Computers & Industrial Engineering 99 (2016) 112–123

Contents lists available at ScienceDirect

Computers & Industrial Engineering

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

Cooperative advertising and pricing in a manufacturer-retailer supply chain with a general demand function; A game-theoretic approach

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ARTICLE INFO

Article history:
Received 19 September 2015
Received in revised form 16 May 2016
Accepted 7 July 2016
Available online 15 July 2016

Keywords:
Supply chain management
Cooperative advertising
Pricing
Game theory

ABSTRACT

The manufacturer participating in a cooperative advertising scheme reimburses a percentage of local advertising expenditures to encourage the retailer into more promotional initiatives. The present study aims to investigate the supply chain coordination through cooperative advertising and pricing by proposing a relatively general consumer demand function. Based on the underlying balance of power among supply chain members, four possible game structures are discussed including the Nash, Stackelberg retailer, Stackelberg manufacturer and cooperation games. Moreover, numerical simulations are provided to exemplify implicit optimal solutions of the Stackelberg retailer-manufacturer games while they will also be used for comparison of the four games. The unprecedented results obtained from this study may be summarized as follows: (1) the cooperation game is strongly found to be infeasible depending on the certain channel's parameters; (2) contrary to previous findings, the manufacturer's margin is found to be always lower than the retailer's in the Stackelberg retailer game; (3) in the Stackelberg manufacturer game, the manufacturer prefers to advertise nationally rather than to support local promotional activities when retailer advertising becomes inefficient; (4) we find that the manufacturer's price is entirely stable compared to classical linear model and increases as effectiveness ratio of national to local advertising increases.

1. Introduction

Supply chain management has received significant attention in business and academics from varied disciplines: supply chain contracts, logistics, purchasing, advertising, inventory and pricing (Arshinder, Kanda, & Deshmukh, 2008; Chen, 2015; Heydari, 2014; Xiao, Shi, & Chen, 2014). It is well documented in the literature that the supply chain coordination through either cooperative advertising (co-op) or pricing leads to better performance in distribution channels (Berger, 1972; Choi, 1991; Dant & Berger, 1996; Jeuland & Shugan, 1983; Jørgensen & Zaccour, 2003a; Somers, Gupta, & Harriot, 1990; Yue, Austin, Wang, & Huang, 2006). Cooperative advertising and pricing strategies play significant roles in marketing programs of channel members in a supply chain. The total expenditures of cooperative advertising range from $900 million in 1970 to more than $50 billion in 2012, indicating the growing significance of this marketing program (Aust & Buscher, 2014a; Nagler, 2006). In addition, the US National Federation of Independent Business estimates an annual amount of nearly $50 billion offered by manufacturers to retailers as cooperative advertising reimbursement (Kraft & Kamieniecki, 2007). When the manufacturer collaborates with the retailer by reimbursing a percentage of the local advertising cost (known as manufacturer's participation rate), the retailer will be strongly motivated to increase his contribution to local advertising efforts. Meanwhile, the absence of a coordinated decision system leads to inefficiencies in distribution channels that result from what has come to be known in the literature as the 'double moral hazard' or 'double marginalization' (Spengler, 1950; Tirole, 1989; Zhang & Chen, 2013). The present paper addresses coordination through simultaneous cooperative advertising and pricing in a manufacturer-retailer supply chain.

Cooperative advertising has long been an attractive research topic (Aust & Buscher, 2012, 2014b; Berger, 1972; Dant & Berger, 1996; Eliashberg & Steinberg, 1987; Huang & Li, 2001; Somers et al., 1990; Xie & Wei, 2009) that has received considerable attention by industrialists, especially those in the automobile industry (Green, 2000; Karray & Zaccour, 2007). Berger (1972) was the first to carry out a mathematical study of cooperative advertising in a manufacturer-retailer channel. Dant and Berger (1996) extended Berger's model using the game theory to obtain optimal solutions of channel members in a franchising system. The game theory

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http://dx.doi.org/10.1016/j.cie.2016.07.007
0360-8352/

has become a popular approach to investigating the role of cooperative advertising models in manufacturer-retailer supply chains. The studies in this area are divided in the respective literature into two main categories: static and dynamic game theoretic models. The static models study the co-op advertising in a single period; examples include Berger (1972), Dant and Berger (1996), Bergen and John (1997), Huang and Li (2001), Huang, Li, and Mahajan (2002), Karray and Zaccour (2006), and Xie and Neyret (2009). Huang and Li (2001) explored the efficiency of co-op advertising regarding transactions in manufacturer-retailer channels. They discussed three co-op advertising models using game theory and applied the Nash bargaining model to determine the sharing rules of advertising expenses. Huang et al. (2002) and Li, Huang, Zhu, and Chau (2002) adopted similar approaches by considering the impact of brand name investments, local advertising, and sharing policies of advertising expenses in order to study cooperative advertising in a manufacturer-retailer supply chain. They utilized Eliashberg (1986) cooperative bargaining model to show how the channel members jointly divide the extra profits. Yue et al. (2006) extended over the models proposed in Huang and Li (2001), Huang et al. (2002), and Li et al. (2002) by introducing the price discount factor along with the advertising impact when only the manufacturer provides a price deduction directly to customers. The negativity problem of sales volume in the four recent papers mentioned above was corrected in Ahmadi-Javid and Hoseinpour (2011, 2012) who developed a modified version of the model by incorporating two constraints previously suggested in Yue et al. (2006). Using this new version, they found that no variations in the marginal profits of either the manufacturer or the retailer would affect advertising expenditures. More recently, Yue, Austin, Huang, and Chen (2013) extended their previous work Yue et al. (2006) to a situation in which both the manufacturer and the retailer offer a price discount to the customer in order to obtain better insights into the underlying relationships of pricing and cooperative advertising.

