Decision Support

Pricing and assortment decisions for a manufacturer selling through dual channels

Betzabé Rodríguez [a,*], Göker Aydın [b]

[a] Department of Industrial Engineering, University of Puerto Ricso, Mayagüez, PR 00681, USA
[b] Kelley School of Business, Indiana University, Bloomington, IN 47405, USA

ABSTRACT

In many supply chains, the manufacturer sells not only through an independent retailer, but also through its own direct channel. This work studies the pricing and assortment decisions in such a supply chain in the presence of inventory costs. In our model, the retailer offers a subset of the assortment that the manufacturer offers through its direct channel. We model the customer demand by building on the nested-logit model, which captures the customer's choice between the manufacturer and the retailer. This model produces several insights into the optimal pricing strategies of the manufacturer. For example, we find that variants with high demand variability will carry a lower wholesale price. Furthermore, we characterize scenarios in which the manufacturer's and retailer's assortment preferences are in conflict. In particular, the manufacturer may prefer the retailer to carry items with high demand variability while the retailer prefers items with low demand variability.

© 2014 Elsevier B.V. All rights reserved.

1. Introduction

In a supply chain setting, the pricing of an assortment is a critical decision not only for the seller itself, but also for its supplier. This pricing question becomes even more critical in supply chains where the manufacturer is both a supplier to and competitor of the retailer. Take the relationship between Sony and Best Buy as an example; specifically the Sony VAIO E line of laptop computers. Sony's direct channel (SonyStyle.com) sells, at the bare minimum, 30 different configurations for the Sony VAIO E Series laptop. Naturally, a Best Buy store will not be able to offer nearly as many configurations. Motivated by such channel relationships, in this work we consider the pricing and assortment selection problems that arise in a supply chain where the manufacturer uses "dual channels", that is, a supply chain where the manufacturer sells directly to the customer as well as selling through a retailer.

The marketing literature suggests that a store's assortment is almost as important as its price profile and location in driving the store traffic, see, for example, Zhang, Kushwaha, Steenburgh, Farris, and Irvin et al. (2009) and the references therein. Hence, in this paper, we model the customer's choice of channel as a function of the assortment and prices offered by both channels. In particular, we use the nested-logit model to capture the consumer choice: The customer first chooses the channel she wants to purchase from (if any) and, subsequently, decides which product to purchase from her chosen channel. This demand model allows us to account for the effect of both channels' assortments and prices on the demand observed by each channel.

There are several assumptions one can make regarding who carries inventory in this dual-channel structure and where. In keeping with the motivating example, we consider a manufacturer (e.g. Sony) who sells a build-to-order product through its direct channel while meeting the orders from the retailer. As for the retailer (e.g. Best Buy), it is assumed that it keeps inventory of the final (assembled) products and meets the observed demand with this inventory. Because the retailer must make stock level decisions before observing the customer demand, there exists the possibility of demand-inventory mismatch at the retailer. Hence, our model accounts for the inventory-related costs associated with the demand-inventory mismatch at the retailer. We assume that when the customer demand seen by the retailer exceeds the retailer's inventory level, the retailer is allowed to procure additional products from the manufacturer. For example, if the demand of a specific VAIO laptop computer is greater than the amount Best Buy had in stock, then Best Buy could order additional units from Sony to meet the excess demand.

A strength of this model is that it allows us to analyze the effect of inventory-related costs on the pricing decisions. We find that the selling prices charged by the manufacturer's direct channel and the retailer follow an equal effective margin property similar to that described in Rodríguez and Aydın (2011). In addition, in this paper, we

* Corresponding author. Tel.: +1 787 265 3819.
E-mail address: betzabe.rodriguez@upr.edu (B. Rodríguez).

characterize the optimal wholesale prices the manufacturer charges to the retailer. For example, we find that, everything else being equal, the manufacturer will charge lower wholesale prices for variants with larger demand variability.

We use our model to study if the manufacturer benefits from selling through two separate channels. In practice one can find both success and failure stories about engaging in dual (or hybrid) sales channel strategies. For example, although Dell has been very successful selling directly to customers, in 2006 it saw its profits and market share decline significantly. The reaction to this decline came in 2007, when Dell successfully embraced a hybrid strategy by adding resellers to their channel mix. In contrast, by 2008, Gateway, another computer business, moved from engaging in dual sales channels to only selling indirectly to customers. Inspired by these examples, in this work we investigate the benefits of engaging in dual-sales channels.

For a build-to-order manufacturer and a retailer engaging in dual sales channels, another relevant question is what assortment to offer through the retailer. More often than not, the retailer offers only a subset of what the manufacturer's direct channel offers as indicated by the Sony VAIO example discussed earlier. Depending on the power structure in the supply chain, the retailer's assortment can be decided by the retailer itself or it could be dictated by the manufacturer. We study both options. Moreover, we study different sequences of decision-making that allow various scenarios regarding the timing of assortment and pricing decisions.

We first explore problems where there is no limit on the number of variants to carry. In such cases, we find that if the manufacturer's pricing decisions precede the retailer's assortment selection, both the retailer and the manufacturer will be best off by offering every available product. However, if the retailer's assortment selection precedes the manufacturer's pricing decisions, then the retailer may strategically leave certain variants out of its assortment.

