



# Supply chain coordination through cooperative advertising with reference price effect

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## ABSTRACT

Cooperative advertising, which usually occurs in a vertical supply chain, is typically a cost sharing and promotion mechanism for the manufacturer to affect retail performance. Research in the literature, however, rarely considers the important phenomenon that advertising has a positive effect on the consumer's reference price. In fact, when a consumer makes a decision to buy a product or not, a reference price is usually in his mind and plays a determinant role. Taking into account the impact of advertising on the reference price, this paper proposes a dynamic cooperative advertising model for a manufacturer–retailer supply chain and analyzes how the reference price effect would influence the decisions of all the channel members. In our model, both the consumer's goodwill and reference price for the product are assumed to be influenced by the advertising and are modeled in differential dynamic equations. In addition, the advertising level, the consumer's goodwill and the reference price are all assumed to have positive effect on sales. Utilizing differential game theory, this paper formulates the optimal decisions of the manufacturer and the retailer in two different game scenarios: Stackelberg game and cooperative game. Also, this paper proposes a new mechanism to coordinate the supply chain in which both the manufacturer and the retailer share each other's advertising costs.

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## 1. Introduction

Cooperative advertising, which usually occurred in a vertical supply chain, is typically a cost sharing and promotional mechanism for manufacturers to affect retailer performance. As distinguished by Huang and Li [18] and Huang et al. [19], advertising can be divided into national and local advertising. National advertising mainly focuses on influencing potential consumers to consider a particular brand and develops brand knowledge and preference, whereas local advertising intends to stimulate consumers' instant buying behavior. To encourage a retailer to invest more in local advertising, the manufacturer usually shares part of the retailer's local advertising cost.

As a typical issue of supply chain coordination, the cooperative advertising program has received significant attention in business and academics. As indicated by Nagler [35], the total expenditure on cooperative advertising in 2000 was estimated at \$15 billion in the USA, nearly a four-fold increase in real terms in comparison to \$900 million in 1970. Karray and Zaccour [27] also indicated that marketing research firms like National Register Publishing has

collected more than 4000 co-op programs subsidized by manufacturers in 52 product classifications.

In 1973, Berger was the first to propose a primary cooperative advertising model [5]. After that, Dant and Berger [9], Huang and Li [18], Huang et al. [19], Li et al. [32], Jørgensen et al. [20,21], Yue et al. [51] and Xie and Neyret [49] extended different aspects of Berger's work. There are two types of modeling in co-op advertising: static and dynamic. For example, Huang and Li [18], Huang et al. [19] and Li et al. [32] used static models to extend Berger's work in a supply chain framework; Yue et al. [51] used a static model to study the cooperative advertising problem by considering price discount in demand elasticity market circumstance, and Xie and Neyret [49] used a static model to propose a more general model by including the cooperative advertising and pricing decisions simultaneously.

For the dynamic models, readers may refer to Chintagunta and Jain [7], Jørgensen et al. [20,21], and Karray and Zaccour [26]. Utilizing the Nerlove–Arrow framework, Chintagunta and Jain [7] developed a dynamic model to determine the channel member's equilibrium marketing efforts for a manufacturer–retailer supply chain. Jørgensen et al. [20] extended the work of Chintagunta and Jain [7] for cooperative advertising by considering that both channel members made long term and short term advertising efforts to enhance sales and consumer goodwill, whereas Jørgensen et al. [21] assumed decreasing marginal returns to

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goodwill and adopted a more flexible functional form for the sales dynamics. These works were extended by Karray and Zaccour [26], in which the retailer sold both his own private product and the manufacturer's product. Further, under the dynamic framework, He et al. [15] studied the cooperative advertising program for a supply chain system consisting of a single manufacturer and two competing retailers.

Although cooperative advertising has been extensively studied during the past several decades, an important marketing phenomenon, i.e., reference price effect, has not been considered in the cooperative advertising models. In fact, reference dependence has a long-standing tradition in psychology and has been the focus of a great deal of empirical research [4,6,30]. According to Kalwani et al. [23], when a consumer buys a product, he usually has a reference price  $r$  in his mind. If he finds the current price  $p$  is less than his reference price  $r$ , he will feel a sense of gain and the sales of the product would increase. On the contrary, if  $r < p$ , the consumer will feel a sense of loss and sales would decrease. In the literature, the impact of reference price on demand is called reference price effect [37]. As argued by Mazumdar et al. [34], reference price represents a consumer's evaluation of a product; the reference price is affected by many factors such as price (including the historical price, the suggested retail price, the rival product's price, etc.), advertisement, quantity, delays, and so on.

