Estimate impact of slot availability on customer demand by using choice-based demand models

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Project Background

The increasing sales through online channels has made large supermarket retailers seek new strategies to meet this surging customer demand in online grocery shopping. However, no matter what new service retailers aim to provide on e-fulfilment, it is important to strike the balance between delivery efficiency and customer satisfaction. A suggested approach is to adopt revenue management techniques to help better understand customer choice behaviour towards delivery time selection considering slots availability and their prices. This research sought to demonstrate that it is useful to analyse the impact of slot availability and price on customer demand for delivery services. It also presented methods to assist the planning of resource allocation and capacity management policies to improve the efficiency of services.

Data and Methods

Data used for this research was collected from Sainsbury's nationwide online transaction records over a period of 26 days, from March 12th 2017 to April 6th 2017. It included information considered relevant for customer decisions, such as slots availability and their prices. The provision of slot information for non-purchasing customers gave a better theoretical basis for the analysis since it avoided the approximation for the non-purchase behaviours.

Two independent multinomial logit (MNL) models were used to estimate the complete delivery slot selection process, one focused on the day whilst the other considered the slot selection. Although both models are independent, their results can be combined to calculate the likelihood of a customer choosing any slot throughout the week. Factors that were used as variables for the delivery day selection MNL model were capacity ratio (% of available slots on a delivery day), price average and customer arrival day. Factors that were assumed to affect slot choices were slot availability and their prices.

Two validation methods were used to assess the predictive powers of the models. The first method compared the modelled results between the estimation data set and validation data set, while the second approach compared the computed model results with real data of slot selections.

Key Findings

The results from both MNL models provided significant insights on customer choices. The results from the delivery day selection model indicate that when all slots are available, most demand fall on the first three days (78%) upon customer arrival, and there is a 13.72% chance that a customer will not pick any slot. As the capacity ratio of each delivery day is lowered in turns, this probability rises but does not exceed 20%. However, it is indicated that a decrease in capacity ratio of delivery days closer to customer arrival results in a greater negative impact.

The delivery slot selection model results comprised two parts. Firstly, without considering price, findings identified that customer behaviour towards delivery slots varies significantly between weekdays (Monday to Thursday) and weekends (Friday to Sunday). Morning slots were found to be more popular than the others during the weekend, while early afternoon sessions were more popular through weekdays. After introducing differentiated prices as a leverage to smooth demand, the choice behaviours were found to be altered and more balanced. Another interesting finding was that with and without price impact, half hour slots (e.g. 13:30 – 14:30) were found to be usually less popular than their closest hourly slots (e.g. 13:00 – 14:00).
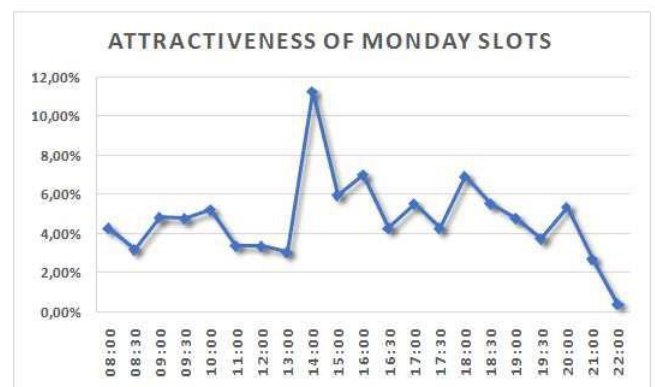

Figure 1. Estimated attractiveness of Monday Slots

Value of the Research

The impact of slot availability on demand can be inferred by combining results from the delivery day and delivery slot selection models with demand forecasts. These insights are valuable in daily delivery capacity management and for improving service delivery. For instance, the results can be used for an effective resource allocation policy focusing on client satisfaction and delivery capability. The results also provided further evidence on MNL models suitability in estimating consumer behaviour, especially in the field of e-fulfilment where validation tests are rarely published.