Return policy and contract design under asymmetric return rate information

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Abstract

In this paper, we mainly discuss how a manufacturer should provide return service with different market-return rates when offers a partial refund. We consider a supply chain model that a dominant manufacturer supplying a single product to a retailer under the revenue sharing contract, in a single-period. The market demand is assumed to be dependent on the return price offering by manufacturer. We first analyse the model with the full information about market-return rate, which shows that manufacturer can determine the optimal return price according to the consumer's sensitivity of return price and the market-return rate. However, when the retailer has more private information about market-return rate, manufacturer can screen out the private information of the retailer through the contract menus in the terms of return price and revenue sharing ratio.

Keywords: revenue sharing contract, market-return rate, return price, contract menu.

1 Introduction

With the rapid economic development in recent years, extensive product range makes it easy for consumers to buy any product they want. Especially with the rise of E-commerce, consumers can buy products through the network without going to the store. However, sometimes, consumers feel much uncertain about whether specific products fit their needs or match their tastes. If the products do not fit their expectations, they may choose to return them back. Hence firms typically offer money-back guarantees to ensure consumer satisfaction. Stock et al. [1] show product returns have become an increasing burden for makers and seller of almost every kind of good. In fact, the value of products that United States consumers return to the nation's retailers each year exceeds $100 billion. However, only about 5% of return was because a product was truly defective; Instead, most consumers gave up on products for other reasons, such as the device being too confusing to use [2]. Therefore, in order to ensure consumer satisfaction, enterprises need develop appropriate return policies. Guide et al. [3] show that most of mass retailers in the European Union offer full refund within 30-90 days of purchase. An efficient-return system will help eliminate consumers' concern, stimulate their desire to purchase, which promote the enterprise have a stable consumer base and a leading position in the fierce competition.

Although enterprises provide return service across all sectors, return service is a double-edged sword. This is because the enterprises will face with "Trade Off" phenolmenon when they offer a return policy. Return service in stimulating demand situation will also lead to high rate of return. Clearly, part of the growth in product returns arises from a liberalization of policies that allow their return, particularly in the United States. The United States electronics industry spent about $13.8 billion to re-box, restock and resell returned products in 2007, according to a study by technology consultant Accenture Ltd. Yet, consumers in Europe are also experiencing more liberal return policies that now go beyond government mandated law [4]. Such return rates are especially apparent in catalogue/internet mail order companies, with can be as high as 75% [5]. Thus many firms are reluctant to offer a full refund unconditionally. They would like to attach some restricttions in order to balance the return cost and demand, for example, set the return period, or offer a partial refund. This paper mainly considers the return policy problem in a supply chain composed of one dominant manufacturer and one retailer, where the consumer returns rate is private information to the retailer. The asymmetry of consumer returns arises from many reasons, such as retailer's sales strategy, after-sales service, and the interaction between the retailer and consumers, which may lead to the retailer having better information about consumer preference [6].

The remainder of this paper is organized as follows. In the next section, we review the relative literatures, and in Section 3 we set up a formal model and detail the timeline. Section 4 analyses the game with a uniquely determined market-return rate. Section 5 we derive how the manufacturer provides return service under different market-return rates. Our conclusions are presented in Section 6.

2 Literature review

This paper is closely related to consumer returns policy and supply chain coordination management.

Different studies of consumer returns policy have been highlighted in recent years. Che [7] studies the economic rationale for customer return policies, by focusing on the "experience goods" aspect of many products. Hess et al. [8] show that retailers are motivated to impose non-refundable return charges based on a percentage of the merchandise value to prevent "inappropriate" returns by consumers. Vlachos and Dekker [9] introduce a single

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period model with resalable returns. Samar and Robert [10] develop a profit-maximization model to obtain optimal policies for price and the return policy in terms of certain market reaction parameters. Michael and Rob [11] study a firm that sells a product to consumers who are sensitive to both price and return policy. Chen and Bell examine how customer returns influence the retailer's ordering decision, the manufacturer's wholesale price decision, and the profits of the manufacturer and the retailer, in a single-period, stochastic demand (newsvendor) setting. Hsiao and Chen [12] investigate the interplay between returns policy, pricing strategy and quality risk. By constructing an analytical model with both demand and return uncertainnties, Liu et al. [13] study the optimal policy with three dimensional decisions on pricing, consumer return, and level of modularity under a mean-variance formulation. Li et al. [14] develop several theoretical models to examine the impact of online distributor's return policy, product quality and pricing strategy on the customer's purchase and the return decisions.

