand. Retailers fear a decline of sales because consumers may choose to visit other centres (Pacione, 1980; Popp, 1992; Timmermans and Van der Waerden, 1992a), or to visit other shops in the shopping centre (Borgers and Timmermans, 1986a, b) in response to parking policies. Residents in the fringe of retail areas are concerned about congestion because consumers may choose to park their cars further away from the retail areas in the fringe.

Research into the effects of parking measures on shopping behaviour is still limited and has mainly focused on effects at the macro level. The research described in this article concentrates to the effects of parking measures at the micro level. The aim of this article is *to provide empirical evidence regarding the influence of the parking situation on the shops visited by motorists*. The way in which shop visits are related to the choice of a parking lot is examined by analysing before-and-after data of supermarket visitors and

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modelling their store and parking lot choice behaviour. The performance of the estimated model is evaluated using data collected after a major change in the parking situation of a regional shopping centre in a suburban area in the south of The Netherlands.

To accomplish this goal, the article is organised as follows. First, the relationship between shopping behaviour and the parking situation of shopping centres is described. Next, the research method is explained. Special attention is paid to the structure of nested logit models. The before-and-after data used in the analyses is described in Section 4. The results of the model estimation and validation process are presented in respectively Sections 5 and 6. The article ends with some concluding remarks.

Shopping behaviour and parking situation

In the context of this study, shopping behaviour is defined as the behaviour resulting in a choice of a shopping destination (shopping centre or individual store). The choice of a shopping destination is influenced by various attributes such as 'distance from home to shopping destination', 'assortment/choice range', 'price of goods', 'quality of products', and 'parking situation' (Oppewal, 1995). The operationalisation of the latter attribute is very complex especially in the context of shopping areas (Van der Waerden and Borgers, 1995). In general, the parking situation is defined as the whole of parking lots surrounding a shopping destination. The available parking lots can be characterised in terms of scale, location, type, tariff, regulation, design, and accessibility. In destination choice research, the parking situation surrounding a shopping destination is usually defined by one, sometimes two attributes. For example, Oppewal (1995) defined the parking situation surrounding a shopping destination by means of parking convenience and parking costs. Other operationalisations of the parking situation are 'parking search time' (Timmermans et al., 1984), 'quality of parking facilities' (Timmermans and Van der Waerden, 1992b), 'availability of parking facilities' (Timmermans, 1996), and 'number of parking spaces' (Timmermans et al. 1992). Aggregate values tend to be based on values of individual parking lots, for example summation. These studies have shown that the parking situation has some influence on consumers shopping destination choice behaviour. For example Van der Waerden and Oppewal (1996) defining a model for the combined choice of parking lot and shopping destination, found that characteristics of available parking lots such as maximum parking duration, parking costs, walking distance between parking lot and shopping area played a significant role in the choice of a shopping centre.

Also at the micro level previous research has shown a relation between the parking situation surrounding shopping centres and shopping behaviour. Borgers and Timmermans (1986a) for example found empirical evidence which supported the hypothesis that store choice and pedestrian movements in shopping centres are strongly influenced by the location of entry points such as parking lots. Also, Brown (1991) emphasised the importance of entry points in the design of shopping centres: '...anchor stores, entry points, escalators and suchlike should be so located as to stimulate shopper circulation within the complex and thereby maximise shoppers' exposure to the temptations of the centre and the blandishment of its occupants...'. Similarly, Lorch and Smith (1993) concluded that customers coming from a parking lot walk straight forward to the nearest shopping mall entrance and only shops immediately adjacent to this entrance benefit. Marjanen (1997) found that visitors of supermarkets and department stores consider parking as one of the most important store-choice variables. Finally, Van der Waerden and Borgers (1994) found empirical evidence of a strong relation between the location of the chosen parking lot and the location of visited stores. The probability for customers to visit stores in the surrounding of the chosen parking is higher than visiting stores located at some distance.

