Pricing and Rebate Strategies in a Dual-Channel Supply Chain with Customer Returns

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Abstract. This paper studies the optimal customer rebate strategy in a dual-channel supply chain, in which online customers can obtain rebates or return unsatisfactory products. We consider that providing rebates can reduce online customers' willingness to return. Three rebate strategies are discussed: no one offering rebates, the manufacturer offering rebates and the retailer offering rebates. We investigate the impact of customer preference and rebate strategies on supply chain members' optimal decisions and manufacturer's performance. It is found that when the manufacturer offers rebates, wholesale price decreases as more customers prefer the online store. Through the numerical study, we find that the manufacturer can always get more profits by providing rebates.

Keywords: Dual channel; Customer rebate; Customer return; Pricing; Game theory.

1. Introduction

Nowadays, more and more retailers have both online and physical stores (e.g. Wal-Mart and Suning). It is estimated that retailers taking a dual-channel selling account for 80% in the US [1]. Like physical stores, many online stores hold promotions. Among them, customer rebate is becoming more popular. After customers accept products, merchants will directly offer them rebates.

Many scholars have studied the customer rebate. Beltramini and Chapman investigate whether customer rebate affects purchasing decisions through an empirical research in the automotive industry [2]. In a supply chain, the customer rebate increases sales, and only if all customers claim the rebate, the rebate causes losses to the manufacturer [3-6]. Some papers compare the customer rebate, the retailer rebate and manufacture-to-retailer rebate [7-10]. The existing studies don't consider the impact of rebate on return quantity. According to an empirical research, incentives for online customers who accept goods impact their willingness to return [11]. From this we know that when customers accept products, rebates can be provided as a kind of reward to reduce return quantity.

Therefore, we study the optimal rebate strategy in a dual-channel supply chain when online customers can obtain rebates or return unsatisfactory products. We also discuss how decisions and manufacturer's performance are impacted by the sensitivity of return quantity to rebate amount.

Contributions of this paper are as follows. Firstly, we consider the situation where the online store provides rebates. This is an emerging promotion activity with the popular of online shopping. Secondly, in our model, providing rebates can reduce online customers' willingness to return, and no paper studies this. It is interesting to find that online customers cost less to get products when either the manufacturer or the retailer provides rebates. And the manufacturer can always get more profits by providing rebates.

2. Model Description

We study a dual-channel supply chain, in which a manufacturer (he) wholesales all products to a retailer (she) and the retailer sells via an online store and a physical store. The manufacturer offers a kind of product to the retailer with a wholesale price w. To reduce channel conflicts, we assume that the prices of the two stores are the same, p, determined by the retailer. Like Hendershott and Zhang (2006), we assume that the online store allows customers to return unsatisfactory products, but the physical store doesn't. And base return quantity is fixed, which is decided by the quality of

product. Besides, all online customers who accept products will get a rebate, h, from the manufacturer or the retailer.

Demand and return functions are as follows:

$$D_o = a\theta - p + t_1 h \tag{1}$$

$$D_r = a(1-\theta) - p - t_2 h \tag{2}$$

$$R = \varphi - rh \tag{3}$$

where a denotes the potential demand of the whole market, θ $(0 < \theta < 1)$ denotes the customer preference for the online store, t_1 and t_2 denote rebate impact coefficient ($0 < t_2 < t_1 < 1$), φ denotes the base return quantity of the online store, and r $(r > 0)$ is the elastic coefficient of return quantity on rebate amount.

3. Model Analysis

3.1 No One Offering Rebates

When neither the manufacturer nor the retailer offers rebates, the rebate amount is zero, that is $h = 0$. Supply chain members' profit functions are as follows.

$$\pi_m^N = w(D_o + D_r) \tag{4}$$

$$\pi_r^N = (p - w)(D_o + D_r) - pR \tag{5}$$

It is easy to find that π_r^N is strictly concave about p. We solve the first-order codition $\frac{\partial \pi_r^N}{\partial p} = 0$ with given w to get $p^N(w)$. Substituting $p^N(w)$ into π_m^N, we can find π_m^N is strictly concave about w. So we can get w^N by solving the first-order codition $\frac{\partial \pi_m^N}{\partial w} = 0$. Then we can get p^N by substituting w^N into $p^N(w)$.The optimal solutions for the manufacturer and the retailer are:

$$w^N = \frac{a + \varphi}{4} \tag{6}$$

$$p^N = \frac{3a - \varphi}{8} \tag{7}$$

3.2 The Manufacturer Offering Rebates

In this strategy, the manufacturer offers rebates. Supply chain members' profit functions are,

