Analysis of consumers' purchase timing decisions

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The frequent practice of markdown pricing leads some customers to take advantage of lower prices. Compared to previous decades, more customers are willing to wait for discounted prices rather than purchase earlier at premium prices (Flickes 2001). Such forward-looking behavior requires consumers to face a trade-off. On the one hand, customers might increase their utility by waiting for high prices to decrease. By waiting, a consumer can enjoy a higher surplus, which is the difference between the market price and consumer's valuation for the product. On the other hand, while waiting, the desired product may stock out and then the customer will lose the chance to gain utility from forgone consumption. Balancing the gains and losses from waiting, a consumer has to decide when to stop waiting and purchase the product in the selling season. In order to capture this trade-off, in this paper the consumer sequential decision-making process is analyzed under uncertain product availability in a multi-period setting.

According to the National Retail Federation, department store sales of markdown goods increased within three decades from 6% in 1967 to 20% in 1997 (Merrick 2001). By 1998, more than 72% of all fashion items were sold at a discount compared to the less than 20% observed in 1950 (Phillips 2005). Exposed to customers' strategic waiting behavior, retailers try to keep less stock to avoid providing markdown sales below their procurement costs. Stocking low inventories together with the high uncertainty of consumer taste in the fashion industry may lead to additional inefficiencies in the market; For example, a retailer may hold a small size of inventory, stock out prematurely in the selling season, and end up losing potential sales. Diminishing profits from consumer strategic waiting have attracted attention from both industry practitioners and academics. Since increasing numbers of consumers wait for discounts rather than purchase at regular premium prices, some retailers (i.e., JC Penney) abandon markdown sales altogether to avoid consumer strategic waiting (Halkias 2012).

Academic researchers have studied various methods to mitigate customer strategic waiting behavior (Aviv et al. 2009). Strategic customer literature stems from Coarse's conjecture (Coarse 1972), which notes that consumers become intertemporal utility maximizers rather than instantaneous utility maximizers when they are able to anticipate markdowns over a selling season. The majority of this literature uses discounted expected utility (DEU) theory in a stylized two-period setting, which enables the analysis of market outcomes (i.e., sales, supply, demand). However, dependency of a consumer's purchasing decision on all expected future outcomes rather than on a single future period's outcome calls for a multi-period setting analysis. Analyzing a single consumer's purchase timing decision under a multi-period setting allows us to study demand dynamics in a disaggregated form.

Understanding demand characteristics is the key to provide accurate methods to mitigate strategic consumer waiting behavior. For this reason, analyzing a single consumer's sequential risky decision making process is our starting point. Focusing on a strategic customer's decision-making process allows the dynamics of sequential risky decisions over time to be studied. To capture these dynamics, our scenario is as follows. A strategic consumer wants to purchase a product, which is carried by a retailer with limited inventory over *n* periods in a selling horizon. The customer knows the current prices and future markdowns, which are announced by the seller at the beginning of the selling season. each period, a random number of other customers visit the retailer to purchase the product as well. After each period in which our focal customer decided to wait, the customer observes the remaining inventory and makes a new decision to wait or purchase. After each period, stock-out risk increases with decreasing inventory level. This setting enables us to structure an analytic model using DEU theory. In this way a more general aggregate demand model can be structured to incorporate intertemporal dynamics.

The above scenario contains a key feature. At the beginning of the selling season, the pricing scheme for the entire selling season is announced by the retailer. Since the prices are known at the beginning of the selling season, consumers know their surplus levels. Many retailers (i.e., Land's End, JC Penney) provide their pricing scheme at the beginning of a selling season (Aviv and Pazgal 2008). One may think that if consumers do not know future prices, the model setting could be more general. If consumers do not know their exact future pay-offs, their decision process can be based on their future expectations of the market price as well as their risk preferences. Since consumers may have different expectations for future prices and different risk preferences, each consumer's purchase timing decision is affected by both price expectations and risk preferences differently. In order to avoid the confounding effects of expectations of future surpluses on risk preferences, our scenario addresses this situation by letting the retailer announce the pricing scheme at the beginning of the selling season. This key feature enables us to identify an optimal threshold-type policy for customers to choose their purchase time in the selling season. For each period under a certain threshold inventory level, a customer should stop waiting and purchase the product. This threshold is affected by the customer's product valuation and discounting factor, the consumer's valuation discount for the forgone consumption per each waited period. The inventory threshold increases with both the increasing valuation and the discounting factor in our extensive numerical analysis.

Our contributions to the literature can be summarized as follows. A strategic customer's purchase timing decision is modeled using DEU theory. An inventory-based threshold-type optimal stopping policy, in which the customer can make optimal purchase timing decision, is identified.