Choice-set Demand in Revenue Management: Unconstraining, Forecasting and Optimization

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Chapter 9

Summary and Conclusion

The ambition of this thesis and the underlying research was to provide a practical feasible approach to estimate customer demand with information on the choice preferences, in order to understand the customer's decision process under offered alternatives. Beyond that, we aimed to develop and extend the major aspects of a RM system to use such advanced information on the customer demand to maximize the overall revenue or profit. Therefore, this thesis contributes mainly to the methodology of the revenue management areas demand modeling, forecasting and optimization; besides it contains also contributions to the general and theoretic body of RM.

Our proposed choice-set demand approach provides an intuitive and effective way to model the customer's choice behavior and preferences. The demand rate curves, which closely approximate the actual observed increasing demand characteristics, allow a straightforward demand estimation in non-observed periods. The proposed unconstraining algorithms require only data that is already practical available at companies, namely historical sales and offer data at some aggregated level. The unconstraining test on actual airline transaction data shows close approximations of the observed sales realizations and is therefore very promising. In the choice model comparison test on a hotel market, we find that the choice-set based model produces very good prediction results. After establishing and testing the demand unconstraining, we focused on the forecasting aspect. Usually in RM settings we have very long booking horizons and a common practical problem is the question of updating the forecast when new information becomes available, e.g., uncertainty becomes revealed by observed sales realizations. We propose a dynamic procedure for booking horizon forecasting, which is based on a forecast dimension reduction and an application of the penalized least squares method in the updating step. The test results on real hotel reservation data show a significant increase in forecast accuracy. To complete the considered revenue manage-

ment process, we focused lastly on the optimization aspect. In particular, we propose a new approach to compute time dependent bid prices in a network RM setting. In our model, we allow for multiple arriving customers per time stage and assume that bid prices are kept constant per period. These assumptions are often more realistic than the usual assumed setting with at most one customer arrival per time stage and the possibility to adjust bid prices at each of this tiny periods. The initial proposed deterministic optimization model is extended to consider stochastic demand information in form of scenarios, resulting in stochastic programming formulations. We further extend the time dependent bid price model to work with choice-set demand input in order to consider the customer's choice behavior under offered alternatives. Finally, we combined all three aspects, i.e., unconstraining, forecasting and optimization, in a simulation study. The objective is to estimate and test the effectiveness and potential of incorporating the choice-set demand approach in a revenue management application. We find that in the presence of actual buy-up possibilities in the market, the consideration of choice behavior in the optimization results in large revenue improvements. In addition, the time dependent bid price model generates considerable extra revenue gains. The proposed unconstraining algorithm estimates the actual demand curves per choice-set reasonably well and therefore provides a good approximation of the underlying demand.

To conclude, the choice-set demand model and its unconstraining, forecasting and optimization approaches provide a coherent and promising framework to incorporate the consideration of customer choice behavior into a real world revenue management applications. All approaches are developed with the focus on a practical application and require only already available company data.

The proposed approaches are already tailored for practical use. But because of the general and scientific scope of the thesis, they are naturally not directly implementable into a complex corporate environment. The models need to be adjusted to comply with actual application and company specific requirements and restrictions. Moreover, the revenue management system, with the pricing and sales control, sits at the heart of the company and is absolutely crucial for the firm's success or failure. Therefore, further testing on more realistic sized and problem specific settings is needed to evaluate the explicit revenue potential and the actual computational requirements, as well as to identify and resolve potential risks. Turning to the theoretic side, we find that further research is needed toward a new perspective on optimization models in network

RM. The pure revenue maximization objective must be changed to incorporate the demand exploration aspect, and possibly also with a concentration on risk averse solutions instead of the plain expected revenue target.