Title: An Optimal Assortment for Complements

Abstract:

Using complements is common practice in assortment planning: Restaurants offer meals with drinks or a music environment, and even allow consumers to bring their own wine. Department stores use one category as complement to the other categories to stimulate purchases. We consider complements in the canonical assortment model (van Ryzin and Mahajan 1999) wherein a newsboy stimulates purchases by offering complements.

van Ryzin and Mahajan (1999) show the optimal assortment when a retailer only has one category of product (distinguished by some attribute such as color or flavor). When the retailer has more than one categories, if those are independent categories, that is, a consumer gets zero bonus utility when s/he purchases them together, we can still use the approach by van Ryzin and Mahajan (1999) to solve the problem for each category respectively; If those are substitutes, nested logit model is widely used in literature (see Davis et al. 2014, Gallego and Topaloglu 2014, etc.).

If those are complements, that is, a consumer gets a positive bonus utility when s/he purchases them together, then what happens? Since now a consumer's decision in one category will be affected by the products in the other category, we cannot use the approach by van Ryzin and Mahajan (1999) anymore. For this reason, our paper studies how a retailer makes decision when there are more than one complement categories.

In this paper, we firstly consider the case that a store selling variants distinguished by some attribute such as color or flavor stimulates purchases by offering a complement gift with
purchase. An individual can receive a bonus utility with the gift by making a purchase in this store and thus is more likely to buy something. In this way, the attractiveness of products in the store gets improved while no extra inventory cost is needed. We regard the gift as a complement to the products in the store in a general way since it is free and brings positive extra utility.

In this case, we note that the bonus utility effect enables the store to achieve profit maximum by choosing the optimal amount of bonus utility. We show that there exists a positive bonus utility that maximizes the store profit under the minimal cost function assumptions. In practice, Sephora, Nordstorm and Barneys New York always offer "gift with purchase" for beauty products online. And Barneys New York uses the word "complimentary" for the gift with purchase.

Complements can also come from products from another category, and thus we secondly consider the case that a store sells products from multiple categories which are complements to each other. For example, department stores sell drinks and foods which are pairings to each other; Or they sell products which are not pairings but a travel cost can be saved by an individual who purchases them together and we regard the products as complements in a general way.

When there are multiple categories, the assortment decision in each category can be made by the store manager, which leads to a centralized setting. Or that can be made by the category managers, which results in a decentralized setting that is also called category management in literature (see Cachon and Kok (2007) and references therein). We obtain the Nash equilibrium for category managers in the category management problem where each manager stocks lower level of variety compared with the case of zero bonus utility.
We also show that the retailer uses lower variety with more categories of complements, and thus a department store usually uses lower variety in a category than a specialty store selling only that category products. We show that the number of variants stocked in each category under centralization is greater than that under decentralization.

Store profit under centralization is always higher than that under decentralization. We come up with the coordination mechanism which helps category managers to achieve store centralized profit under decentralization when there are multiple categories. The coordination mechanism requires equivalent transfer payment exchange between two category managers after the selling season. Although a category manager gains and loses nothing through the payment transferring, this rule motivates him to optimize the profits of other categories as well as the category of himself.

The following extensions are considered in our paper. First, we measure the benefit of incorporating the complementarity in the decisions. We investigate the profit loss when the centralized retailer ignores the bonus utility factor and optimizes the two categories separately. Second, we consider that complementarity is pair-specific. That is, combining different pairs from two categories will give a consumer different values of bonus utility. Third, we also consider heterogeneous consumers who have different values of bonus utility for the same pair of complements, which helps to explain the basket shopper phenomenon in literature.