When assessing this empirical evidence, one should realise that these studies typically involve cross-sectional data. Consequently, the evidence indicates that the variance in consumers spatial store choice behaviour is systematically related to the variance in the characteristics of the parking situation surrounding shopping centres, and that this relationship has some validity at both the macro and micro scale. Although this is an interesting and potentially important findings, cross-sectional evidence is weak. Stronger support for the relationship between parking situation and consumer store choice behaviour could be acquired by conducting a before-and-after study and demonstrate how changes in the parking situation have impacted consumers store choice behaviour. The limits of such a study will be described in the following section of this article.

Research method

To get insight into the spatial store and parking lot choice behaviour of consumers a hierarchical logit model (HL-model) is estimated. HL-models are preferable in situations of multi-dimensional choices. The structure of HL-models is characterised by grouping all subsets of correlated (or more similar) choice into so called nests. Each nest is represented by a composite alternative which competes with the other alternatives or composites available to the individual.

The hierarchical logit model is estimated by using the software-package HIELOW (Bierlaire, 1994). HIELOW defines structural (similar to a composite alternative) and elemental (similar to an individual alternative) nodes. Associated with the structural node is the composite utility or inclusive value. This value synthesises the utility of the different elemental nodes forming the structural node. The value is multiplied by the structural coefficient that must fall between 0 and 1. When all structural coefficients are equal to 1, the model reduces to the multinomial logit model. If we assume utility-maximising, the HL-model is defined by the following equations. First, the probability of the structural node is defined by

$$P_j = \frac{e^{[V_j + \theta_j \cdot V'_j]}}{\sum_{j' \in J} e^{[V_{j'} + \theta_{j'} \cdot V'_{j'}]}} \tag{1}$$

where, P_j is the probability of structural node *j*; V_j, utility value for structural node *j*, apart from V'_j; V'_j, composite utility of the set of elemental nodes under *j*; θ_j structural coefficient for structural node *j*; *J*, set of structural nodes *J*.

The probability of elemental nodes equals

$$P_{i|j} = \frac{e^{V_i}}{\sum_{i' \in I_j} e^{V_{i'}}} \tag{2}$$

where, $P_{i|j}$ is the probability of elemental node *i*, given structural node *j*; V_i, utility value for elemental node *i*; I_j, set of elemental nodes given structural node *j*.

Then, the probability of choosing elemental node *i* and structural node *j* is equal to

$$P_{ji} = P_j \cdot P_{i|j}. \tag{3}$$

The composite utility of structural node *j* is defined as

$$V'_j = \ln \left[\sum_{i \in I_j} e^{V_i} \right]. \tag{4}$$

In the present study, the HL-model is tested against a model with all coefficients equal to zero (null model) using the log-likelihood ratio test (Equation (5)) which is defined as minus two times the difference between the log-likelihood of the optimal HL-model (LL(β)) and the log-likelihood of the null model (LL(0)). This ratio is asymptotically distributed according to a chi-square distribution with degrees of freedom being equal to the number of coefficients in the model, in formula:

$$LR = -2[LL(0) - LL(\beta)]. \tag{5}$$

The HL-model is estimated for supermarket visitors. Due to the volume of purchases, supermarkets seems to be more related to the parking situation than other kinds of stores (East et al., 1995). This is supported by research findings of Marjanen (1997) who found that in contrast to other shoppers supermarket shoppers considered parking facilities as third important store-choice criterion after range of goods and price.

The data

The data for the analyses were collected in one of the major shopping centres (CityCentre Veldhoven) in the Eindhoven Metropolitan area. Approximately eighty-five business units with in total 15000 square metres retail floor space are situated in this shopping centre (Figure 1). Most units are located along a 400 m long central shopping street. The remainder of the units are located in adjacent streets only at a short distance from the central street. A supermarket is located at both ends of the central shopping street. The supermarkets belong to two different national retail chains (Torro and Albert Heijn). In the north-western edge of the area the city-hall, a theatre and a public library are located.

