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Price differentiated channel switching in a fixed period fast fashion supply chain

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ABSTRACT

Fashion products are characterized by short product life cycles and high market success uncertainty. An unsuccessful product requires multiple price discounts to clear inventory. Fast-fashion retailers use a variety of strategies to counter these uncertainties including: frequently changing collections, quick response sourcing, and data driven channel switching. This paper proposes a switching solution for the Fast Fashion Supply Chain (FFS) of retailers who have preordered an initial or block inventory, and plan to use channel switching as opposed to multiple discounting steps. We consider a retailer which ships product from a central warehouse to store/clearance and outlet channels. The FFS Multi-Channel Switching (MCS) problem then is to monitor market demand data, such that at the optimal period the store inventory is switched to clearance, and the warehouse inventory is switched to the outlet channel. Using a linear projection of the moving average demand trend, we estimate the remaining cycle revenue at any time in the cycle. Channel prices are fixed, and the remaining revenue is a concave function of switching time. Using a set of conditions the objective is further simplified into cases. The Linear Moving Average Trend (LMAT) heuristic prescribes whether a channel switch should be made in the next period. The LMAT was compared with the optimal decision, the No-Switch rule and an intuitive heuristic using a simulation experiment. The LMAT performed well and for most problems provided a solution within 0.4% of the optimal. Confirming the LMAT can readily and effectively be applied to real time decision making in a FFS.

1. Introduction

Rapid changes in consumer buying behavior coupled with supply chain redesigns, has motivated both existing and new retailers to adopt a variety of new inventory management strategies. These include omni-channel and multi-channel retailing which combines outlet and online stores with regular stores (Melis et al., 2015). Here we focus specifically on fashion goods, which are characterized by a short life cycle, high customer demand uncertainty, long supply lead times, and high price discounting after the regular selling period (Huang et al., 2014). Generally supply chains are concerned with demand variance, or periods of low demand followed by periods of high demand. In fashion the uncertainty is whether the product will or will not be a success. An unsuccessful product will then require multiple price discounts to clear the inventory. A new generation of retailers (e.g. Zara and H&M) have successfully developed and implemented fast-fashion supply chains (FFS) in an effort to reduce the use of discounting. These combine a variety of strategies including, frequently changing low-cost clothing collections that mimic current luxury fashion trends (Joy et al., 2012), quick response sourcing of products (Iyer and Bergen, 1997), and/or demand data driven placement of products in the appropriate retail channel. This paper considers the last strategy, whereby the retailer is able to use real-time market demand data to replenish the stores and sequentially switch product inventory to alternate retail channels. In a more traditional environment such decisions would be made on sales forecasts, such that store allocations are predetermined. When a product is unsuccessful then sequential markdown are the primary method to dispose the inventory. When the product is held back in the warehouse, then a data driven strategy would switch the store channel off and the outlet channel on.

Şen (2008) characterizes the fashion industry as having short product life cycles, volatile and unpredictable demand, and long and inflexible supply processes. They note that a fashion product is typically defined by a 10 week life cycle, with five selling seasons per year. Choi (2007) observe that demand uncertainty is a crucial and prominent factor in the stocking and pricing decisions for fashion retailers. In a traditional supply chain products are ordered several months in advance, and the success risk rests primarily with the retailer. In the more well-known FFS solution, as practiced by Zara, quick response sourcing is a key element of

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inventory risk reduction. Supply lead times tend to be relatively short such that the store is able to manipulate and align supply quantitates in response to the observed product demand. Stratton and Warburton (2003) found that fashion retailers prefer to assign fast-response products to local manufacturing in order to achiever shorter lead times. When this is not possible, then an alternative solution is to preorder a large quantity to meet the expected demand for the selling cycle. This is termed the wholesale purchase quantity and set by the store buyer or merchandiser. Since market success for fashion products is difficult to predict, the ordered quantity is often not sold at regular prices and has to be discounted. An FFS strategy then is to plan for a shorter product selling cycle, with more frequent style turnovers, so as to reduce but not eliminate the discounting risk. Products are then switched between channels in a market responsive strategy.

This paper proposes a multi-channel switching (MCS) solution for fast-fashion retailers who have preordered an initial or block inventory. These retailers plan to use channel switching as an alternative to multiple discounting steps. We consider the case where the retailer operates a centralized warehouse from which product is supplied to multiple stores plus several retail outlets. In a multi-channel setting the outlet could be an online store, where orders are fulfilled directly from the warehouse. The multi-channel model incorporates multiple retail channels which may or may not operate simultaneously. Here we are restricted to three sequential channels. At the start of the selling cycle the wholesale purchase quantity is delivered to the warehouse, from which small quantity replenishments are made to the stores. Product is sold in three sequential pricing channels with no overlap: regular store price, clearance store price, and outlet price. This is equivalent to a dynamic pricing model but limited to only two predetermined price steps. For the successful product case demand remains strong through the selling cycle, and all the inventory is sold in the regular channel. For the unsuccessful product case demand weakens early on and a significant portion of the inventory is sold through clearance and outlet. The FFS Multi-Channel Switching (MCS) problem then is to monitor real-time demand and store inventory, such that at the optimal period the remaining store inventory is sold at clearance, and the warehouse inventory is switched to the outlet channel.