Our work is closely related to the literature on supply chain coordination under a return policy. Pasternack [15] demonstrates that a policy whereby a manufacturer offers retailers full credit for a partial return of goods may achieve channel coordination. Choi et al. [16] study a supply chain which is integrated by a returns policy. They first investigate the optimal returns policy under the existence of the e-marketplace, and then further study the risk issue associated with the optimal policy. Konstantaras et al. [17] research the optimal pricing, return and modular design policy for build-to-order (BOT) products in a two parties supply chain system. Su [18] studies the impact of full returns policies and partial returns policies on supply chain performance. Hsieh and Lu [19] study the manufacturer's return policy and the retailers' decisions in a supply chain consisting of one manufacturer and two risk-averse retailers under a single-period setting with price-sensitive random demand. Xiao et al. [20] investtigates coordination of a supply chain consisting of one manufacturer and one retailer facing consumer return. Alinovi et al. [21] focus on a stochastic EOQ-based inventory control model for mixed manufacturing/re-manufacturing systems with return policies.

Although the importance of consumer behaviour and supply chain return policy is widely investigated, few researches integrate them. In view of this gap in the literature, there are the main contributions in this paper: First, we describe the problem with different types of consumers. Second, we study the optimal return policies under different market-return rates. Third, we investigate the effect of consumer return on coordination mechanism.

3 The model

3.1 PROBLEM DESCRIPTION

We consider a supply chain with a dominant manufacturer (he) supplying a single product to a retailer (she) in a single period. The manufacturer faces consumer returns and implements a consumer returns policy. We assume the manufacturer sells the product at a fixed price 1. When the selling period ends, there are $\mu(0 \le \mu \le 1)$ percent of the consumers who brought the products would return at a price of $1 - r(0 \le r \le 1)$.When the selling period ends, The manufacturer and the retailer obtain their own profit through the revenue sharing contract, according to which the retailer gets $1 - \beta(0 \le \beta \le 1)$ percent of the sales revenue. In the selling event, the manufacturer's decisions include revenue sharing ratio β, as well as the return price $1 - r$ to be paid if consumers choose to return the product. As Su shows, when $0 < 1 - r < 1$, we say that the manufacturer offers a partial refund (or partial return). In practice, partial refunds have alternative reincarnations: they may appear as restocking fees, or may be disguised as non-refundable shipping charges. In contrast, when $1 - r = 1$, we say that the manufacturer offers a full refund (or full return). The unit production cost for the manufacturer is c and the unit holding cost for the retailer is h. We assume that the products returned from the consumers cannot be resold during the period and the market-return rate μ satisfies $\mu < 1 - h - c$.

We assume the demand is sensitive to the return price and the demand function is given by $D = a' + k(1 - r)$, which increases with $1 - r$, where a' is the fundamental capacity of the market, $1 - r$ is the return price which is decided by the manufacturer and k is consumer's sensitivity of return price. Denote $a' + k = a$, so the demand can rewrite to be $D = a - kr$.

3.2 TIMELINE OF THE MODEL

The timeline of our model is illustrated in Figure 1. First, the manufacturer supplies a contract (r, β) to the retailer. Once the retailer accepts it, D units of products will be sold. At the end of the sales period, parts of the sold products will be returned, the market-return rate is μ and the return price is $1 - r$. When the deadline of the return cycle comes, the manufacturer calculates the actual sales $(1 - \mu)D$, and then gives β percent of the actual sales profit to the retailer. The final profit of the manufacturer and the retailer can be realized finally.