Several parking lots which are directly connected to the main road network surround the shopping centre. There are no on-street parking facilities. The number of spaces per parking lot ranges from 15 to 244. The parking lots also differ in term of maximum allowed parking duration, distance to the various shops in the shopping centre, location vis-à-vis the origin of consumers, and design. The use of the parking facilities is free. Between 1988 and 1993 the parking situation in the surrounding of the CityCentre has changed. The total number of parking spaces remained approximately the same. However, the distribution of the parking spaces has changed considerably (compare Figures 1 and 2). In 1988 there were 7 parking lots available with in total 990 parking spaces. The number of parking lots in 1993 was also 7 with 960 spaces. Two parking lots (P6 & P7) were closed and two new parking lots (P8 & P9) were built in the north-western edge of the shopping area. This change in parking situation implies that the relative location of the Torro in regard to parking spaces decreases and the relative location of Albert Heijn increases. For example, the number of parking spaces within 200 meter distance from the Torro decrease from 609 to 459 spaces, while the number in the surrounding of Albert Heijn increases from 379 to 489 spaces.

In 1988 on-street interviews were administered among motorists who were leaving the shopping centre. This data set is used to estimate the supermarket and parking lot choice model. The data used to validate the model were collected in 1993. In both interviews, questions were asked about parking choice, knowledge about parking facilities, and stores visited. Table 1 shows the distribution of the respondents for both samples in terms of the main purpose of their visit and the number of parking lots they are familiar with. In the spring of 1988 a total of 816 consumers collaborated in the survey. The data of 414 consumers were used to estimate the HL-model. The consumers visit at least one of the supermarkets and are familiar with more than one parking lot. The data of 155 consumers were selected from the 1993 sample as a validation sample.

Modelling parking lot and supermarket choice

In this study it is assumed that the choice of supermarket is related to the choice of a parking lot. Grocery shopping behaviour does not involve a substantial degree of comparative shopping. Moreover, the items bought are often heavy to carry. Hence, we postulate that the distance between a parking lot and a supermarket influences both store and parking lot choice probabilities. We also estimated a dummy variable to test for any differences in attractiveness between the two supermarkets. In addition, we assume that the number of parking spaces, the facilities for supermarket trolleys, and the location of the parking lot vis-à-vis the origin of the consumer, is influential in choosing a parking lot.

