Assortment Planning with n-Pack Purchasing Customers

For many product categories, customers often buy multiple differentiated products on a given store visit for staggered consumption until the next store visit. This multi-item purchase behavior can be explained by a desire to avoid multiple trips to the store as well as a taste for variety (Simonson (1990)). Dubé (2004) study some of the top revenue-generating categories in the dry grocery department in U.S. food stores (specifically carbonated soft drinks, ready-to-eat cereals, canned soups and cookies) and find that more than 20% of shopping trips include multiple products being purchased in the same product category. Further, 61% of shopping trips for carbonated soft drinks result in the purchase of multiple kinds of products, that is, different flavors with possibly more than one item from each kind. According to Harlam and Lodish (1995), the corresponding number is 74% for yogurt, and is 78% for canned soup. Thus, retailers should take such basket shopping behavior of customers into consideration when making assortment decisions. Yet, most research on assortment planning has focused until now on models which assume single-unit purchases by all incoming consumers\(^1\).

In this paper, we study the assortment planning problem for a single product category when retailer faces multi-item purchasing, so called “n-pack” consumers as introduced by Fox et al (2017). With some mild assumptions on consumer behavior, Fox et al (2017) develop a choice model to obtain the expected value from consuming an n-pack, which we use as an input into our demand function for given assortment. We study the structure of the optimal assortment under two choice rules: consumers either purchase the maximum value n-pack with probability one (maximum choice rule) or they probabilistically choose between each possible n-pack using an attraction-based formula akin to the Multinomial Logit (MNL) model purchase probability equation (probabilistic choice rule). In addition, we explore how the retailer’s assortment decision and total profits are impacted when the retailer

\(^1\) One notable exception of the work by (Cachon and Kok (2007)) who consider the basket shopping behavior across product categories.
ignores a key feature of the n-pack choice model, called “choice premium”. Specifically, this choice premium captures the utility that consumers derive from variety in their shopping basket which allows them to hedge against future preference uncertainty. Moreover, we investigate the impact on the retailer’s optimal assortment and profits when he ignores the multi-item shopping behavior of consumers, i.e. when he assumes all consumers buys at most one unit from the product category on a store visit.

We summarize our results as follows. First, we find that, under probabilistic choice rule, the optimal assortment has the following structure: it includes a certain number of the most and least popular products (using the terminology from Alptekinoğlu and Grasas (2014), we say the optimal assortment is a “popular-eccentric set”). In contrast, under maximum choice rule, one can only guarantee that the optimal assortment includes the most popular product. These results on the structure of the optimal assortment differ from the well-known “popular set” result from van Ryzin and Mahajan (1999) who show that, when consumer buys at most one unit and their choice is captured by the MNL model, it is optimal to offer a subset of the most popular products. Under maximum choice rule, we propose a heuristic method for selecting an assortment and show numerically that it reaches 100% optimality of the problem instances we considered, although we were able to find some other ‘extreme’ examples where the algorithm was suboptimal. Further we obtain the structure of optimal assortment when the choice premium is ignored and when the multi-item shopping behavior is ignored. Specifically, when retailer does not take choice premium into consideration, the optimal assortment under the probabilistic rule is a popular-eccentric set but can be different from the optimal assortment when considering choice premium. Finally, we conduct a numerical study and find that under the probabilistic rule: the retailer may lose up to 1.67% in profit from ignoring the choice premium, and up to 4% from ignoring the consumers’ basket shopping behavior.
Our paper contributes to the literature in assortment planning in three ways. First, to the best of our knowledge, we are the first to use the novel model of consumer choice that is well grounded in the theory of shopping and consumption, namely n-pack consumer choice model from Fox et al. (2017), for assortment planning problem. We augment this model by considering two possible choice rules to calculate individual product demand. Second, we highlight an interesting and intuitive structure for the optimal assortment in a given product category, namely the popular-eccentric sets and prove its optimality when consumer choose probabilistically between all possible n-packs. Finally we highlight the need for retailers to incorporate consumers’ multi-item shopping behavior and the choice premium they receive when buying more than one unit on each shopping trip.

REFERENCE


