When Prospect Theory Meets Consumer Choice Models:  
The Role of Reference Prices

Reference prices are the points against which consumers evaluate their willingness to pay for the products they are considering. Reference prices may arise in several scenarios and can be influenced by time or context. Repeated consumers may remember the prices encountered on the past purchase occasions; for example, historical prices or future price trajectory may also be available online for certain products. A temporal reference price is formed by past prices; consumers adapt to or assimilate past prices of the product they purchased or considered. In these cases, when evaluating a product, the consumers may take its historical prices into account, in addition to the product’s attributes and current price. The literature refers to this effect as *internal* or *temporal* reference price. However, it is documented that consumers have consistently demonstrated a limited ability to recall past prices they paid before, so the accuracy of the internal reference prices may be in doubt; see, e.g., Dickson and Sawyer (1990).

We consider other definitions of what constitutes a reference price. Unlike time in the past prices, context refers to the prices of other products in the same or similar category in a store at the point of purchase. Some consumers evaluate the price of a product by comparing with the prices of other products on the shelf. When the consumers make a choice among multiple similar products, the prices of other products may also be taken into account in the evaluation of a particular product. The external information on other products in this purchase environment determines what consumers think they should pay for a particular product, which impacts their choice behavior. Similarly, this kind of effect is called *external* or *contextual* reference price. Because the formation of an external reference price involves a comparison between the price of a product and the current prices of other products, it captures the effects of this reference price across products; see, e.g., Mazumdar and Papatla (2000).

How do consumers form their external reference prices? Are these reference prices mostly related to the lowest, the highest, the median, the average market prices or the price of a particular product? The lowest price may play an important role in product evaluation, because it is often featured in local newspapers or displayed in the best shelf location. The price of a particular product/brand may form another reference price in some consumer choice scenarios. In addition,
assortment variety may also affect the evaluation of certain products. In this paper, we incorporate reference prices into consumer choice models, validate their importance by empirical study and investigate the impact of various external reference prices on consumer choice behavior, as well as on assortment planning and pricing.

The multinomial logit model has been widely used as a model of choice behavior (see, McFadden 1974), but it exhibits a restrictive substitution pattern, known as the independence of irrelevant alternatives (IIA) property, a special case of the so-called simple scalability; see Tversky (1972). Simple scalability implies the order of the choice probabilities for two alternatives – not necessarily the ratio – is independent of the offer set or the attributes of other alternatives. In particular, if one alternative is preferred to another in one scenario, it is preferred in any other scenario. However, the order of choice probabilities does not necessarily hold if a reference price exists. If the changes of the offer set or prices of existing products lead to a dramatically different reference price, the preference order may reverse, because the changes of utility or disutility due to the reference price may overwhelm others.

Under many other consumer choice models including the multinomial logit and preference-based choice models, consumer surplus is always higher as more products are offered or the attractiveness of some existing products is higher by, for instance, increasing feature values or decreasing prices. Different from these choice models, the “more is not always better” phenomenon may happen under the reference-dependent choice models; that is consumer surplus may be lower due to the effects of different reference prices by changing offer set or prices of existing products. The choice models with reference prices allow more flexible substitution patterns.

Our empirical study on a data set about consumer choices for ketchup brands shows that incorporating reference prices into choice models can significantly improve the goodness-of-fit and prediction accuracy of consumer choice behavior. Moreover, the reference prices (e.g., the lowest price and the store brand price) play an important role in consumer choices for ketchup brands. In addition, we also show that failure to account for reference prices may lead to substantial losses in some scenarios, where the reference price effects indeed exist. Therefore, incorporating reference prices into consumer choice models and investigating the associated assortment planning and pricing problems is necessary.

In particular, if the reference price is defined by the lowest price, we show that a quasi-markup-
ordered assortment, which includes products following the markup-decreasing order plus at most one additional item, is optimal. For the pricing problem, we show that the same-markup/same-price policy, which charges the same markup for high-cost products and the same price for low-cost products, is optimal. For the reference price defined by assortment variety, the same-markup/same-price/same-markup policy is optimal: high-cost products charge the same markup; medium-cost products charge the same price that is equal to the reference price; low-cost products charge another same markup.

In the above discussions, consumers form their reference prices based on the offer set and product prices on a particular purchase occasion. In some other scenarios, firms may be able to choose the reference price or may have more direct influence on the reference price to some extent by, for instance, advertising or salesforce efforts. In particular, firms may advertise theirs products through multiple media or exert extra salesforce efforts to influence the reference price. As a result, the reference price may increase and consequently consumers’ willingness to pay may also increase. However, it may be costly to change the reference price. We also characterize the optimal reference price level if firms can directly choose it (perhaps) at a cost.

Reference price is a relatively new concept in the field of operations management, especially for revenue management and pricing under consumer choice models. We take the widely used multinomial logit model as a showcase to examine the effects of reference prices. Incorporating reference prices into other consumer choice models and investigating the effects analytically or empirically on choice behavior, assortment planning and pricing under consumer heterogeneity would be another interesting and useful future research topic.

References