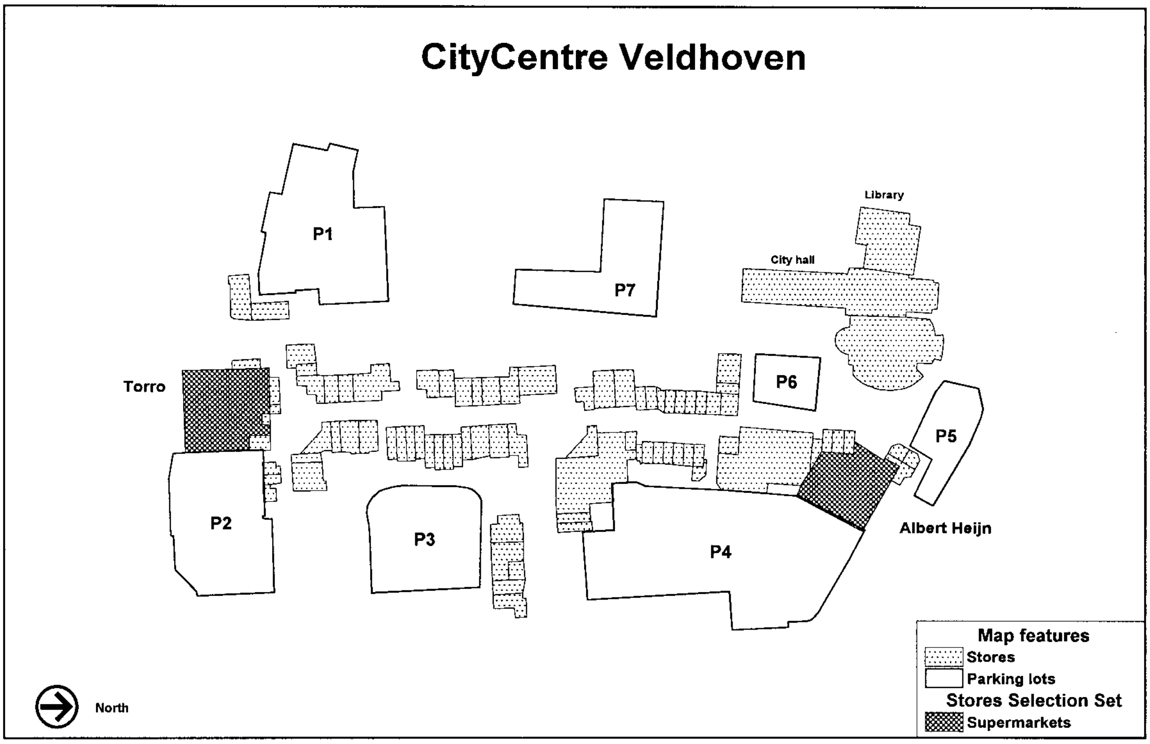

Figure 1. City Centre Veldhoven and the location of parking lots and supermarkets, 1988

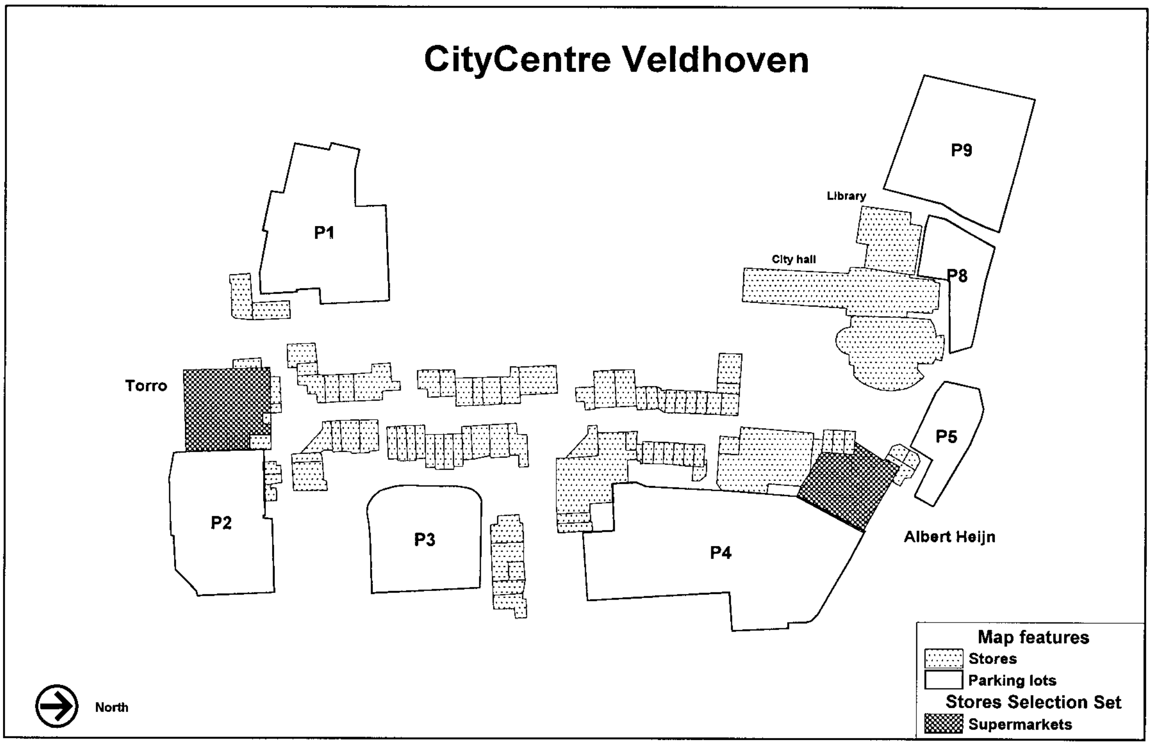

Figure 2. City Centre Veldhoven and the location of the parking lots and supermarkets, 1993