Due to its significant influence on consumers' behaviors, reference price has received much attention from researchers. Thaler [47] explained that the impact of a reference price on consumer demand was influenced by the dynamic comparison between reference price and current market price. Pulter [38] further indicated that an actual price which is higher or lower than the reference price has a different impact on demand. Greenleaf [12] showed that reference price effect could increase the impact of promotions. Taking this effect into account, Greenleaf demonstrated how a retailer should develop an optimal strategy for long-term promotions to maximize his profits. Kopalle et al. [29] considered customer heterogeneity in a study of reference price effect and showed that cyclical pricing policies were optimal. Taking threshold effects into account, Raman and Bass [40] provided a test of reference price theory and assumed a basic asymmetry in market response. Their research suggested that a price-promotion would not be noticed by consumers except if it exceeded a minimum threshold. Fibich et al. [14] studied how the profitability of price promotion was affected by the asymmetric reference price effect and results showed that if effects of loss on demand were larger than that of gain, price promotions could lead to a decline in profit, and vice versa.

Because reference price has a significant impact on consumer buying decisions and because reference price can be affected by advertising, it is necessary to consider the reference price effect in cooperative advertising models so that managers can make better decisions about promotional strategies. In this paper, we consider a dynamic cooperative advertising model with reference price effect for a manufacturer–retailer supply chain. In our model, both the consumer's goodwill and reference price for a product are assumed to be influenced by advertising and are modeled in differential dynamic equations. In addition, the advertising efforts, the consumer's goodwill, and the reference price are all assumed to have a positive effect on product sales. Utilizing differential game theory, we obtain the optimal advertising decisions of the manufacturer and retailer under two different game scenarios, i.e., the Stackelberg game and the cooperative game structure. Also, we propose a new cooperation mechanism to coordinate the supply chain in which both the manufacturer and retailer share the other's advertising costs.

Some interesting results of this paper include the following: (i) as opposed to most previous literature, which did not take into

account advertising's impact on reference price and proved that the steady state reference price equals to the market price [13,37], our model illustrates that the steady state reference price is usually higher than the market price; (ii) due to the reference price effect, a firm will invest more in national advertising; the larger the impact of the reference price, the more national advertising should be invested in, and (iii) when the retailer has a relatively high profit, it is necessary for him to share a part of the manufacturer's national advertising costs, which is contrary to the common cooperative advertising practice by which the manufacturer usually shares the retailer's local advertising costs.

This paper is organized as follows. Literature reviews are in Section 2. In Section 3, the reference price effect is added into the dynamic cooperative advertising model. Based on the model, in Sections 4 and 5 we analyze the manufacturer and retailer's optimal decisions in the Stackelberg game and the cooperative game structure, respectively. A new supply chain coordination mechanism is introduced in Section 6. Concluding remarks are given in Section 7.

## 2. Literature review

Literature related to this paper focuses mainly on cooperative advertising and reference price effect. Research about cooperative advertising is usually divided into static models and dynamic models. For the static model, Berger [5] proposed a cooperative advertising model by taking the participation rate as the manufacturer's decision variable, i.e., the manufacturer was to decide the optimal cost sharing rate that he would undertake for the retailer. The model was then extended by Dant and Berger [9], who considered an uncertainty demand in franchising systems. Using game theory, Dant and Berger [9] obtained the manufacturer's optimal participation rate and the retailer's optimal advertising spending. Dividing the advertising into the retailer's local advertising and the manufacturer's national advertising, Huang and Li [18], Huang et al. [19], and Li et al. [32] further extended the manufacturer–retailer cooperative advertising model. Utilizing a game theory approach, the research discussed cooperative advertising problems under two scenarios, i.e., (i) the manufacturer was the leader and the retailer was the follower and (ii) the manufacturer and retailer made decisions in a co-op partnership.

For the dynamic model, Chintagunta and Jain [7] determined equilibrium marketing efforts for a manufacturer and a retailer. Then, Jørgensen et al. [20,21] examined the case where both channel members made long term and short term advertising efforts to enhance sales and consumer goodwill. Also, Jørgensen et al. [22] investigated an interesting phenomenon, i.e., the retailer's promotions could damage the brand image. With consideration of this phenomenon, the authors examined whether a cooperative program could still work in such a context. Then, Karray and Zaccour [26] extended the models of Jørgensen et al. [21] by considering a retailer who sold both his own products with a private label and the manufacturer's products while choosing promotion efforts for these two products. Furthermore, He et al. [16] modeled a typical supply chain problem as a stochastic Stackelberg differential game, in which the relationship between the manufacturer and retailer is asymmetric. Sigué and Chintagunta [45] studied a cooperative advertising problem by considering a franchise system consisted of a franchisor and two competing franchisees.

As an important factor that influences the market demand, the reference price has been researched since at least the 1980s. Lattin and Buckin [31] indicated that the reference price framework was consistent with several psychological theories of

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