Performance of solution methods for assortment optimization problem under consideration of product-related fixed cost

Product line selection or assortment optimization is among firms' most critical strategic decisions. Offering more extensive assortments will usually better serve customer needs and thus might increase market share and bring more customer satisfaction. On the other hand, smaller assortments will minimize costs associated with design, manufacturing, distribution, etc.

Various versions of this problem exist in the literature with different choice behavior models (MNL, MMNL, etc.) and constraints (capacity, cardinality, etc.). Under the MNL model, optimal assortments can be found with efficient optimization algorithms. However, the same cannot be said for assortment optimization under MMNL demand, either capacitated or incapacitated. Additionally, mixed-integer linear programming (MILP) formulations of the problem are computationally challenging when applied to real-world problems. Sen et al. (2017) solve the constrained assortment optimization problem under the MMNL choice model by developing a novel conic quadratic mixed-integer formulation. Using commercial mathematical optimization software, many problems under the proposed formulation could be solved, and compared to the traditional mixed-integer linear programming (MILP) formulation, the proposed formulation performs far better.

In practice, it is common to consider the fixed costs associated with products in the model. Kunnumkal et al. (2009) show that if customers choose according to the MNL, the assortment problem with fixed costs for offering a product is NP-complete.

For the case where fixed costs associated with products are not considered in the model, Sen et al. (2017) showed their approach is superior to the MILP formulation. Now, the question is that considering fixed costs, how well can a conic quadratic mixed-integer formulation perform compared to the MILP formulation?

The objective of this thesis is to:

- review the recent literature on the assortment optimization and product line selection problem and discuss the approach of Sen et al. (2017) in detail,
- extend the model and method of Sen et al. (2017) to account for product- or resource-related fixed cost,
- implement and solve the extended problem with commercial solvers under both MILP and conic quadratic mixed integer formulation,
- explain the performance of the conic approach compared to MILP formulation in terms of solution time.

Basic Literature:

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