Table 1. Distribution of respondents of the Veldhoven data sets

1988 data set				1993 data set			
816				426			
supermarket visitors		other visitors		supermarket visitors		other visitors	
487		329		173		253	
1 P-lot	>**1 P-lot**	1 P-lot	>1 P-lot	1 P-lot	>**1 P-lot**	1 P-lot	>1 P-lot
73	**414**	85	244	18	**155**	39	214

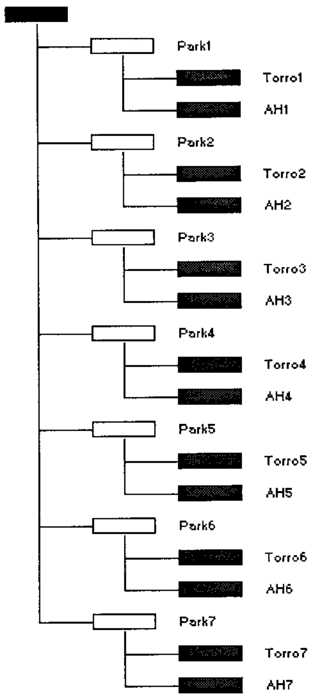

Figure 3. Structure of the hierarchical logit model for parking lot and supermarket choice.

Table 2. Estimation results of the hierarchical logit model for parking lot and supermarket choice

Attributes	Parameters	*t*-statistic
Supermarket constant	−1.0772	−4.496
Distance Parking lot – Supermarket	−0.0098	−10.640
Number of spaces	−0.0036	−3.008
Location of the Parking lot vis-à-vis origin	0.1646	1.989
Facilities for supermarket trolleys	0.7076	3.804
Theta	0.2023	6.094
Log-Likelihood LL(0)	−659.461	
Log-Likelihood LL(β)	−465.679	
Log-Likelihood ratio	387.564	
(critical chi-square for $\alpha = 0, 05$)	12.59	

To test these hypotheses a hierarchical logit model is estimated. Hierarchical logit models assume that consumers are engaged in a sequential decision-making process. For example, they may first choose their preferred supermarket and then dependent in their choice of supermarket, choose a parking lot. Alternatively, the choice of parking lot may overrule the choice of supermarket. To test these different choice processes a series of hierarchical logit models was estimated. Figure 3 captures the best fitting structure which acknowledges that the consumers consider the supermarkets as more similar than the available parking lots.

As illustrated in Table 2, the parameter of the inclusive value (Theta) is significant and equal to 0.2023, providing evidence of utility-maximising behaviour. Most estimated parameters are in the anticipated directions. The negative sign of the supermarket constant suggests that consumers tend to prefer AH over Torro. The negative distance parameter indicates that an increase of the distance between a parking lot and a supermarket results in a decrease of the utility of the supermarket in relation to that specific parking lot. Surprisingly, the parameter for the number of parking spaces is negative and significant. Perhaps this result means that consumers tend to avoid large parking lots and hence risking long walking distance. This choice mechanism apparently is more important than the chance of finding a free parking space. The positive sign of the location parameter means that consumers prefer mostly parking lots located between their home and the shopping centre. Also the existence of facilities to leave the supermarket trolley after shopping at the parking lot increases the utility of a parking lot.

The log-likelihood ratio test indicates that at the conventional 5% significant level the estimated HL-model explains the parking lot and supermarket choice better than the model with all parameters equal to zero. The rho-square of the model is equal to 0.294, which is not unsatisfactory.

