European Journal of Operational Research 205 (2010) 113–126

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Production, Manufacturing and Logistics

Price and lead time decisions in dual-channel supply chains

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ARTICLE INFO

Article history:
Received 17 September 2008
Accepted 9 December 2009
Available online 28 December 2009

Keywords:
Supply chain management
Dual channel
Internet/direct marketing
E-commerce
Game theory

ABSTRACT

Manufacturers today are increasingly adopting a dual channel to sell their products, i.e., the traditional retail channel and an online direct channel. Empirical studies have shown that service quality (we focus on the delivery lead time of the direct channel) even goes beyond product price as one of the major factors influencing consumer acceptance of the direct channel. Delivery lead time has significant effects on demand, profit, and pricing strategy. However, there is scant literature addressing the decision on the promised delivery lead time of a direct channel and its impact on the manufacturer's and retailer's pricing decisions. To fill this gap, we examine the optimal decisions of delivery lead time and prices in a centralized and a decentralized dual-channel supply chain using the two-stage optimization technique and Stackelberg game, and analyze the impacts of delivery lead time and customer acceptance of a direct channel on the manufacturer's and retailer's pricing behaviours. We analytically show that delivery lead time strongly influences the manufacturer's and the retailer's pricing strategies and profits. Our numerical studies reveal that the difference between the demand transfer ratios in the two channels with respect to delivery lead time and direct sale price, customer acceptance of the direct channel, and product type have great effects on the lead time and pricing decisions.

1. Introduction

The Internet has significantly changed customers' consumption patterns, and manufacturers' and retailers' sale models. Customers today have increasingly accepted and become accustomed to purchasing products online, which prompts more and more manufacturers to redesign their traditional sale channel structures by engaging in direct sale in order to reach different customer segments that cannot be reached by the traditional retail channel, expand market coverage, control sale price, and increase profits. Another reason for firms to expand to the online direct channel is that the Internet has substantially lowered the entry barrier (Choi, 2003). Online retail sales comprised about 5.5% of all retail sales excluding travel in the USA in 2004 (Mangalindan, 2005; Dumrongsiri et al., 2008). According to one survey, about 42% of the top suppliers in a variety of industries such as IBM, Hewlett-Packard, Nike, Pioneer Electronics, Mattel, Estee Lauder, the former Compaq, Dell, and Cisco System are selling directly to consumers through the direct channel (Chiang et al., 2003; Tedeschi, 2000; Tsay and Agrawal, 2004a,b; Wilder, 1999).

As more and more manufacturers are engaged in direct sale, their retailer partners resist the direct channel initiative because they perceive that the direct channel is bound to cannibalize their market shares. In fact, this is only retailers' psychological perception as studies have found that the introduction of the direct channel is accompanied by a wholesale price reduction, which can actually benefit the retailers (Chiang et al., 2003). Most important of all, customers prefer dual channels, which benefit them by providing more shopping choices and lower prices, so manufacturers are forced to or voluntarily introduce direct channels as a strategic necessity. Retailers have also realized that it is unwise to boycott the direct channel and drive customers to buy elsewhere (Hanover, 1999). So we suppose in this paper that dual-channel supply chains already exist even in the presence of channel conflicts.

Empirical studies have shown that service quality (Devaraj et al., 2002; Rohm and Swaminathan, 2004) and transaction costs (Liang and Huang, 1998) are the major factors contributing to consumer acceptance of the direct channel. There are indications that service quality even goes beyond product price as one of the main reasons for consumers' preference for the direct channel (Reichheld and Schefter, 2000). Delivery lead time is widely recognized as an important measure of the service quality of the direct channel, and it has significant effects on

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doi:10.1016/j.ejor.2009.12.012

customers' channel choice, demand and loyalty. Delivery lead time refers to the duration between the time when a customer places an order on the web to the time when he receives his goods, which includes the order handling time comprising the collecting time, binding time, and delivery time from the warehouse to the customer. Moreover, as the most important element of trust, the commitment to order fulfillment on the web can build customers' trust in the manufacturer and his web site (Urban et al., 2000). "Price does not rule the Web, trust does." (Reichheld and Schefter, 2000). This is why so many e-retailers, such as Amonzon.com, BestBuy.com, Walmart.com, and FYE.-com, are striving to offer competitively quoted lead times (Maltz et al., 2004). Studies have also shown that direct marketers can reduce consumer resistance to Internet purchases by reducing delivery times (Balasubramanian, 1998). However, a shorter delivery lead time would lead to increases in logistics costs and reductions in profit margins; conversely, a longer lead time would reduce customers' acceptance and loyalty to the direct channel. So, the decision on the delivery lead time of the direct channel is very important for dual-channel management.