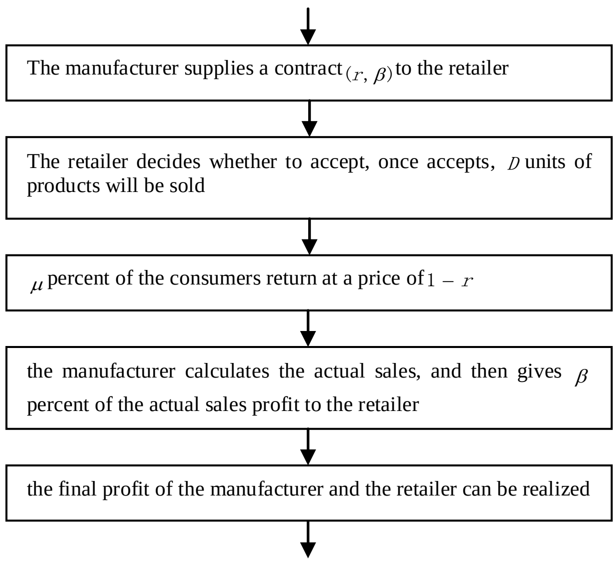

FIGURE 1 Timeline of the model

4 Benchmark: The model with a uniquely determined market-return rate

The empirical studies (for example, Anderson et al. [22]) showed that the quantity sold has a strong positive linear relationship with the number of returns. Vlachos and Dekker assumed that customer returns are a fixed proportion of quantity sold. To focus on investigating the impact of consumer's sensitivity of return price on the optimal return price, for the benchmark case, we assume that market-return rate is uniquely determined and known to both the manufacturer and the retailer. We represent the manufacturer's profit function, the retailer's profit function and the total profit function, respectively, to be Π_M, Π_R and Π_T.

$$\Pi_M = [(1-\beta)(1-\mu) - c + \mu r](a - kr) \tag{1}$$

$$\Pi_R = [\beta(1-\mu) - h](a - kr) \tag{2}$$

$$\Pi_T = (1 - h - c - \mu + \mu r)(a - kr) \tag{3}$$

Proposition 1. For the consumer's sensitivity of return price, there exists a low threshold $\underline{k} = \frac{a\mu}{1-h-c+\mu}$ and a high threshold $\bar{k} = \frac{a\mu}{1-h-c-\mu}$. Under a uniquely determined market-return rate, the optimal return price is presented as follows:

$$1 - r^* = \begin{cases} 0, if \ k \le \underline{k}; \\ \frac{k(1-h-c+\mu) - a\mu}{2k\mu}, if \ \underline{k} < k < \bar{k}; \\ 1, if \ k \ge \bar{k}. \end{cases}$$

Proof. The manufacturer's profit maximization problem as

$$\Pi_M = \max_{\beta, r}[(1-\beta)(1-\mu) - c + \mu r](a - kr) \tag{4}$$

Subject to $\Pi_R \ge 0$ (5)

From constraint (5) we can get $\beta \ge \frac{h}{1-\mu}$, for Π_M is decreasing in β, so $\beta = \frac{h}{1-\mu}$. According to $\frac{\partial \Pi_M}{\partial r} = 0$, we get $r = \frac{a\mu - k(1-h-\mu-c)}{2\mu k}$. So that we can easy get the relation between $1 - r$ and k, just as Figure 2 describes, in which we set $c = 0.2$, $h = 0.1$, $\mu = 0.2$, $a = 10$.

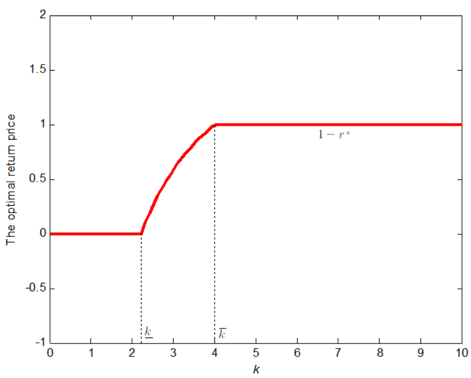

FIGURE 2 The optimal return price changes with k in the benchmark case

Proposition 1 points out the manufacturer's optimal return price in different situations. Facing different consumer types, the manufacturer provides may provide different return service. When the consumer's sensitivity of return price is low (i.e., $k \le \underline{k}$), manufacturer cannot provide return service. In this case, the consumer cares more about the value of product than the return price. Hence, even if the manufacturer does not provide return service, the impact on demand is relatively small. On contrary, the consumer is very sensitive to the return price (i.e., $k \ge \bar{k}$), the optimal strategy should be to return with a full refund policy. Because the return price has a great influence on the demand, if not attractive enough, the consumer would not consider buying the product, and then the manufacturer's profit may also be affected. For the same reason, when the consumer has a moderate sensitivity of return price (i.e., $\underline{k} < k < \bar{k}$), manufacturer can determine the return price according to the consumer's sensitivity of return price and the market-return rate. As can be seen from Proposition 1, the optimal return price is monotonic increasing in the consumer's sensitivity of return price and monotonic decreasing in the market-return rate. Therefore manufacturers need develop the optimal return strategies based on the real market environment, thus ensuring adequate access to effective earnings.