Under the assumption of utility-maximisation a comparison of observed and predicted parking lot choice of supermarket visitors can be presented (Table 3). This table shows that the HL-model predicts a somewhat more rigid parking lot and store choice behaviour than observed.

Model validation

The estimated HL-model is applied to the new situation of the City Centre Veldhoven. For this situation there are observations available of 155 consumers. The external validation of the model results into a log-likelihood of −235.642. A comparison with the log-likelihood of the null model (*LL*(0)) indicates that the prediction results of the HL-model are significantly better than those of the null model.

Table 3. Observed and predicted parking lot choice of supermarket visitors in 1988 (percentages)

Parking lot	Observed		Predicted	
	Torro	AH	Torro	AH
P1	15	0	13	0
P2	28	0	40	0
P3	4	2	1	0
P4	1	18	0	9
P5	0	19	0	36
P6	0	5	0	1
P7	4	4	0	0
Total	52	48	54	46
Total	100		100	
Number of motorists	414		414	

Table 5. Observed and predicted parking lot choice of supermarket visitors in 1993 (percentages)

Parking lot	Observed		Predicted	
	Torro	AH	Torro	AH
P1	10	0	4	0
P2	21	1	46	0
P3	7	3	0	0
P4	6	36	0	11
P5	0	12	0	39
P8	1	3	0	0
P9	0	0	0	0
Total	46	54	50	50
Total	100		100	
Number of motorists	155		155	

Table 4. Goodness-of-fit of the model validation

Goodness-of-fit	Value
Log-Likelihood $LL(0)$	−296.523
Log-Likelihood $LL(\beta)$	−235.642
Log-Likelihood ratio	121.762
(critical chi-square for $\alpha = 0.05$)	12.59

From Table 5 it can be observed that the model predicts the choice between Torro and Albert Heijn reasonably well. However, the prediction of the parking lot choice is too rigid. According to the model only two parking lots seem to be relevant for each supermarket. For the Albert Heijn supermarket, the order of preference for P4 and P5 is even reversed to what was observed.

To summarise, this validation has shown that even when a model reproduces the estimation data pretty well, it is not able to reproduce the validation data at an acceptable level. This might be due to the model, however, other effects might play some role. For example, the distribution of the observations in the before and after situation might differ over time of the day (morning, afternoon, evening). or days of the week. An other cause might be that the supply of shops changed during the period between the before and after observations.

Discussion

Although real estate experts, marketers and urban designers emphasise the importance of the relationship between the location of supermarkets and other stores and the locations of parking lots, better empirical research has to be conducted to test this relationship, especially in a before-and-after study. The purpose of the study was to fill this gap in our empirical knowledge. A hierarchical choice model was estimated to test the hypothesis that (i) consumers choice of supermarkets is influenced by store characteristics and the distance between the supermarket and the parking lot, (ii) that the probability of choosing a parking lot increases with an increasing size of the parking lot, a positive location of the parking lot vis-à-vis the origin of the consumer, and the availability of supermarket trolleys, (iii) that a sequential decision making process represents the choice process reasonably well, and that (iv) this relationship is relatively constant over time.

The results of our analysis show that these hypothesis are partially supported. The consumers choice of supermarkets is influenced by store characteristics and also by parking lot characteristics. Most influences are as expected, except the one for the number of parking spaces. The probability of choosing a parking lot decreases with an increasing size, suggesting that customers want to avoid long walking distances. The estimation results indicate that a sequential decision making process represents the supermarket and parking lot choice process well. However, this relationship is not constant over time.

The model described in this article is just a first attempt to get more insight into the relationship between store choice behaviour of consumers and the parking situation surrounding a shopping centre. Suggestions for future research include additional characteristics of parking lots like parking tariffs and traffic circulation, additional characteristics of the shopping centre such as location of other stores vis-à-vis the supermarkets and the parking lots, other modelling approaches like probit models, and extension of the model with a choice set and a mode choice part.

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