



Pricing and service decisions of complementary products in a dual-channel supply chain



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ABSTRACT

This paper investigates the pricing and service decisions of complementary products in a dual-channel supply chain which consists of two manufacturers and one common retailer. One of two manufacturers distributes products through both the direct online channel and the traditional retail channel. Considering the efficacy of different supply chain structures and two types of channel pricing forms, four game models are established. By using the backwards induction and game theory, the corresponding analytical equilibrium solutions are obtained. Finally, numerical examples are presented to compare the effectiveness of optimal results, which gained from the model above and perform a sensitivity analysis of some key parameters, by which obtain some valuable managerial insights.

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1. Introduction

Recently, with the rapid development of the Internet, an increasing number of people has begun shopping directly on line. The expanding role of the Internet in business activity and consumer has created unprecedented opportunities for manufacturer to have easy and convenient access to consumer. According to the report from New York Times, there are approximately 42% of the manufacturers redesign their traditional channel structures by engaging in direct online sales to reach different customer segments that cannot be reached by the traditional retail channel, which are giving birth to a combination channel of the burgeoning direct online channel and traditional retail channel (also known as the dual-channel). In the market, the dual-channel not only provides revenue but also gives rise to channel conflict. Therefore, the interesting issues are whether a manufacturer should open an direct online channel to motivate retailers to perform more effectively, and how each channel member adopts strategies when adding an direct channel into the traditional retail channel.

During the recent years, the discussion of dual channel supply chain, which contains the burgeoning direct online channel and traditional retail channel, has been carried out from different perspectives by experts and scholars and achieved fruitful results. They are mainly focused on inventory control problems, Alptekinoglu and Tang (2005) developed a model to determine the proportions of

online demand that should be handled by each fulfillment location when fixed operating costs are negligible at all sites; Yao, Yue, Samar, and Wang (2009) discussed three different inventory strategies from the manufacturer's perspective of managing the two channels, then obtained the optimal inventory levels in retail and e-tail stores and the respective expected profits; Bretthauer, Mahar, and Venakataamanan (2010) considered where and how much inventory should be allocated and held at each site for a company that satisfies both in-store and online demand; Netessine and Rudi (2006), gatz and Fleischmann (2008), and so on. Channel competition problems, Balasubramanian (1998) utilized a strategic analysis of competition, which between direct marketers and conventional retailers, in a dual-channel environment, and showed that it is a mechanism to control competition by using the level of market coverage; Geyskens, Gielens, and Dekimpe (2002) discovered that less powerful companies with larger direct market offerings would obtain less profit than powerful ones with a fewer direct paths; Cai, Zhang, and Zhang (2009) assessed the impact of price discount contracts and pricing schemes on the dual-channel supply chain competition, and found that the former scenarios can outperform the non-contract scenarios; Lippmann and Macardle (1997), Sharma and Mehrotra (2007), and so on. Channel coordination problems, Koulamas (2006) proposed that both the manufacturers and the retailers might carry out revenue-sharing policies to coordinate effectively; Yan (2011) established an analytical model to solve a multi-channel manufacturer-retailer supply chain problems by considering the differentiated branding and profit sharing; Chen, Zhang, and Sun (2012) coordinated the dual-channel supply chain

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by using a two-part tariff or a profit-sharing agreement, which can make both the manufacturer and the retailer win; [Iyer \(1998\)](#), [Si and Ma \(2013\)](#), and so on. Pricing decisions problems, [Hua, Wang, and Cheng \(2010\)](#) discussed the pricing decisions in a dual-channel supply chain considering the factor of delivery lead time; [Wei, Zhao, and Li \(2012\)](#) established five pricing models under decentralized decision cases with consideration of different market power structures among channel members; [Chiang, Chhajed, and Hess \(2003\)](#), [Liu, Zhang, and Xiao \(2010\)](#), and so on.

The consumer might enjoy more convenience and lower price through the Internet, because the direct sale through Internet will mitigate the double-marginalization. Therefore, it is an interesting phenomenon to motivate retailers to provide and improve his retail service, including presale service (technical service, counseling service, product advertising, etc.), in-sale service (on-time product delivery, etc.) and after sale service (subsequent tracking service, enjoy all-around technical support and counseling all the time, etc.) ([Wang & Zhao, 2014](#)), which in order to cope with disadvantage factors from the channel conflict and attract consumers to help drive his sales. Retail services have significant effects on customers' channel choice, demand and loyalty ([Yan & Pei, 2009](#)).