5 Manufacturer provides return service under different market-return rates

In the previous analysis, we discuss how an enterprise to provide the return policies under a certain market-return rate. However, in practical situations, manufacturer and retailer may face with different market-return rates. Assuming there are two markets, a market-return rate is lower set μ_L, and another one is $\mu_H (\mu_H > \mu_L)$. In the market with lower return rate, the consumers care more about the value of the product, they would make a full understanding of the product before buying it, unless the product has quality problems, they would not return them easily. In contrast, in the market with higher return rate, consumers buy the product blindly without a sufficient understanding or they just want to have an experience rather than buy it, so before buying it, they have had the thought of return. Based on this situation, in this section, we give a detailed analysis of the model in two scenarios: symmetric information and asymmetric information. Under the condition of symmetric information, we derive the optimal return price for the manufacturer. In the asymmetric case, we derive the optimal return price and revenue sharing ratio in equilibrium.

5.1 SYMMETRIC INFORMATION

Under the condition of symmetric information, the information for market-return rate is public and known to both the manufacturer and the retailer. Similar to Proposition 1, we can easily figure out the thresholds of k under different market-return rates.

$$\underline{k_L^S} = \frac{a\mu_L}{1-h-c+\mu_L}, \ \overline{k_L^S} = \frac{a\mu_L}{1-h-c-\mu_L},$$

$$\underline{k_H^S} = \frac{a\mu_H}{1-h-c+\mu_H}, \ \overline{k_H^S} = \frac{a\mu_H}{1-h-c-\mu_H}.$$

By comparison it is not difficult to find the magnitude relation between the thresholds satisfies

$$\begin{cases} \underline{k_L^S} < \underline{k_H^S} < \overline{k_L^S} < \overline{k_H^S}, if\ (\frac{1}{\mu_L} - \frac{1}{\mu_H})(1-h-c) < 2; \\ \underline{k_L^S} < \overline{k_L^S} \le \underline{k_H^S} < \overline{k_H^S}, if\ (\frac{1}{\mu_L} - \frac{1}{\mu_H})(1-h-c) \ge 2. \end{cases}$$

Similar to Proposition 1, we have Proposition 2.

Proposition 2. Under the condition of symmetric information, the optimal return price for the manufacturer under different market-return rates can be written as

$$1 - r_{iS}^* = \begin{cases} 0, if\ \ k \le \underline{k_i^S}; \\ \dfrac{k(1-h-c+\mu_i) - a\mu_i}{2k\mu_i}, if\ \ \underline{k_i^S} < k < \overline{k_i^S}; \\ 1, if\ \ k \ge \overline{k_i^S}. \end{cases}$$ where $i \in \{H, L\}$.

Proof. Proposition 2 can be proved as Proposition 1.

We can visually see how the optimal return price changes with k in Figure 3 (the parameters are $c = 0.2$, $h = 0.2$, $\mu_H = 0.3$, $\mu_L = 0.2$, $a = 10$). According to the above results, consumer's sensitivity thresholds of return price in low return rate market are always lower than the high return rate market (i.e., $\underline{k_L^S} < \underline{k_H^S}$, $\overline{k_L^S} < \overline{k_H^S}$), namely return policies in low return rate market are more favourable. It is because that low return rate market has the lower amount of return, even if the high return price, manufacturer's return cost is still relatively low, so the manufacturer can provide preferential policies to eliminate consumer's concerns for the product and thus stimulating demand. In the high return rate market, changes in the return price have a greater impact on the return cost, so manufacturer will not easily provide preferential return services. In general, manufacturer would like to provide discount return service or even not provide the return service. Only if the consumers are extremely sensitive to return price, the optimal strategy for the manufacturer should be a full refund policy.

