Revenue Management in the Hotel Industry

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Summary and Conclusion

This dissertation proposed and analysed several revenue management models, with focus on the effects of cancellations, overbooking, customer purchase behaviour, and reviews, in presence of flexible products and group reservations in a network setting. Chapter 2 provided exploratory data analysis of an independent Dutch hotel, demonstrating how one should analyse client segment mix, the nature of demand, and effect of cancellations and group reservations, amongst others. The results showed that a major part (21.71%) of the reservations are cancelled, which has a big impact on revenues. Motivated by this, in Chapter 3 we proposed a single-leg revenue management model that takes into account cancellations and overbooking along with purchasing behaviour of customers. A dynamic programming formulation to solve the discretised Markov process suffers from the curse of dimensionality, since it has to keep track of the purchases of different product types. Therefore, three heuristics were proposed, each appropriate under different assumptions. Numerical results revealed that not taking cancellations into account can lead to a revenue loss of up to 20%.

Another result from the data analysis is that demand follows a Poisson Process, which implies relatively more uncertainty in demand for small hotels than for larger hotels. Therefore, revenue optimisation models, which generally attempt to optimise the *expected* revenue, should take this uncertainty into account, e.g., by using robust optimisation techniques. Chapter 4 (and Section 7.4) discuss robust optimisation techniques for revenue management models. Chapter 4 is devoted to a robust solution method for the single-leg choice-based RM model of Chapter 3. The uncertainty in customer purchasing probabilities is modelled using a ϕ-divergence measure, and tractable reformulations of robust counterparts are presented. A numerical study implies that using the robust solution method to model uncertainty in demand, e.g., due to estimation errors or the distribution of demand, can lead to significantly higher revenues than when the nominal solution is used.

Chapter 5 presented a network RM model that allows flexible products, which are common practice in TV and online advertising, and show potential to increase revenues in retailing and fast-moving consumer goods as well. Flexible products give the company the flexibility to assign the customer close to consumption to a selection specific products, as capacity allows. Moreover, since flexible products give the company this flexibility, it can ask for a lower price, which attracts new customer segments. Hence flexible products can lead to better capacity utilisation and higher revenues. The numerical studies endorse this by showing an increase in revenue of up to 20% when flexible products are offered alongside specific products.

A recent development that impacts revenue is the wide availability of reviews and online ratings. Chapters 6 and 7 proposed RM methodologies that model the effect of reviews on demand and the effect of the price/quality perception of clients on writing reviews. This feedback mechanism complicates the model, because demand depends on past reviews. For instance, by sacrificing revenue now, *long-term* revenue can be increased. Chapter 6 proposes a single-leg model with a novel solution method, to model the effects of reviews for amongst other theatres, concerts, sport events, or cinemas. The elaborate solution method can unfortunately not be used in the extension to networks Therefore, in Chapter 7 two heuristics are proposed, one of which deals with uncertainty in demand by means of robust optimisation. Results show a significant improvement in long-term revenue of up to 11%. Two insightful results from the numerics in Section 7.5 are that considering reviews has more impact when demand is low than when demand is high, relative to the hotel size; and that small hotels are more effected by reviews than larger hotels.

The results in this paper motivate future studies where challenges and opportunities in RM, observed by analysing practical instances and data, are exploited. The wide availability of data and technological advances provide great opportunities to perform research on customer behaviour and price sensitivity, and to develop new product types to conquer different market segments. In particular I would like to point out the opportunities of research on the effect of reviews on long-term revenue in *collaborative consumption* platforms. *Collaborative consumption* is the coordination of people to share products amongst relative strangers by means of the online sharing economy (Belk, 2014). Prominent examples of shared products are *temporary housing* (e.g., Airbnb, Couchsurfing) and *transportation* (e.g., Blablacar, Lyft, and Uber).

To continue in the spirit of the hospitality industry, consider the popular online mediation platform Airbnb. Airbnb allows house owners to host travellers, by offering them (a part of) their home (e.g., the whole house or a room) to spend the night, which otherwise would accommodate nobody. For example, when a house owner travels he can rent the house during that period to relative strangers; or a house owner can offer their guest room to travellers. A cornerstone of Airbnb is their reputation system, where both house owners and guests write reviews about one another and the stay itself (Edelman & Luca, 2014), which builds trust between house owners and guests. Guests are more willing to stay at a stranger's house when the house owner has a good reputation, and, vice versa, house owners are more willing to accept a stranger in their home when he has a good reputation.

House owners can offer competitive prices compared to established means of temporary housing such as hotels and hostels. It is beneficial for Airbnb to increase their market share, and pricing is an effective tool to reach this goal. Each property can be described by a vector of perhaps hundreds of features, including the space, facilities, geographical location; and demand may depend on many factors including seasonality, competitor prices, and reviews (Javanmard & Nazerzadeh, 2016). With this vast amount of information at hand, the field of RM has a great opportunity to grow by developing high-dimensional optimisation and statistical techniques that use this big data for accurate demand forecasts, price sensitivity, and, finally, for optimising long-term expected revenues.