$$\pi_m^M = w(D_o + D_r) - h(D_o - R) \tag{8}$$

$$\pi_r^M = (p - w)(D_o + D_r) - pR \tag{9}$$

We get the results provided that $2(5t_1 + \mathrm{r}(6 + t_1 - t_2) + 3t_2) - (r-1)^2 - (t_1 - t_2)^2 > 0$. The optimal solutions for the manufacturer and the retailer are:

$$w^M = \frac{a(1 + 5r + 7t_1 + t_2 - 4\theta(1 - r + t_1 - t_2)) + \varphi(3(1 + r + 3t_1) - t_2)}{2(2(5t_1 + \mathrm{r}(6 + t_1 - t_2) + 3t_2) - (r-1)^2 - (t_1 - t_2)^2)} \tag{10}$$

$$h^M = \frac{a(3 - r + t_1 - t_2 - 8\theta) + \varphi(7 - r + t_1 - t_2)}{2(5t_1 + \mathrm{r}(6 + t_1 - t_2) + 3t_2) - (r-1)^2 - (t_1 - t_2)^2} \tag{11}$$

$$p^M(w,h) = \frac{1}{4}(a - \varphi + h(r + t_1 - t_2) + 2w) \tag{12}$$

Proposition 1. Based on the above results, we have $\frac{\partial w^M}{\partial \theta} < 0,\ \frac{\partial h^M}{\partial \theta} < 0,\ \frac{\partial p^M}{\partial \theta} < 0.$

Proposition 1 shows that when θ increases, the wholesale price, rebate amount and selling price decrease. The explanation is as follows. As θ increases, more and more customers prefer shopping online. To reduce cost, the manufacturer lowers rebate amount. Since potential demand of the physical store decreases, the manufacturer lowers the wholesale price to stimulate the retailer. And the retailer is willing to reduce the selling price to attract more customers.

3.3 The Retailer Offering Rebates

When the retailer provides rebates, profit functions of the manufacturer and the retailer are,

$$\pi_m^R = w(D_o + D_r) \tag{13}$$

$$\pi_r^R = (p - w)(D_o + D_r) - h(D_o - R) - pR \tag{14}$$

We can get results provided that $8(\mathrm{r} + t_1) - (1 + r + t_1 - t_2)^2 > 0$. The optimal solutions for the manufacturer and the retailer are:

$$w^R = \frac{a\big(2(\theta(1+r) + 2t_1) - (1-r)^2 - (t_1 - t_2)(1 + r + 2\theta)\big)}{8(r(2 - t_1 + t_2) + t_1 + t_2)} - \frac{\varphi\big((1-r)(2 - t_1 + t_2) + (t_1 - t_2)^2 - 4t_1\big)}{8(r(2 - t_1 + t_2) + t_1 + t_2)} \tag{15}$$

$$p^R(w) = \frac{2(r + t_1)(a + 2w - \varphi) - (1 + r + t_1 - t_2)\big((t_1 - t_2)w + a\theta - \varphi\big)}{8(\mathrm{r} + t_1) - (1 + r + t_1 - t_2)^2} \tag{16}$$

$$h^R(w) = \frac{2(1 + r - t_1 + t_2)w + a(1 + r + t_1 - t_2 - 4\theta) - \varphi(3 - r - t_1 + t_2)}{8(\mathrm{r} + t_1) - (1 + r + t_1 - t_2)^2} \tag{17}$$

Proposition 2. Referring to the above results, we have $\frac{\partial w^R}{\partial \theta} > 0,\ \frac{\partial h^R}{\partial \theta} < 0,\ \frac{\partial p^R}{\partial \theta} < 0.$

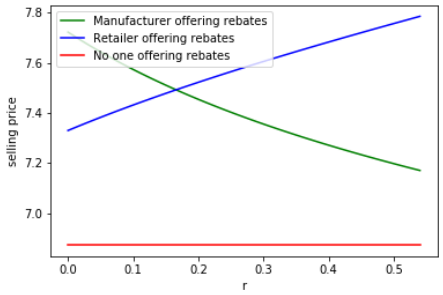
Proposition 2 shows as θ increases, the wholesale price increases, but selling price and rebate amount decrease. This is because when the retailer offers rebates, the manufacturers' profit is related to wholesale price and total demand. So, the manufacturer can make more profits by increasing wholesale price. As more customers prefer the online channel, the retailer reduces the rebate amount to reduce cost. And in order not to reduce demand, the retailer lowers selling price.

4. Sensitivity Analysis

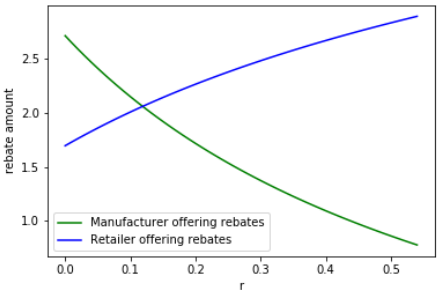
In this section, we conduct numerical experiments to discuss the effect of r on selling price, rebate amount and manufacturer's performance under three rebate strategies. The following parameters are utilized in this study: $a = 20,\ \theta = 0.5,\ \varphi = 0.5,\ t_1 = 0.9$, and $t_2 = 0.4$.

