

## Performance of MNL and MMNL choice models in assortment optimization and product line selection

Product line selection or assortment optimization is among the most critical strategic decisions of firms. There are various versions of this problem in the literature under different choice behavior models (MNL, MMNL, etc.) and constraints (capacity, cardinality, etc.). Under MNL, optimal assortments can be found with efficient optimization algorithms; however, the same cannot be said for assortment optimization under MMNL demand. Chen and Hausman (2000) studied the product line selection problem combined with pricing decision under the MNL model. They formulated a nonlinear binary integer programming problem. After relaxing the binary constraint, they proved that due to some nice structures of the problem, the optimal solution to the relaxed problem is integral and a local maximum of the product line problem is also a global maximum for the problem. In case of heterogeneous consumer preferences, the MMNL model might be empirically more adequate to represent customer choice behavior. However, the resulting product line and price selection problem under MMNL choice is intractable, and mixed-integer linear programming (MILP) formulations of the problem can only be solved exactly for small-sized problems. Therefore, the question arises that if customer behavior is better represented by an MMNL model, which bias with regard to solution quality is made by using a single-segment MNL as an approximation to keep the product line selection tractable?

Further, when there are multiple segments of customers, the assortment optimization model can be solved specifically for each segment which is equivalent to the approach of Chen and Hausman (2000) and then the sum of segment-specific maximum profits is an upper bound on the optimal objective function value of the original problem where all segments are offered the same assortment. It is interesting to see how tight this upper-bound is from a practical point of view.

The objective of this thesis is to:

- review the recent literature on the assortment optimization and product line selection problem with a focus on MNL and MMNL choice models,
- use an application with parameter estimates of MNL and MMNL from a suitable empirical study from the literature (e.g., Keane & Wasi 2013) and implement the optimization problem once under MNL and once under MMNL choice model,
- calculate the bias with regard to the solution quality under the condition that a single-segment MNL model is used instead of MMNL (Your supervisor will provide some guidance on how to set up this experiment straightforwardly.),
- Assess the performance of the upper bound obtained from the sum of segment-specific maximum profits if compared to the optimal objective function value under MMNL choice.

### **Basic Literature:**

**Chen, K. D., & Hausman, W. H. (2000).** Mathematical properties of the optimal product line selection problem using choice-based conjoint analysis. *Management Science*, 46(2), 327-332.

**Keane, M., & Wasi, N. (2013).** Comparing alternative models of heterogeneity in consumer choice behavior. *Journal of Applied Econometrics*, 28(6), 1018-1045.

**Schön, C. (2010).** On the optimal product line selection problem with price discrimination. *Management Science*, 56(5), 896-902.