The second class of game theoretic models, i.e., dynamic models, considers the long-term perspective affecting consumer's goodwill through national and local advertising efforts. Studies in this class include Chintagunta and Jain (1992), Jørgensen, Sigué, and Zaccour (2000, 2001), Jørgensen, Taboubi, and Zaccour (2001), Jørgensen and Zaccour (2003b), Karray and Zaccour (2005), He, Prasad, and Sethi (2009) and He, Krishnamoorthy, Prasad, and Sethi (2011). Although Chintagunta and Jain (1992) studied a dynamic model taking into account only the dynamic effects of channel members' advertising efforts, Jørgensen et al. (2000), Jørgensen, Sigué, et al. (2001) and Jørgensen, Taboubi, et al. (2001) extended their model to include a cooperative advertising environment where both short and long-term impacts of advertising efforts boost up sales and consumer goodwill. Karray and Zaccour (2005) extended the models developed by Jørgensen et al. (2000), Jørgensen, Sigué, et al. (2001) and Jørgensen, Taboubi, et al. (2001) to show how the manufacturer could employ the cooperative advertising strategy for reducing the negative effect of the retailer's private label when he sells two products: the manufacturer's and a private label at a lower price. He, Krishnamoorthy, Prasad, and Sethi (2011) and Wang, Zhou, Min, and Zhong (2011) investigated the cooperative advertising problem with one monopolistic manufacturer and competing duopolistic retailers using the dynamic and static game theoretic models, respectively. Their analysis showed that the competitive behaviors affected the profits of all the channel members, which motivated them to move to a different game structure. Further, Alaei, Alaei, and Salimi (2014), Giri and Sharma (2014) and Karray and Amin (2015) examined the cooperative advertising scheme in a channel with single manufacturer and two retailers under different game structures. In addition, the impact of price elasticity on pricing and cooperative advertising decisions has been addressed by Zhao, Zhang, and Xie (2015) considering Stackelberg manufacturer game.

Several attempts have been made to study the different factors that influence sales volume; these include national advertising, local promotions, participation rate, retail price, and price deduction in the supply chain coordination settings. Manufacturer's national brand name investment and retailer's local advertising are two common types of advertising strategies; the former aims to reinforce the brand image and influence the potential consumers, while the latter is intended to induce short-term sales with the aid of local promotional initiatives. A number of recent studies have been undertaken aimed at developing a model that comprises most of the above mentioned factors in order to examine the manufacturer-retailer relationships in a supply chain (Aust & Buscher, 2012; Huang et al., 2002; SeyedEsfahani, Biazaran, & Gharakhani, 2011; Szmerekovsky & Zhang, 2009; Xie & Neyret, 2009; Yue et al., 2006). For instance, Yue et al. (2006) and Szmerekovsky and Zhang (2009) extended Huang et al. (2002) by examining different ways of integrating national and local advertising with price sensitivity impacts and explored the relationships between these factors and the expected market demand. Xie and Wei (2009) developed two models including conflict and cooperation situations where the consumer demand function is determined by both the retail price and the cooperative advertising efforts. A similar approach was adopted by Xie and Neyret (2009). They reviewed the four game theoretic models to identify optimal cooperative advertising and pricing policies. SeyedEsfahani et al. (2011) built upon Xie and Wei (2009) by incorporating a price elasticity (v) impact that yields a convex ($v < 1$), linear ($v = 1$), or concave ($v > 1$) price demand curve in the four game scenarios. The restrictive assumption of equal margins in the Nash and Stackelberg retailer games was relaxed in Aust and Buscher (2012) by incorporating the models proposed by SeyedEsfahani et al. (2011) and Xie and Wei (2009).

In this paper, we develop four models in which the consumer demand function is simultaneously affected by retail price and cooperative advertising efforts. Our objective is to investigate the underlying interactions among the channel members in a manufacturer-retailer distribution channel. The current study is not only closely connected to the three papers cited above, namely Xie and Neyret (2009), SeyedEsfahani et al. (2011), and Aust and Buscher (2012), but also extends beyond by generating a number of insights. The work of Xie and Neyret (2009) is extended by considering a general price demand function and relaxing the assumption of equal margins in order to understand pricing impacts on channel members' profits. The general price demand function employed is the one proposed in SeyedEsfahani et al. (2011) which may lead to one of the convex ($v < 1$), linear ($v = 1$), or concave ($v > 1$) curves. As Piana (2004) points out, a convex demand curve arises from a polarized distribution of reserve prices (maximum acceptable price) with most consumers having low reserve prices, few are rich, and only slightly more are in the middle. A uniform distribution of reserve prices brings about a linear demand curve and, a distribution of reserve price with a wide number of consumers having a similar middle reserve price, only few rich and few poor, gives rise to concave demand curve. Relaxing the equal margins assumption has also been proposed by Aust and Buscher (2012) who adopted the model proposed in SeyedEsfahani et al. (2011). The last two papers just mentioned are similar to the work by Xie and Wei (2009) in that they employ the same model to address advertising effects on the consumer demand function. Finally, all these papers employed models which have been rarely ever reported in the literature (see Table 1). In contrast, we address the advertising-sales response function by utilizing the model proposed by Huang and Li (2001) which is very popular in the