Product Bundling: Consumer Behavior and Optimization in Scale

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Abstract

In this talk, we will present our findings from two recent papers on bundle promotions. Bundle promotions can take various forms in how retailers offer them to the consumers (i.e., after a purchase incidence, as advertised deals or personalized promotions) and how they are structured (e.g., buy one get one free, spend $100 get 25% off or buy 3 get $20 off). They have become increasingly popular among brick-mortar and online retailers due to a potential increase in revenue and profit. Designing an optimal set of bundle promotions in scale and understanding consumer response to these promotions are very relevant but challenging problems due to the non-linearity of the promotions.

In the first part of the talk, we present our empirical findings on how bundle promotions affect consumer purchase and return behavior compared to markdowns, using a large apparel brand’s in-store purchase and return panel data. Existing literature focuses on the impact of bundle discounts on purchases and concludes that bundle discounts improve revenues due to the increase in order incidence. In this work, we show that bundle promotions increase the incidence and decrease the return probability of each product compared to products sold with markdowns, controlling for price, discount depth, and item characteristics. We find that returns of products purchased with a bundle discount decrease on average by 21% compared to returns of the same products while purchased with a markdown discount.

In the second part, we study the optimal design of bundle promotion sets in scale. The general bundle set selection problem is NP-hard. We develop pseudo-polynomial ($O(mK^4)$ where $m$ is the number of products, and $K$ is the size of the bundle promotion) and polynomial-time algorithms ($O(m \log m K)$) for the special cases of the problem. We use the insights from the special cases to develop a linear time approximation ($O(mK)$) with a performance guarantee under some assumptions. We test our algorithms in medium to large instances and show that their performance is close to optimal. We also present insights on when bundle promotions are most useful to the firm. We find that connectivity of product graphs (i.e., products $i$ and $j$ are connected in the graph if they are purchased together) and the strength of the connection (i.e., how often they are purchased together) are the main factors that derive the magnitude of the revenue improvement. We also find that allowing for multiple bundle sets can strictly increase the expected revenue, and the increase can be arbitrarily large. Last, we study the problem of offering product-personalized bundle promotions and design algorithms that find optimal solutions for this problem in polynomial time.

Joint work with Wedad Elmaghraby, Ali Fattahi, Sahar Hemmati.

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