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## Effects of the pricing and cooperative advertising policies in a two-echelon dual-channel supply chain



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### ABSTRACT

The rapid development of e-commerce has reduced the intermediary channels between manufacturers and consumers and changed consumption patterns. However, channel conflicts occur when manufacturers engage in direct sales. Using traditional and direct online channels as its setting, this paper evaluates the impact of price schemes and cooperative advertising mechanisms on dual-channel supply chain competition. Our analysis offers structural and quantitative insights into the interplay between upstream and downstream entities in the supply chain, helping managers to understand the interplay between the upstream and downstream entities of a dual channel structure.

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### 1. Introduction

The rapid development of e-commerce has reduced the intermediary channels between manufacturers and consumers and changed consumption patterns. The Internet can provide wider coverage with lower operating costs than physical channels, and provides easy access to vast numbers of potential customers. A retail forecast report for U.S. cross-channel sales for the period 2012 to 2017 predicted that by 2017, sixty percent of all U.S. retail sales will involve online sales, either as a direct e-commerce transaction or as an element of shoppers' research on a laptop or mobile device. Within five years, about 10.3 percent of total retail sales will be online purchases, for \$370 billion in online sales versus \$3.6 trillion in total retail sales, according to the study (Dusto, 2013). Consequently, thousands of manufacturers have adopted a dual distribution channel structure, selling through traditional distribution channels and through their own websites. However, when manufacturers engage in direct sales, channel conflicts may occur. To prevent competition with their retailer partners, some manufacturers, such as Levi Strauss & Co., Daimler-Chrysler, Nikon, and Rubbermaid, have decided not to sell products from their own website. Instead, they offer information on the nearest retailer carrying their products. These cases signal a need to investigate the impact of the introduction of a direct channel on a supply chain, along with the requirements for coordinating the upstream and downstream entities of the supply chain

(Cai, Zhang, & Zhang, 2009; Cattani, Gilland, & Heese, 2006; Collett, 1999; Kumar & Ruan, 2006; Yoo & Lee, 2011).

Using traditional retail channel and direct online channel settings, this study evaluates the impact of pricing schemes and cooperative advertising mechanisms on dual-channel competition. In a two-level supply chain structure, the retailer and the manufacturer can affect the market size by investing in local advertising and making marketing expenditures on national brand names, but with diminishing returns. The decision problem facing profit-oriented entities in the dual-channel problem is to determine the optimal advertising and pricing policies for maximizing their own profit. Both the traditional retail channel and the direct online channel are formulated to offer structural and quantitative insights into the interplay between upstream and downstream entities of the dual-channel supply chain. The implications of a revenue-sharing contract for mitigating the channel conflicts of channel members is also proposed.

This paper differs from previous works in several ways. First, this study attempts to integrate the three streams of, as yet, rather disjointed research work: pricing schemes, cooperative advertising, and dual-channel management. Both the traditional retail channel and the direct online channel are investigated. The second difference is that this study focuses on the channel coordination challenge of mitigating the channel conflict between upstream and downstream entities of the supply chain, when the channel leader operates a direct online channel.

The remainder of this study is organized as follows. The literature review is given in Section 2. Section 3 outlines the problem and summarizes the necessary assumptions and notations. In

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Section 4 we develop the mathematical models for both the traditional retail channel and the direct online channel models, and provide the optimal properties of the underlying problem. In Section 5 we conduct an extensive numerical analysis. This provides the reader with insight into the structure of the proposed models and analyzes the sensitivity of the solutions in relation to the major parameters. Finally, conclusions are drawn in Section 6.

## 2. Literature review

Many papers examine issues related to channel coordination and supply chain management. Below we review the literature on pricing schemes, advertising management, and dual-channel management.