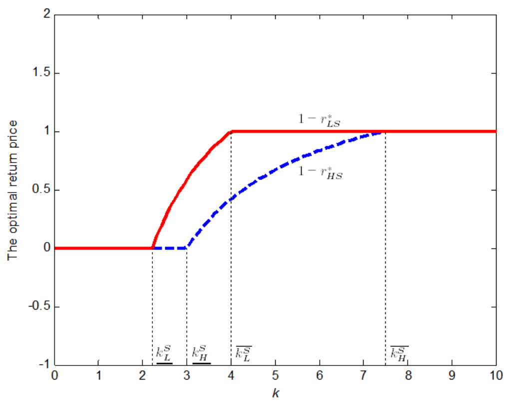

FIGURE 3 The optimal return price changes with k under symmetric information

5.2 ASYMMETRIC INFOTMATION

When the information for market-return rate is not public, we assume that the retailer has more private information about market-return rate. In this section, we introduce a menu of contracts $(r_i, \beta_i)(i \in (H, L))$ offered by the manufacturer to screen out the private information of the retailer. Ex-ante, the market-return rate is uncertain, which is μ_H with probability $\lambda \in (0,1)$ and μ_L with probability $1-\lambda$. The retailer in different market-return rates market may choose different contracts to maximize her profit. Assume that the retailer with μ_i to be type i. Then, we represent $\Pi_{AR}^{i,j}$ to be the profit function of the type i retailer to choose the contracts (r_j, β_j), $i, j \in (H, L)$. At the same time, we reduce the superscript ij of Π_{AR}^{ij} to i whenever $i = j$. Rewriting the profit function of the retailer, we have

$$\Pi_{AR}^H = [\beta_H(1-\mu_H) - h](a - kr_H)$$
$$\Pi_{AR}^L = [\beta_L(1-\mu_L) - h](a - kr_L)$$
$$\Pi_{AR}^{LH} = [\beta_H(1-\mu_L) - h](a - kr_H)$$
$$\Pi_{AR}^{HL} = [\beta_L(1-\mu_H) - h](a - kr_L)$$

When the manufacturer offers the contracts $(r_i, \beta_i)(i \in (H, L))$, he wants to maximize the profit. We present the manufacturer's contracts design problem as the following optimization model:

$$\Pi_M^A = \max_{\beta_H, \beta_L, r_H, r_L} \lambda[(1-\beta_H)(1-\mu_H) - c + r_H\mu_H](a - kr_H) + (1-\lambda)[(1-\beta_L)(1-\mu_L) - c + r_L\mu_L](a - kr_L) \quad (6)$$

Subject to

(I.R. H) $\Pi_{AR}^H \ge 0$ (7)

(I.R. L) $\Pi_{AR}^L \ge 0$ (8)

(I.C. H) $\Pi_{AR}^H \ge \Pi_{AR}^{HL}$ (9)

(I.C. L) $\Pi_{AR}^L \ge \Pi_{AR}^{LH}$ (10)

The object function (6) is the manufacturer's expected optimal profit. Constraints (7) and (8) are individual rationality restrictions to show the retailer's profit should no less than zero. Constraints (9) and (10) are incentive compatibility restrictions which ensure either the retailer with μ_H or μ_L doesn't have the incentive to mimic each other.

For $\mu_H > \mu_L$, we get $\Pi_{AR}^{LH} > \Pi_{AR}^H$, so

$\Pi_{AR}^L \ge \Pi_{AR}^{LH} > \Pi_{AR}^H \ge 0$,

constraint (8) is redundant. From constraint (7) we know $\beta_H \ge \frac{h}{1-\mu_H}$, for Π_M^A decreases in β_H, so $\beta_H^A = \frac{h}{1-\mu_H}$.

Similarly, we can get

$\beta_L^A = \frac{h(\mu_H - \mu_L)(a - kr_H)}{(1-\mu_H)(1-\mu_L)(a - kr_L)} + \frac{h}{1-\mu_L}$ from constraint (10).

From constraint (9) we know $\Pi_{AR}^{HL} \le 0$, i.e. $\beta_L \le \frac{h}{1-\mu_H}$, it is not difficult to figure out that $\beta_L^A - \frac{h}{1-\mu_H} < 0$, so constraint (9) can be satisfied.

Substituting β_H^A and β_L^A into objective function (6), according to $\frac{\partial \Pi_M^A}{\partial r_H} = 0$ and $\frac{\partial \Pi_M^A}{\partial r_L} = 0$, we have

$$r_H^A = \frac{a\mu_H - k(1-h-c-\mu_H) + \dfrac{kh(1-\lambda)(\mu_H - \mu_L)}{\lambda(1-\mu_H)}}{2k\mu_H},$$

$$r_L^A = \frac{a\mu_L - k(1-h-c-\mu_L)}{2k\mu_L}.$$

According to r_H^A and r_L^A, we can easily derive the thresholds of k under different market-return rates.