Fig. 1a and Fig. 1b shows that, as r increases, selling price and rebate amount decrease when the manufacturer offers rebates and they increase when the retailer offers rebates, but, both of them are greater than no one offering rebates. And we can find that online customers get products at a higher price $(p - h)$, if neither the manufacturer nor the retailer offers rebates. That is, when any member offers rebates, physical customers cost more to obtain products, while customers cost less, compared with no one offering rebates. As shown in Fig. 1c, when the retailer provides rebates, the

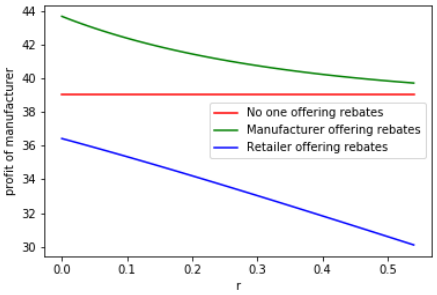
manufacturer will lose, but the manufacturer can get more profits by providing rebates by himself. This can be explained as follows. Providing rebates increases the manufacturer's cost, but it will be offset by increased total demand and wholesale price, making the manufacturer obtain more profits.



(a) Effect of r on selling price



(b) Effect of r on rebate amount



(c) Effect of r on profit of manufacturer

Fig. 1 Effects of r on selling price, rebate amount and profit of manufacturer

5. Conclusion

In this paper, we investigate the optimal pricing and rebate strategies when online customers can return unsatisfactory products or get rebates, assuming that offering rebates can reduce online customers' willingness to return. We consider three rebate strategies: no one offering rebates, the manufacturer offering rebates and the retailer offering rebates. We find that when the manufacturer offers rebates, wholesale price decreases as more customers prefer the online store. Besides, through the numerical experiment, it is found that when one of supply chain members offers rebates, physical customers cost more to get products, but online customers cost less, compared with no one offering rebates.. And the manufacturer can always get more profits by providing rebates himself.

Limitations of this paper is that we suppose both supply chain members are neutral towards risk. Besides, we assume that all online customers who accept products get rebates. In the future, it is possible to study how redemption rate impacts rebate strategies.

References

[1]. Zhang, J., Farris, P. W., Irvin, J. W., et al. Crafting integrated multichannel retailing strategies. Journal of Interactive Marketing. Vol. 24 (2010) No. 2, p.168–180.

[2]. Beltramini, R. F., Chapman, P. S. Do customers believe in automobile industry rebate incentives? Journal of Advertising Research. Vol. 43 (2008) No. 1, p. 16-24.

[3]. Chen, X., Li, C.-L., Rhee, B.-D., et al. The impact of manufacturer rebates on supply chain profits. Naval Research Logistics. Vol.54 (2007) No. 6, p. 667-680.

[4]. Arcelus, F. J., Kumar, S., Srinivasan G. Pricing and rebate policies for the newsvendor problem in the presence of a stochastic redemption rate. International Journal of Production Economics. Vol. 107 (2007) No.2, p.467-482.

[5]. Gourville, J. T., Soman D. The consumer psychology of mail-in rebates. Journal of Product & Brand Management. Vol. 20 (2011) No. 2, p. 147-157.

[6]. Muzaffar A., Malik M. N., Rashid A. Rebate mechanism for the manufacturer in two-level supply chains. Asia Pacific Management Review. Vol. 23 (2018) No. 4, p. 301-309.

[7]. Demirag O, C., Baysar O., Keskinocak P. et al. The effects of customer rebates and retailer incentives on a manufacturer's profits and sales. Naval Research Logistics. Vol. 57 (2010) No. 1, p. 88-108.

[8]. Geng Q., Mallik S. Joint mail-in rebate decisions in supply chains under demand uncertainty. Production and Operations Management. Vol. 20 (2010) No. 4, p. 587-602.

[9]. Caliskan-Demirag, O., Chen, Y., Li, J. Customer and retailer rebates under risk aversion. International Journal of Production Economics. Vol. 133 (2011) No. 2, p. 736-750.

[10]. Caliskan-Demirag, O., Keskinocak, P., Swann, J. Customer rebates and retailer incentives in the presence of competition and price discrimination. European Journal of Operational Research, Vol. 215 (2011) No. 1, p. 268-280.

[11]. Gelbrich, K., Gäthke J., Hübner A. Rewarding customers who keep a product: How reinforcement affects customers' product return decision in online retailing. Vol. 34 (2017) No. 9, p. 853-867.