Interfaces with Other Disciplines

Pricing and advertisement in a manufacturer–retailer supply chain

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ABSTRACT

We use a game theoretical approach to study pricing and advertisement decisions in a manufacturer–retailer supply chain when price discounts are offered by both the manufacturer and retailer. When the manufacturer is the leader of the game, we obtained Stackelberg equilibrium with manufacturer's local allowance, national brand name investment, manufacturer's preferred price discount, retailer's price discount, and local advertising expense. For the special case of two-stage equilibrium when the manufacturer's price discount is exogenous, we found that the retailer is willing to increase local advertising expense if the manufacturer increases local advertising allowance and provides deeper price discount, or if the manufacturer decreases its brand name investment. When both the manufacturer and retailer have power, Nash equilibrium in a competition game is obtained. The comparison between the Nash equilibrium and Stackelberg equilibrium shows that the manufacturer always prefers Stackelberg equilibrium, but there is no definitive conclusion for the retailer. The bargaining power can be used to determine the profit sharing between the manufacturer and the retailer. Once the profit sharing is determined, we suggest a simple contract to help the manufacturer and retailer obtain their desired profit sharing.

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1. Introduction

A typical manufacturer–retailer supply chain has long been a topic of interest. In such a supply chain, the manufacturer and retailer make interactive actions, sometimes non-cooperative to emphasize individual interests, and sometimes cooperative to benefit the whole supply chain. Noncooperative always starts with the assumption that one party in the chain has manipulative power and acts as the leader of the chain. The other party has to respond to the actions of the leader and becomes the follower in the chain. However, when the power of a supply chain shifts to both parties, they may choose to compete, or may agree to cooperate. In this research, we are interested in studying pricing and advertisement in a supply chain with one manufacturer and one retailer, and the associated market and profit impacts of different operation strategies.

1.1. Price discounting and cooperative advertising in a manufacturer–retailer supply chain

Price discounts can be provided by the manufacturer and/or the retailer. For the price discount by the manufacturer, some studies assumed that the price discount is provided from the manufacturer to the retailer to compensate a retailer's cost increases for ordering higher than the EOQ (Monahan, 1984; Lee and Rosenblatt, 1986; Chiang et al., 1994). Some other studies, however, assumed the discount is provided to the consumers (Abad, 1994; Li et al., 1996 and Yue et al., 2006); therefore, consumers pay less than MSRP (Manufacturer's Suggested Retail Price) to purchase the brand name product. A discount to the consumers from the manufacturer and/or the retailer may stimulate the brand name product market demand and increase the total profit for the manufacturer and/or the retailer.

Advertising is a common marketing activity. Brand name investment and local advertising are considered two major types of advertisements. Brand name investment is a national advertisement that focuses on building brand name image and long-term sales, and is traditionally conducted by the manufacturer. Local advertising, however, focuses on the local market and short-term sales and is usually accomplished by the retailer. Cooperative

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advertising is typically defined as a cost sharing promotion mechanism used by manufacturers which helps retailers with their local advertising expense. Since the retailer may have a better idea about local consumer tastes and efficient local advertising channels, the manufacturer may provide the retailer some money for local advertising purposes. Warner Brothers, a maker of corsets, issued the first co-op agreement in 1903. Since then, the use of co-op advertising spread to grocery stores and then to fashion and hard goods stores. The automobile industry is the most common user of cooperative advertising today.

1.2. Power of the channel members

In a manufacturer and retailer supply chain, traditionally the manufacturer holds manipulative power, acts as the leader of the chain, and is followed by the retailer. In a leader–follower two-stage supply chain, the manufacturer usually anticipates the reactions of the retailer and decides its first move, and then prescribes the behavior of the retailer (Gaski, 1984).

However, power shifting from manufacturers to retailers has been a new trend. According to Kadiyali et al. (2002), the common thinking is that retailers hold more channel power than manufacturers and this power has shifted from the manufacturer to the retailer over time. Kadiyali et al. (2002), measured the power of channel members for price setting behavior and found that retailers have more power than manufacturers. However, Messinger and Narasimhan (1996) found no evidence in their research that the profitability of retailers was better than manufacturers from 1961–1991, indicating that retailers may not hold more power in the channel than manufacturers. Situation when both parties have power is also a common observation in the business world.

