1. Introduction

Price promotions, that is, temporary price reductions, have been employed by many industries. This is nicely reflected in the marketing literature, where a large number of studies have focused on price promotions and their impact on retailers and, in some cases, on manufacturers. For a review, see Ailawadi (2001).

Our focus in this paper is on price promotions provided by manufacturers through manufacturer rebates. Consider the following examples with products of short life-cycles:

- Nikon Coolpix Digital Camera is sold either on-line or in stores for about $600. The manufacturer provides a rebate of $100 independently of where the camera is purchased.

- Sharp VL-WD255U Digital Camcorder is sold for about $500 at retail or virtual stores. Sharp provides a $100 rebate to the customer independently of where the product was purchased.

Both examples are part of a growing practice, where manufacturers are using rebates, a form of price promotion, to improve their operations and, ultimately, their bottom line (see Simchi-Levi et al. 2003). When manufacturer rebates are utilized in a two-echelon environment, i.e., a supply chain with a manufacturer and a retailer, they can be classified into two different types. The first is the channel rebate, which is a payment from a manufacturer to a
retailer based on the amount of sales that the retailer generates. The second is the consumer rebate, where the manufacturer pays the end customer via a coupon.

Consumer rebates, which are the focus of this paper, have been investigated in the marketing literature. For example, Ali et al. (1994) have developed a simple model to study the optimal size of a rebate when the consumers are categorized into loyal customers and brand switchers. Zhang et al. (2000) have analyzed the choice between immediate value promotions (e.g., peel-off coupons, free-standing inserts, and direct-mail coupons) and delayed value promotions (e.g., in-pack coupons, on-pack coupons, and contests).

In the economics literature, a number of studies have been conducted to explain why rebates are used. Some studies have been performed on the use of manufacturer rebates as a means of price discrimination (see for example, Gerstner et al. 1994). On the other hand, Gerstner and Hess (1991a, 1991b, 1995) have developed a model to demonstrate that a manufacturer may find it profitable to offer rebates even when price discrimination does not occur, i.e., when the redemption rate of the rebate is 100%. In their model, they assume the existence of two groups of consumers with different reservation prices and different redemption costs, where all cost parameters are deterministic. Ault et al. (2000) have developed a deterministic multi-period inventory model and used it to demonstrate that manufacturer rebates can be used to increase the profits of manufacturers by mitigating arbitrage by retailers across temporally separated markets. Our model differs from these models in that we assume the retailer is facing a single-period stochastic demand, and we identify conditions under which the manufacturer and the retailer will benefit from the manufacturer rebate. One of our major findings is that for seasonal products (or products with short life-cycles), a manufacturer rebate can always increase the manufacturer’s profit, as long as some customers are forgoing the rebate.

Another area of related research involves manufacturer-retailer contractual relationships. In particular, the use of quantity discounts (Weng 1995), return policies (Emmons and Gilbert 1998), channel rebates (Taylor 2002), consignment contracts (Wang et al. 2004), and so forth, to achieve channel coordination has been studied extensively in the supply chain contracting literature. To the best of our knowledge, none of these supply chain management publications has explicitly analyzed the impact of a consumer rebate on a supply chain. See Cachon (2003) for a recent survey of analyses on supply contracts.
2. The Model

We consider a two-stage supply chain with a manufacturer and a retailer, and a single
seasonal product facing an uncertain and price-sensitive demand. Each unit of the product
requires a production cost of $k > 0. The manufacturer, which acts as a Stackelberg leader,
has to determine the unit wholesale price of $w > 0 of the product as well as a rebate of
$rw to be offered to the end customers so as to maximize the manufacturer’s expected total
profit, where $0 \leq r \leq 1$. We call $r$ the “rebate factor.” It is the fraction of the revenues
that the manufacturer is prepared to return to the customers through the rebate program in
case all customers eventually claim the rebate. The manufacturer has to make its decision in
anticipation of the reaction of the retailer after it has announced the wholesale price $w$ and
rebate $rw$. Once $w$ and $r$ are given, the retailer, which acts as a Stackelberg follower, has to
determine the order quantity $q \geq 0$ as well as the unit retail price $p > 0$ of the product so
as to maximize its expected total profit.

To model the relationship between retail price $p$, the rebate $rw$, and customer demand,
we classify customers into three categories, where some of which may be empty:

- customers who perceive the price of the product as $p$ and do not claim the rebate;
- customers who perceive the price of the product as $p - rw$ and claim the rebate;
- customers who perceive the price of the product as $p - rw$ when they make the purchase
  but do not claim the rebate later.

