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# PARKING DEMAND

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## EFFECTIVENESS OF DOWNSIZING



# DEMAND

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Graduation year: 2014

### On the effectiveness of downsizing: New evidence from the service industry

“The behavioural revolution” in economics has brought about a shift in economic thinking and modelling away from the traditional assumptions of fully rational individuals to a more realistic set of assumptions incorporating aspects of bounded rationality.

This development has led to the questioning of many well-established economic “rules” which had been found not adequately reflect individuals’ behaviour in a real world environment. In this spirit, our study challenges the traditional belief of the neutrality of price framing and the related proposition of rational choice models that claims unit prices to be the final standard of judgment for consumers.

More precisely, we investigate if individuals are more sensitive to a unit price increase induced by an increase in the labelled price than to an equivalent decrease in quantity. Our preferred model provides some support for this view.

### An effective strategy

Using a large panel dataset on parking prices and transactions and estimating a dynamic two-way fixed effects model, we find that consumers indeed show significantly less sensitivity to a reduction in the length of the time intervals than to an equivalent increase in the labelled price.

As a result, we suggest that downsizing, the strategy of increasing unit prices by shrinking product size and keeping prices fixed, is an effective strategy also in the service industry.





# FACTORS AFFECTING PARKING DEMAND

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## 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

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## 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, a significantly large amount of 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, currently 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

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time via web-based - or smartphone applications or other media.

# SOCIAL COSTS OF ON-STREET PARKING

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## The social costs of on-street parking: searching, policy and unpriced externalities

We introduce a methodology to estimate the marginal external costs of parking by extending the theoretical model introduced by Zakharenko (2016), which allows for endogenous parking durations.

### External parking costs

External parking costs encompass both additional in-vehicle search and walking time costs incurred by arriving motorists.

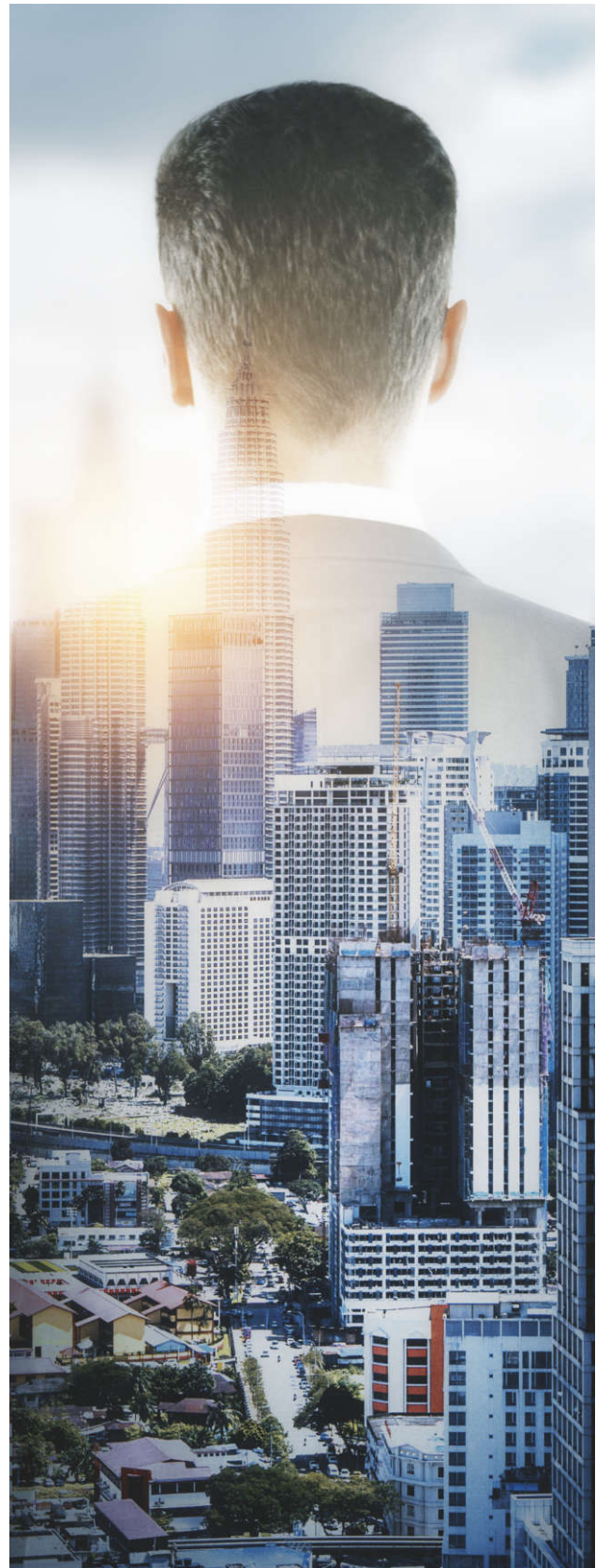
We show that the unpriced marginal externality is the key metric that parking authorities should use to inform their parking policies. We apply this methodology to the city centre of Melbourne, where strict time limits are combined with on-street parking prices that are below short-term off-street parking prices.

### Using parking externalities for parking policies

We demonstrate that generally parking externalities are low and far below their optimum, so relaxing many of the current parking time limits will increase welfare.

Alternatively, on Sundays in many areas parking externalities are high while parking is free, so introducing paid parking will also increase welfare.

Similarly on weekdays and Saturdays late in the evening just before restrictions end parking externalities are high, and so extending their hours of operation will also improve welfare.





# OPTIMISING REVENUES OF AIRPORTS

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## Optimising non-aeronautical revenues of airports: the case of Rotterdam The Hague Airport

This study examines the possibilities of optimising non-aeronautical revenues of Rotterdam The Hague Airport. This is done by assessing the price elasticities for all different segments over the years 2013 -2017.

Results indicate that price adjustments can be made to increase non-aeronautical revenues.

The overall price elasticity for parking on the airport is -1.13. This elasticity coefficient lies above unit elasticity, due the busiest months of the year.

In these months, relatively more leisure travellers, which are price elastic, are travelling via the airport.

Therefore, increasing the price in the busiest months is desirable due to possible capacity problems at the airport. In all other months, an increase of the price would result in an increase of revenues, due to the relatively inelastic coefficients of these months.