### 2.1. Pricing scheme

In the early stages of a product's evolution, most companies compete on the basis of product performance when a product's functionality does not yet meet the needs of key customers. Later, as the underlying technology improves and mainstream customer needs are met, companies are forced to compete on the basis of convenience, customization, flexibility, and pricing (Christensen, Raynor, & Verlinden, 2001). Cohen (1977) first analyzed the interaction effect of pricing and ordering decisions for a retailer who sells a perishable item in a deterministic marketplace. He extended the classic inventory model by combining the issues of pricing, exponentially decaying products, and shortages in his models. For a short life cycle commodity inventory problem, Pasternack (1985) extended the classical newsboy model to examine the pricing decision and return policy for maximizing the profit of a supply chain. His results showed that a partial credit return for unsold products provided by the manufacturer to the retailer can achieve channel coordination. In order to reflect the interaction between time-varying costs and price in the presence of decay, Rajan, Rakesh, and Steinberg (1992) developed a pricing and ordering model that incorporates both losses from physical deterioration and inventory carrying costs for a monopolistic retailer. Their research showed that the selling price and the appeal of the product to the customer vary depending on the item's wastage and value drop factors. Mukhopadhyay, Mukherjee, and Chaudhuri (2004) proposed a joint pricing and ordering model for deteriorating items. They removed the limitations of Cohen (1977), and made the study more realistic by taking into consideration the time-proportional deterioration of items in addition to nonlinear price dependent demand rates. Sajadieh and Akbari-Jokar (2009) developed an integrated production–inventory–marketing model for two-stage supply chains. The major contribution of their paper is to add the pricing policy for the previous integrated vendor–buyer models. They also pointed out that supply chain coordination can produce a reduction in the selling price, and their analysis showed that it is beneficial for supply chain members to cooperate with each other in competitive environments, where the end customers have a number of purchasing choices, and can easily shift to other less expensive supply chains. Chen and Chang (2010) dealt with the problem of jointly determining the optimal retail price, the replenishment cycle, and the number of shipments for exponentially deteriorating items. Both non-integrated and integrated policies were investigated while taking into account the combined effects of channel coordination, joint replenishment program, and lot-sizing integration for the two-level supply chain. These realistic considerations made their models more applicable. Wu (2011) used four game theory strategies to investigate the equilibrium behavior of a

two-echelon supply chain. In simultaneous and sequentially policy cases, he examined the price and service level decision for each channel strategy. The results of his study showed that vertical integration dominates other strategies and leads to the highest service level.

### 2.2. Advertising mechanism

To increase profits in a channel, many researchers (Bergen & John, 1997; Berger, 1972; Dant & Berger, 1996; Dutta, Bergen, John, & Rao, 1995; Nagler, 2006; Somers, Gupta, & Herriott, 1990) have contended that coordination of both local and national cooperative advertising in a partnership relationship between supply chain members can be very effective. Castillo, Sarabia, and Gonzalez (1999) provided the general market demand function of a single-product depending on the selling price and on the exogenous variable advertising expenditure by using some common sense assumptions. They obtained the equilibrium strategies for a monopoly and a duopoly, the Cournot and Stackelberg cases. Their analysis shows that an additive or multiplicative change in the unit price and the advertising expenditure would yield an additive or multiplicative change in sales. Krishnan and Jain (2006) developed an empirically proven diffusion demand function that explicitly incorporates the advertising component. They determined the optimal advertising expenditure by considering the advertising effectiveness, discount rate, and the ratio of advertisement to profits. Krishnan and Jain (2006) demonstrated the optimal advertising has a decrease–increase, increase–decrease, monotonically increasing or monotonically decreasing shape, depending upon the interplay among the aforementioned factors. They provide valuable recommendations for adjusting advertising expenditure as sales progress. Nagler (2006) provided an exploratory empirical investigation for determining the cooperative advertising participation rates of the channel members. The author examined how participation rates vary with average manufacturers' margins by industry, average retail margins by category, and additional category-level variables. Using data for 2286 brands, Nagler (2006) demonstrated a quadratic relationship in which a positive correlation between participation rates and national advertising expenditures over the range of most brands gives way to an inverse correlation of the two variables for the most intensely advertised brands. Szmerekovsky and Zhang (2009) investigated a Stackelberg game in a decentralized system with the manufacturer as the leader and the retailer as the follower. Contrary to previous research, their model allowed for a continuous level of promotion efforts to be selected by both the manufacturer and the retailer. Their research results showed that cost sharing of local advertising does not work well, and that it is better for the manufacturer to advertise nationally and offer the retailer a lower wholesale price. In further contrast to the literature, He, Prasad, and Sethi (2009) incorporated uncertainty in awareness share and derive optimal feedback policies for price and advertising by the manufacturer and retailer. They noted that it is not always optimal for the manufacturer to offer a co-op advertising program when the retailer's margin is significantly higher than the manufacturer's. Chen (2011) dealt with the news-vendor problem as a case of a two-level supply chain. Both non-cooperative and cooperative policies were formulated considering the combined effects of the cooperative advertising mechanism, returns policy, and vendor–buyer coordination. The results of the study revealed that the cooperative decision policy is always found to be superior to the non-cooperative decision policy in profit improvement. Chen (2011) also demonstrated that a profit-sharing mechanism is necessary to make the cooperative policy acceptable to the supply chain members by compensating the disadvantaged partner.

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