When both the manufacturer and the retailer have powers, they may consider either competing or cooperating. In a study of products sold in declining price environments, Taylor (2001) found that coordination in the form of price returns and price protection provides a win-win situation for the manufacturer and retailer. Lee and Rosenblatt (1986) studied price protection in the personal computer industry and found that cooperation in the channel benefits the total chain and the retailer. Dant and Berger (1996) used game theory to obtain Stackelberg equilibrium in advertising investment sharing where allowance from a manufacturer promotes a retailer's advertising expense and increases the profit for the whole chain. Huang, Li, and Mahajan (2002) observed that manufacturers pay not only brand name investments, but also part of local advertising expenses incurred by retailers.

In our previous research (Yue et al., 2006), we proposed a manufacturer–retailer coordinative advertisement model with both the manufacturer leading a Stackelberg game and the optimal policy for integrated channel when only the manufacturer provides a price discount. However, the assumption of only the manufacturer providing price discounts and leading the supply chain does not cover many business scenarios discussed in this section. In practice, both the retailer and the manufacturer can provide the price discount to the consumers. Both may have negotiation power, but choose not to coordinate in cooperative advertising and pricing. To better understand the effects from the pricing and cooperative advertisement, it is necessary to discuss the business decisions in a manufacturer–retailer supply chain.

- when both the manufacturer and the retailer provide price discounts;
- if coordination happens in a two-stage game through price discount and local allowance contracts;

and answer the following questions

- when both the manufacturer and the retailer have the negotiation power in the supply chain and do not plan to coordinate;
- why each party tries to obtain power in the supply chain;
- which party will benefit in each equilibrium;
- how to share the profit gain if both the manufacturer and the retailer have bargaining powers, and
- which contract will assure both parties to achieve their desired profit sharing.

Solutions will be provided for the above topics in following sections of this paper.

The rest of the paper is organized as follows. Section 2 provides profit functions for both the manufacturer and retailer based on the demand function with brand name investments and local advertising expenses when both the manufacturer and retailer offer price discounts. It is also proved that the optimal policy for the integrated channel is unique. Section 3 obtains Stackelberg equilibrium when the manufacturer is the leader and the retailer is the follower. It is shown that an optimal solution cannot be achieved when the manufacturer leads the game. Section 4 discusses structures when both the manufacturer and retailer have bargaining power. Nash equilibrium in a competition game is obtained with the closed form solutions. Nash equilibrium is also compared with Stackelberg equilibrium to explain the importance of the power in the supply chain. Section 5 discusses the bargaining results to determine the shares of profits between the manufacturer and retailer. A simple contract is also provided to assure the profit sharing. Conclusion remarks are given in Section 6.

2. Demand function and profit function determination with price discounts

In this section, we determine the demand function with local advertising expense, brand name investment, and price discount effects and further determine the profits of the manufacturer and the retailer when both the manufacturer and retailer offer price discounts in a cooperative advertisement structure. We discuss a two-level supply chain with one manufacturer and one retailer. A similar supply chain structure is seen in other literature, such as Monahan (1984), Lee and Rosenblatt (1986), Abad (1994), Chiang et al. (1994), Li et al., 1996, Huang et al. (2002), Yue et al. (2006) and Xie and Wei (2009).

Assume a product's MSRP is P_0, the variable cost in the whole supply chain is VC_w, the manufacturer and retailer's profit margins of each product unit sold at P_0 are ρ_m and ρ_r, respectively. We have the following relationship among P_0, VC_w, ρ_m and ρ_r:

$$P_0 = VC_w + (\rho_m + \rho_r). \tag{1}$$

A one period market demand (sale volume) function with the effects of local advertising, brand name investments and price discount by Yue et al. (2006) is:

$$S(a, q, P) = (\alpha - \beta a^{-\gamma} q^{-\delta}) \left(\frac{P}{P_0}\right)^{-e}, \tag{2}$$

where α, γ and δ are positive constants, a and q represent local advertising expense and brand name investment, respectively; β is a scaling parameter; P is discount retailing price charged to consumers; and e is the price elasticity which is always positive. γ and δ are the quasi-advertising elasticity and the quasi-investment elasticity, respectively.

Assuming that the manufacturer offers ϵ_m percentage and retailer offers ϵ_r percentage of full price P_0 as the price discounts to consumers, their profit margins will reduce to $(\rho_m - \epsilon_m P_0)$ and