The MCS objective is to maximize the total revenue. Using a linear projection of the moving average demand trend, we estimate the remaining cycle revenue at any time in the cycle. This estimate is shown to be a concave function of the switching time. Using a set of conditions the objective is further simplified. A heuristic solution is then developed to determine whether a channel switch should be made in the next period. A simulation analysis on a set of experimental problems with different demand behaviors is reported. These shows that the heuristic provides solutions within 2% of the optimal solution. The MCS problem has not been discussed previously in the research. We present a structural definition of the problem and introduce the key parameters and decision variables. The model is shown to complement other FFS solution methods, which focus on pricing and inventory allocation to stores. The MCS demonstrates the utility of channel switching to retailers transitioning to the FFS mode. Specifically it shows how they can leverage a price differentiated outlet or online channel to maximize revenues from less successful products.

2. Background

Several topics and problems related to FFS supply chains have been addressed in the literature. In the following subsections, we review two of these in the context of this research.

2.1. Fast fashion and quick response supply

Şen (2008) provides an extensive review about the US fashion industry and the supply chain driving it. They note that a quick response retailer will track sales at the store-level on a real-time basis, and maintain minimal inventories at the store. Zara is the most prominent example of an FFS model and key aspects are reported by Ghemawat and Nueno (2003). They observe that the FFS operations strategy combines two critical features: (i) quick response production capabilities and (ii) enhanced product design capabilities (Cachon and Swinney, 2011). Caro and Gallien (2010) found the Zara supply chain incorporates a forecasting model which would prescribe the initial block inventory, and an optimization model to control the warehouse to store replenishment once actual sales data is tracked. Iyer and Bergen (1997) discuss quick response supply from manufacturing to retailer channels in general, while Cachon and Swinney (2009) give a detailed explanation about the strategic customer behavior under quick response. Huang et al. (2014) derive a dynamic pricing model with partial backlogging to investigate the important factors that influence the replenishment cycle and profit. Caro and Gallien (2012) and Karakul (2008) show that regular demand behavior is a function of price and age of the product while clearance or discounted price is more difficult to manipulate. From discussions with leading fashion retailers Choi (2007) found that many use a two-stage stocking policy, whereby an initial block inventory is supplemented with a second stocking order using actual demand data. Pricing decisions were also made similarly. In these papers a primary focus is on real time inventory driven replenishment policy. Our model is similar in that we also consider the current store inventory and also generate a prediction of future demand. The proposed model though differs in that we consider the case where we can switch to an alternate channel which is price differentiated with stable demand.

2.2. Multi-channel distribution and multi-period retailing

In today's retailing environment retailers are leveraging their supply chains to expand sales volume and profit beyond their traditional store channels (Chiang et al., 2003; Ding et al., 2016). Several researchers have broadly studied customer behavior differences across channels and specifically looked at channel adoption, channel choice and usage (Verhoef et al., 2015). Innovations in retail promotions and expansion of outlet malls are providing new retail channels that are readily integrated into a multi-channel distribution strategy. Specifically dynamic pricing combined with targeted promotions can be used to effectively and quickly sell excess inventory (Grewal et al., 2011). Coughlan and Soberman (2005) present an analysis of two possible structures of dual-distribution through both regular retailer channel and outlet channel. One option is to sell in multiple channels simultaneously. Alternatively, the manufacturer or retailer can make sequential decisions in two or three channels. The identify possible decisions as (i) how much to distribute to a primary regular store channel, and (ii) whether or not to add an outlet into the distribution mix. The current omni-channel literature assumes parallel channels, our model differs in that we consider sequential channels with each displaying a different demand behavior. Our models differ in that the channels operate sequentially with no overlap, such that customers cannot exploit one channel against the other.

Two-period pricing models are widely studied in the literature, most of these consider the price to be the decision variable (Zhang et al., 2014). Zhou et al. (2015) consider a two period pricing model for launching fashion products. Three strategies are identified one of which is labelled the S-Strategy: that is the firm launches a new style and stops selling the previous one immediately. This operationally equivalent to the model developed here, in that the old design is shifted to another channel, so that the high value store channel is immediately focused on the new product. Similar to this research they observe that luxury retailers will sell then their discontinued styles in their outlet stores. Here we consider the price to fixed and decide on the switch time. Khouja et al. (2010) analyze channel selection and price setting of a manufacturer or retailer with several channel options. Most of the research is focused on the consumer pricing behavior, and assume a known price demand relationship. Here the demand is assumed to unknown, and channels decisions are made in real-time using tracked demand data. Others have considered channel entry decision, most commonly an online or direct