STUDENT AWARDS

Quality in parking

FACTORS AFFECTING PARKING DEMAND

Student information
Author; Jakub Romaszewski
Institution; Erasmus University Rotterdam
Graduation year; 2014

Analysis of the parking demand for Q-Park car parks in Rotterdam

This paper sets out to explain the factors affecting parking demand. Specifically, the case of Q-Park in the city of Rotterdam is examined, in order to see what factors affect the number of cars leaving the car parks, as well as parking duration. This is done by distinguishing between internal factors, under the control of the parking operator, and external factors, which are determined by the outside environment. The study of these factors will allow to see what factors parking operators should consider to be important in their business, as well as how these can be used to reach company specific goals or objectives.

Literature review

The first step is the literature review, which highlights the study of parking price elasticity, as the main internal factor affecting parking demand. Research finds that price elasticity changes occur over time, and hence the necessity of considering these effects is highlighted.

Furthermore, **price elasticity is found to be inelastic for parking demand**. With regards to external factors, literature on the matter is quite scarce, and hence reasoning is used in order to come up with external factors that may have an effect on parking demand. These are concluded to be location desirability, built up from several indicators, as well as income.

Data from Q-Park and the city of Rotterdam

Next, data from Q-Park is used to account for the internal factors, while data on the external factors is collected from the city of Rotterdam database. This data is determined to fit a panel data analysis, and hence the fixed effects Error Correction Model is constructed.

This model is able to estimate the short run and long run effects of each variable, and is estimated for the number of cars leaving on weekdays, number of cars leaving on weekends, and parking duration.

The model finds **price elasticity to be a significant factor only in the parking duration and weekend model**, although it is highly dependent on the time and location.

The external factor number of households is found to be a significant factor affecting parking demand in both the weekday and weekend models, along with the number of companies and employment being significant in the weekend model, but all external factors lack significance in the parking duration model. The exception is the monthly external factor dummies, which show differing levels of significance for different months in each model.

Price elasticity, time and location

The paper concludes to find that price elasticity is an important factor to consider, but is highly volatile depending on time and location. Furthermore, the number of households has a significant effect on parking demand, although it differs between the weekdays and weekends. Trends of external factors however can be used in order to find suitable location for parking garages. Furthermore, price elasticity can be used in order to maximise certain company specific goals, such as high profits or high occupancy rates. These do however require more flexible parking policies.

"Price elasticity is an important factor to consider, but is highly volatile depending on time and location."

PREDICTING PARKING SPACE OCCUPANCY

Student information
Author: Robert Boer
Institution: Erasmus University Rotterdam
Graduation year: 2017

Know before you go: predicting parking space occupancy by exploiting publicly accessible data

Global urban population is growing at rapid pace and as a result, the demand for mobility in urban areas is exploding. Nowadays, road networks become increasingly congested and as a consequence massive amounts of time, fuel and money are wasted. In certain urban areas, 30 to 45% of overall traffic is caused by cars in search of a parking space.

In an attempt to guide motorists towards vacant parking spaces, existing solutions provide real-time parking space availability information. These solutions are far from optimal, as the information disseminated might have already become obsolete by the time of arrival.

It would therefore be of great benefit to motorists when parking space availability upon arrival can be predicted in an accurate manner well ahead of time.

Although previous research has attempted to predict parking space by including external variables in predictive models, it falls short in attributing significant attention to the identification of external variables that are capable of improving accuracy obtained from prediction algorithms.

Furthermore, prior literature has failed to investigate the impact of extending the time horizon of predictions on the prediction error of the models.

In order to close these gaps in literature,

1. we identify to what extent the inclusion of external, publicly accessible data in the parking space prediction model influences its predictive performance and
2. we assess the effect of extending the forecasting horizon up to 24 hours on the predictive performance of parking space prediction models.

Inclusion of external variables

For this purpose, we leverage data on three distinct parking facilities in the city of Amsterdam, the Netherlands. Our research shows that the inclusion of external variables in prediction models for parking space occupancy can significantly improve its performance. Compared to baseline models that only leverage historical occupancy, we are able to reduce error rates with up to 49.15% by including external variables.

However, the choice for which external data sources to include in these models is heavily dependent on the parking facility studied and the predictive modelling technique used. Nevertheless, we find evidence that including Fourier terms as external variables leads to improved forecast accuracy in nearly all situations.

Inclusion of event information

Furthermore, we find that the inclusion of event information as external variables in Artificial Neural Networks leads to significant forecast improvements, particularly for parking facilities situated in areas where (large-scale) events happen on a regular basis.

Moreover, we find that including all external variables into the predictive model, does not necessarily lead to the best predictive model in terms of accuracy.

Furthermore, our results show that, although forecast errors increase rapidly for small step ahead predictions, error rates typically converge to a stable and acceptable maximum error rate after predicting six hours ahead of time. This paves the way for informing motorists by disseminating parking space predictions in real time via web-based - or smartphone applications or other media.