Define

$$D_b(p, y) = \rho(y)(p - y)^{-b} + [1 - \rho(y)]p^{-b},$$

where $b > 1$ and $\rho$ is a function such that $0 < \rho(y) \leq 1$ for any $y \geq 0$. We assume
that the demand of end customers is given as $D_b(p, rw)\varepsilon$, where $\varepsilon$ is a nonnegative random
variable with a general continuous probability distribution. We let $f(x)$ and $F(x)$ denote the
probability density function and cumulative distribution function, respectively, of $\varepsilon$. Note
that

$$D_b(p, rw) = \rho(rw)(p - rw)^{-b} + [1 - \rho(rw)]p^{-b}. \quad (1)$$

When the manufacturer is not offering any rebate (i.e., when $r = 0$), equation (1) becomes
$D_b(p, 0)\varepsilon = p^{-b}\varepsilon$. Such a multiplicative demand model has been widely adopted in the
literature, where parameter $b$ represents the price-elasticity index of the expected demand.
When \( r > 0 \), equation (1) implies that the customers are divided into two groups. One group consists of rebate-sensitive customers who perceive the rebate as a direct reduction of the selling price, while the other group consists of rebate-insensitive customers whose purchasing behavior is unaffected by the rebate. There are \( \rho(rw) \times 100\% \) of the customers belonging to the first group.

We further assume that \( [\rho(rw) - \tilde{\rho}(rw)] \times 100\% \) of the customers actually claim the rebate, where \( 0 \leq \tilde{\rho}(y) \leq \rho(y) \) for \( y \geq 0 \). Thus, if \( \rho(rw) \neq 0 \), then only \( \frac{\rho(rw) - \tilde{\rho}(rw)}{\rho(rw)} \times 100\% \) of the customers in the first group will eventually claim the rebate. The other customers in the first group, as well as all of the customers in the second group, will never claim the rebate. In other words, \( \tilde{\rho}(rw) \times 100\% \) of the customers perceive the selling price of the product as \( p - rw \) when they make their purchasing decision but end up forgoing the rebate.

Observe that if \( \rho(rw) = 1 \) and \( \tilde{\rho}(rw) = 0 \), all customers claim their rebate, and in this case, again, the demand model is the classical multiplicative demand model.

We assume that \( \rho \) and \( \tilde{\rho} \) are continuous and differentiable functions. We also assume that \( \tilde{\rho} \) is a nonincreasing function. This is justified by observing that the larger the rebate, the smaller the proportion of customers who will forgo the rebate. In practice, function \( \rho \) should be nondecreasing, since a larger rebate tends to induce more customers to treat the rebate as a reduction in price, whereas a small rebate can easily be ignored by consumers. However, our analysis does not require such a monotonic condition on \( \rho \). Finally, we assume that unsold items bear no salvage value or disposal cost.

3. Main Results

In this section, we summarize our main observations derived from the above model.

(a) We show that unless \( \tilde{\rho} \equiv 0 \), the optimal size of the rebate for the manufacturer is always nonzero. That is, unless all customers are claiming the rebate, the rebate always benefits the manufacturer. This suggests that it is always beneficial for the manufacturer to offer some rebates to end customers, as long as the rebate claiming process is designed in such a way that some customers who are attracted by the rebate will forgo the rebate. Such a condition is satisfied when the manufacturer rebate is a mail-in rebate, where some customers end up not claiming the rebate, particularly when the size of the rebate is very small. Therefore, a reason for manufacturers to offer
mail-in rebates is to increase their own profits by introducing lower perceived selling prices for the products.

(b) The wholesale price increases as the rebate factor increases. Indeed, unless all rebate-sensitive customers forgo the rebate, a small rebate will result in an increase in the manufacturer’s wholesale price from the nominal wholesale price (i.e., the wholesale price when no rebate is provided). Further, the realized wholesale price (i.e., the wholesale price less the rebate amount) is smaller than the nominal wholesale price. Therefore, the retailer partially pays for the rebate provided by the manufacturer.

(c) If $\rho$ and $\tilde{\rho}$ are independent of the size of the rebate amount $rw$, i.e., the sizes of the three categories of customers are insensitive to the size of the rebate $rw$, and if less than 100% of the customers who perceive the rebate as a direct reduction of the selling price will actually claim the rebate, then there exists a manufacturer rebate which can benefit the retailer. This, together with (a), implies that a mail-in rebate exists to increase the overall expected profit of the system.

(d) If not all the rebate-sensitive customers are claiming the rebate, then the retailer tends to order more than the case with no rebate being offered. With regard to the retailer’s selling price, one legitimate guess is that the retailer will increase its selling price if a manufacturer rebate is provided. However, this is not necessarily the case.

(f) When all the customers always claim the rebate, regardless of the size of the rebate, it is not necessarily beneficial for the manufacturer to provide rebates. Neither is it beneficial for the retailer. Such a case occurs when the rebate offered by the manufacturer is an “instant rebate,” where every customer will redeem the rebate on the spot when they make the purchase.

References