In this paper we present an analytical framework for price and lead time decisions in a centralized and a decentralized dual-channel supply chain, provide a decision making aid for the manufacturer and the retailer, and analyze the impacts of delivery lead time and customer acceptance of the direct channel on the manufacturer's and retailer's pricing decisions. In a centralized dual-channel supply chain, a vertically integrated manufacturer controls all three decisions: the traditional retail price, the direct sale price, and the quoted lead time in the direct channel. In this setting, the structure of the supply chain and the decisions are the same as those of the "click-and-mortar" retailer such as Best Buy, Wal-Mart, and Barnes & Noble, so our results also apply to them. For a decentralized dual-channel supply chain, we formulate a Stackelberg game model, with the manufacturer as the leader, determining the delivery lead time, the sale price in the direct channel and the wholesale price, and the retailer as the follower, determining his own retail price given the manufacturer's delivery lead time and wholesale price.

Our findings show that delivery lead time strongly influences the manufacturer's and the retailer's pricing strategies and profits. Our numerical studies show that the difference between the demand transfer ratios in the two channels with respect to lead time and direct sale price, and customer acceptance of the direct channel have great effects on the lead time and pricing decisions. Since different products lead to different degrees of customer acceptance of the direct channel (Liang and Huang, 1998), product type has a great impact on the lead time and pricing decisions, too. Our numerical studies also show that the retail price may be set higher (lower) than or equal to the direct sale price in the centralized dual-channel supply chain, and the direct sale price may be set higher than or equal to the wholesale price in the decentralized dual-channel supply chain, which depend on customer acceptance of the direct channel (denoted by θ). Generally speaking, if the base level of demand in one channel is relatively high (e.g., higher than a threshold), the sale price in that channel should be set higher than that in the other channel. The lead time and the direct sale price in the decentralized dual-channel supply chain become closer to those of the centralized dual-channel supply chain with increasing θ. The wholesale price and the retailer price in the decentralized supply chain become closer to each other with increasing θ, too.

In the past few years, the dual-channel supply chain has gained much attention of the supply chain management research community. Tsay and Agrawal (2004a,b) provided a comprehensive review of quantitative approaches to modelling conflicts in multi-channel distribution systems and policies that may coordinate the actions of channel partners. Cattani et al. (2004) explored comprehensively recent research on coordination opportunities that arise for firms having the traditional sale channel, as well as the direct sale channel. Chiang et al. (2003) examined a price-setting game between a manufacturer and its independent retailer in a dual channel based on the consumer choice model. They found that the manufacturer is more profitable even if no sales occur in the direct channel. Cattani et al. (2006) and Huang and Swaminathan (2009) investigated the pricing decisions of the manufacturer and its retailers. Yao and Liu (2005) looked at price competition between the two channels using Bertrand and Stackelberg game models. Chen et al. (2008) investigated service competition in the dual-channel supply chain using the consumer choice model, where the direct channel's service is measured by delivery lead time, the retail channel's service is measured by product availability. They found that the manufacturer's optimal channel strategy depends on the channel environment. Different from Chen et al. (2008), we consider the manufacturer's price competition and service competition simultaneously using the demand model. We show that the lead time and pricing decisions depend on customer acceptance of the direct channel, and if customer acceptance of the direct channel is relatively high, then the direct sale price should be set high and the lead time set relatively long.

Our work is also related to previous research on lead time decisions. Liu et al. (2007) examined price and delivery lead time decisions in decentralized supply chains based on the Stackelberg game. Yang and Geunes (2007) studied inventory and lead time decisions with lead-time-sensitive demand. Lederer and Li (1997) examined the effect of lead time performance on price, demand, and profit. Palaka et al. (1998) and So and Song (1998) studied the optimal pricing and delivery time decisions that maximize the revenues of the M/M/1-type make-to-order system. Boyaci and Ray (2003) examined the price, lead time, and capacity decisions of two substitutable products for a firm with price- and time-sensitive demands. Keskinocak et al. (2001) developed two models to coordinate scheduling and lead time quotations. Hopp and Sturgis (2001) examined lead time-quoting polices that minimize the average lead time, subject to customer service constraints on fill rate, tardiness, or relative tardiness in simple systems with random processing times. The products in these studies were sold only through a single sale channel. Differing from their study, we examine in this paper the lead time decision in the dual-channel supply chain.

This paper is organized as follows. Section 2 introduces the notation and formulates the decision models for the manufacturer and the retailer, respectively. In Sections 3 and 4, we examine the price and delivery lead time decisions and analyze the impacts of delivery lead time on the pricing decisions of a centralized (vertically integrated) and a decentralized dual-channel supply chain, respectively. In Section 5, we report the results of numerical experiments carried out to examine the relationships between the lead time decisions and pricing strategies and investigate the factors that influence these relationships. We conclude the results and suggest topics for future research in Section 6.

2. The model

In this section, we consider a dual-channel supply chain consisting of a manufacturer and a independent retailer (see Fig. 1). The manufacturer sells to the retailer, as well as to the end customers directly. Customers may use either the retail channel or the direct channel to