$$\underline{k_L^A} = \frac{a\mu_L}{1-h-c+\mu_L}, \overline{k_L^A} = \frac{a\mu_L}{1-h-c-\mu_L},$$

$$\underline{k_H^A} = \frac{a\mu_H}{1-h-c-\mu_H-h\dfrac{(1-\lambda)(\mu_H-\mu_L)}{\lambda(1-\mu_H)}},$$

$$\overline{k_H^A} = \frac{a\mu_H}{1-h-c+\mu_H-h\dfrac{(1-\lambda)(\mu_H-\mu_L)}{\lambda(1-\mu_H)}}.$$

The thresholds satisfies

$$\begin{cases} \underline{k_L^A} < \underline{k_H^A} < \overline{k_L^A} < \overline{k_H^A}, if\, (\dfrac{1}{\mu_L}-\dfrac{1}{\mu_H})[1-h-c+\dfrac{h\mu_L(1-\lambda)}{\lambda(1-\mu_H)}] < 2; \\ \underline{k_L^A} < \overline{k_L^A} \le \underline{k_H^A} < \overline{k_H^A}, if\, (\dfrac{1}{\mu_L}-\dfrac{1}{\mu_H})[1-h-c+\dfrac{h\mu_L(1-\lambda)}{\lambda(1-\mu_H)}] \ge 2. \end{cases}$$

From the above results, we come to the following proposition.

Proposition 3. When the retailer has more private information about market-return rate, the optimal contracts (r_i, β_i) $(i \in (H, L))$ for the manufacturer under different market-return rates satisfy

$$1-r_{HA}^* = \begin{cases} 0, if\ k \le \underline{k_H^A}; \\ \dfrac{k(1-h-c+\mu_H)-a\mu_H-\dfrac{kh(1-\lambda)(\mu_H-\mu_L)}{\lambda(1-\mu_H)}}{2k\mu_H}, \\ \qquad if\ \underline{k_H^A} < k < \overline{k_H^A}; \\ 1, if\ k \ge \overline{k_H^A}. \end{cases}, \beta_H^A = \frac{h}{1-\mu_H},$$

$$1-r_{LA}^* = \begin{cases} 0, if\ k \le \underline{k_L^A}; \\ \dfrac{k(1-h-c+\mu_L)-a\mu_L}{2k\mu_L}, if\ \underline{k_L^A} < k < \overline{k_L^A}; \\ 1, if\ k \ge \overline{k_L^A}. \end{cases},$$

$\beta_L^A = \dfrac{h(\mu_H-\mu_L)(a-kr_{HA}^*)}{(1-\mu_H)(1-\mu_L)(a-kr_{LA}^*)} + \dfrac{h}{1-\mu_L}$, under which the supply chain can achieve the coordination.

Proposition 3 demonstrates the manufacturer's optimal contract menus under different market-return rates. When retailer has more private information about the market, manufacturer must offer a menu of appropriate contracts depending on different markets, including the return price and revenue sharing ratio. We can also see how the optimal return price changes with k in Figure 4 (the parameters are $\lambda = 0.5$, $c = 0.2$, $h = 0.1$, $\mu_H = 0.3$, $\mu_L = 0.2$, $a = 10$).

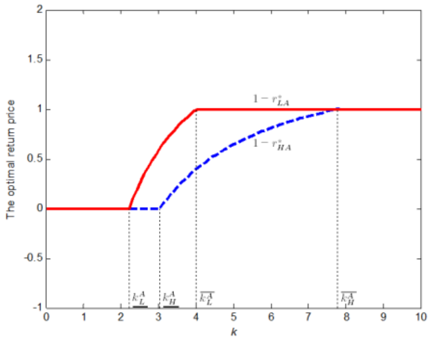

FIGURE 4 The optimal return price changes with k under asymmetric information

6 Conclusions

This paper studies how to develop optimal return strategies when the return service is offered by a dominant manufacturer. We first consider the model with a uniquely determined market-return rate. The results show that there are some thresholds about consumer's sensitivity of return price, according to which consumers can be divided into three types: insensitive, moderate sensitive, and sensitive, respectively, the optimal return policies should be no return, partial return and full return.

In addition, we study how the manufacturer provides return service under different market-return rates. When the information for market-return rate is public, manufacturer can make different return policies according to different markets. However, when the retailer has more private information about market-return rate, manufacturer can use appropriate contract menus to screen out the private information of the retailer.

We discuss the return policies from the manufacturer's perspective. In future researches, we can continue to study from the retailer's perspective or with a dominate retailer. Other opportunities for future research include extending the analysis to multiple periods, enabling continuous processing of returns, and assessing other forms of uncertainty such as the retail price and the cost of processing returns.

Acknowledgments

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