By reviewing the previous researches and studies on service decisions, there can be mainly divided into two types about pricing problems: a supply chain with manufacturer's service, such as [Goffin \(1999\)](#), [Wu \(2012\)](#), [Zhao, Liu, and Wei \(2013\)](#); a supply chain with retailer's service, [Yan and Pei \(2009\)](#), [Dan, Xu, and Liu \(2012\)](#), [Zhao and Wang \(2015\)](#), and so on. [Table 1](#) illustrates the major literature review with our paper. It is closer to the actual with the structure of two manufacturers and the complementary products. The discussion of pricing consistent and inconsistent will provide more management insights for the company.

Little research has considered the pricing and service problem of complementary products in a dual-channel supply chain environment. The concept of complementary products emerges when customers may have to buy more than one product at the same time to obtain the full utility of the products ([Yan & Pei, 2009](#)). For example, mobile phone and memory card, computer and software, camera and film. The marketing paradigm of complementary goods is different from that of substitutable goods in that the goods benefit from each other's sales rather than losing sales to the other firm, and the goods can be thought of as a bundle ([Yan & Pei, 2009](#)). Based on the previous literature, we establish some analytical models for pricing decisions and retail services in this paper, which considers the efficacy of different supply chain structures, (1) MS-Bertrand model: the two manufacturers move simultaneously, (2) M_1 -leader Stackelberg model: the duopolistic manufacturers move sequentially, and the manufacturer m_1 serves as the first mover and the manufacturer m_2 as the second mover, (3) M_2 -leader Stackelberg model: the manufacturer m_2 acts as a Stackelberg leader. In addition, we consider whether the two channel pricing is different or not, i.e. consistent pricing and inconsistent pricing. If

the direct sale price equals to the retail price, it is consistent pricing, while, it's inconsistent pricing when the direct prices and retail price are priced differently. By using the backwards induction and game theory, we obtain the analytic solutions, then, illustrate the effectiveness of key parameters on the optimal prices, optimal service levels and maximal profits. Our primary findings include the following: it's not beneficial to the retailer improving his service level infinitely, because the higher the service level the larger the service cost, then, the greater the demand reduction will be; the direct online channel activities can bring about a slightly increase on profit in inconsistent pricing decision, but the channel conflict can lead to the decreasing obviously of the consumer demand through the retail channel, then, could further result in the decreasing of the manufacturer's maximal profit, etc.

The rest of this paper is organized as follows. In [Section 2](#), the problem description and assumptions are presented. One model in consistent and three in inconsistent pricing decisions are discussed in [Section 3](#). In [Section 4](#), we give numerical examples to compare the results obtained in models above, respectively, and to study the channel members' behaviors facing changing parameters. Finally, [Section 5](#) summarizes the main results and some directions for future research.

2. Problem description

Pricing and service decisions of complementary products are considered in a dual-channel supply chain with two manufacturers (denoted m_1 and m_2) and one retailer. Manufacturer m_1 , who produces product 1 at a cost c_1 , distributes product 1 not only through the traditional retail channel to the retailer at wholesale price w_1 , but also through the direct online channel to the consumer at direct sale price p_0 (which satisfies $c_1 < p_0$). Meanwhile, product 2 is produced by manufacturer m_2 at a unit cost c_2 and sold only through the traditional retail channel at wholesale price w_2 . The two products are complementary for each other. The retailer sells them to the consumer with unit retail price p_1 and p_2 (which satisfy $c_1 < w_1 < p_1, c_2 < w_2 < p_2$), respectively. Consumers may use either the retail channel or the direct online channel to purchase the product, then they can also choose to purchase product 1 or product 2 or both products. Moreover, the retailer can provide better services, which is denoted by s , such as sales explanation, immediate response, technical and shopping assistance, attractive environment and personal interaction to consumers through traditional retail channel. Both manufacturers and the retailer choose their decision variables to maximize their respective profits. The framework of the supply chain is depicted in [Fig. 1](#).

In this paper, let D_0 denote consumer demand for product 1 through the direct online channel, D_1 denote consumer demand for product 1 through the retail channel and D_2 denote consumer demand for product 2. In defining the consumer demand function, the linear form has been adopted in many literature, such as

Table 1
Summary of the major literature review.

Reference	Decisions structure	Channel	Service	Pricing type	Product status
Cai et al. (2009)	Pricing policy	Dual channel	No	Two	Single
Chiang et al. (2003)	Pricing policy	Dual channel	No	No	Single
Yan and Pei (2009)	Ordering policy				
	Pricing policy	Dual channel	Retail	No	Single
	Service decision				
Wu (2012)	Pricing policy	One echelon	Manufacturer	No	Substitutable
	Service decision				
Zhao et al. (2013)	Pricing policy	One echelon	Manufacturer	No	Substitutable
	Service decision				
Dan et al. (2012)	Pricing policy	Dual channel	Retail	No	Single
	Service decision				

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