We then study cases where there is a limit on the size of the assortment. When there is a limit on the size of the retailer's assortment, we find that the manufacturer and the retailer may disagree about which product to sell through the retailer, because the manufacturer prefers products with higher demand variability while the retailer prefers products with lower demand variability.

The rest of the paper is organized as follows. In the following section we review the related literature. Section 3 describes the model. The pricing problem is analyzed in Section 4 and the benefit of adding an indirect channel is analyzed in Section 5. In Section 6 we explore the assortment decisions. Finally, Section 7 summarizes the results and contributions. The proofs are provided as an online supplement.

2. Literature review

The analysis of distribution systems has received considerable attention in the operations and marketing literature. In the context of the broad literature on distribution systems, the problem studied in this paper belongs to the subset that deals with multiple-channel distribution systems, in which a supplier sells through more than one channel. Cattani, Gilland, and Swaminathan (2004) present an extensive literature survey on the coordination of multiple channels.

The multiple-channel distribution system studied in this paper belongs to the narrower subset of dual-channel systems, in which the supplier sells through two channels only. The interest in dual channel systems (which have also been labeled as "hybrid distribution") dates back to as early as 1965 (Preston & Schramm, 1965). However, the interest in dual-channel systems has been revived in recent years due to the tradeoffs presented by e-commerce. Swaminathan and Tayur (2003), Tsay and Agrawal (2004) and Agatz, Fleischmann, and van Nunen (2008) review the literature dealing with multiple-channels that arise in the e-business setting.

One could separate between two streams of work on the dual-channel distribution systems. The first stream of work deals with

questions surrounding how much to stock and where to keep that stock in the distribution system, see for example Moinzadeh (2002), Boyaci (2005), Alptekinoğlu and Tang (2005), Chiang and Monahan (2005), Seifert, Thonemann, and Seike (2006) and Schneider and Klabjan (2013). Another example is Zhao (2008), which adds the pricing problem to the inventory decision. In commonality with this work, we take into consideration inventory costs of the products offered. However, we simplify the inventory aspect of the problem by assuming that the inventory levels are chosen to satisfy an exogenously fixed service level and the only stock-keeping location is the retailer. These assumptions are in line with our motivating examples, which revolve around build-to-order manufacturers adding a retailer to their channel mix. The second stream of work in dual-channel systems deals with how the prices should be set and/or coordinated in this distribution system., e.g. Rhee and Park (2000), Yao and Liu (2005), Chiang and Chhajed (2005), Cattani, Gilland, Heese, and Swaminathan (2006), Kumar and Ruan (2006), Liu, Parlar, and Zhu (2007), Dumrongsiri, Fan, Jain, and Moinzadeh (2008), Huang and Swaminathan (2009), Hua, Wand, and Cheng (2010) and Chen, Fang, and Wen (2013). Our paper is related to this second stream of research in that we study, among other things, the pricing decisions in a dual-channel system. Earlier work that is particularly related to the type of pricing problems that arise in our paper are Chiang, Chhajed, and Hess (2003) and Tsay and Agrawal (2004), who treat the manufacturer's channel structure as a decision variable, i.e., manufacturer decides whether or not to use a dual-sales channel. They study the effects of the channel structure on the pricing strategies and profits. Tsay and Agrawal (2004) build on Chiang et al. (2003) by incorporating sales effort and the unit cost of supplying an item; however, they restrict the selling prices to be the same in both channels. Our work differs from Chiang et al. (2003) and Tsay and Agrawal (2004) in a number of ways. In particular, we incorporate demand uncertainty and we explicitly model the inventory costs associated with demand-inventory mismatches at the retailer.

This work also addresses the question of whether it is always beneficial to sell through dual-channels. There has been some work on the question of channel design, especially when considering the distribution costs, e.g. Rangan (1987), Chiang et al. (2003) and Bhatnagar and Syam (2014). In our case, we do not explicitly model distribution costs but we incorporate inventory costs and compare the expected profits for the manufacturer under both scenarios.

One important distinction between our work and the existing literature is that in our model each channel sells an assortment of substitutable products, and we analyze the assortment decisions.

3. Model description

Consider a product that can be purchased through two channels: directly from the manufacturer and through an independent retailer. Take a Dell Inspiron desktop computer as an example: A customer can purchase a Dell Inspiron computer directly from Dell.com (the manufacturer's direct channel) where the customer configures the computer by choosing from several colors, processor speeds, operating systems, memory and hard drive capacities. On the other hand, the customer may choose to purchase a Dell Inspiron from Best Buy (retailer) in which case she must choose from only a few pre-configured Inspiron computers the store carries in stock. In keeping with this scenario, we model a build-to-order manufacturer, who offers an assortment of all possible variants; we denote this set of variants with S^M. The retailer in our model, on the other hand, offers a subset of the variants in S^M and keeps stock of the variants it carries. Let S^R denote the set of variants carried by the retailer.

In our model, the pricing decisions available to the manufacturer are the prices for the direct channel, $\boldsymbol{p}_k^M$ for variant $k \in S^M$ (i.e. prices charged to the customers who purchase from the manufacturer), and the wholesale price charged to the retailer, w_k for variant $k \in S^R$. On