Services and Prices in The Dual Channel Decision Research Considering the Return Rate

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Abstract

Considerating the impact of return rate on service and price. There are two methods used to discuss the decision of centralized and distributed dual-channel supply chain respectively. The Research found that the return rate can improve the level of sales price and service. Under the condition of dispersion, the manufacturer's profit is greater than the retailer's profits. But the retailer's profit is greater than the manufacturer with the increase of return rate. The total profit of the supply chain declined with the return rate increased. At last, Under the condition of=centralized decision-making, total supply chain profit rises with the highter return rate.

Keywords

Dual Channel; Return rate; service.

1. Introduction

With the rise of mobile payments and e-commerce, online shopping has long been an integral part of people's lives. Whether online retailers or traditional retailers are inevitably facing the "consumer return" dilemma. Regarding the "consumer return" problem, according to the research results of previous scholars, the return policy can be divided into three aspects: return cost, return period, return condition(Wang & Qu, 2017). Focusing on Return Costs, "Return Charges" and Full Refund and Partial Refunds Can Supply Chain Coordination McWilliams (Mcwilliams, 2013) establish a Double-Retailer Model for Retailers with Quality Differences and Think Full Refund Policy Can Make Low Retailers benefit from high quality but profit from high quality retailers. With regard to the return deadline, different companies have different return deadlines, Laura requires the return deadline must be within 14 days from the date of purchase, but John Lewis returns deadline are 90 days (Diggins Chen & Chen, 2016). With regard to return conditions, many businesses set "barriers" to reduce returns. For example, Nike's return policy includes a number of "Barrier Conditions" such as: The product must be un-repaired, unwashed, original packaging required, valid receipt or invoice provided. However, there are few studies discussing the dual impact of return rates and services on dual channels. Ofek (OfekKatona & Sarvary, 2011) pointed out that retailers usually only show low returns on online channels because retailers are more willing to create conditions, the high return rate of products purchased in physical stores, and then improve service levels, improve product matching rate and reduce the return rate. Chen (JingxianFeng & Liang, 2016) set up a hotelling model for competitive retailers and companies choose to invest in services to reduce the return rate of consumers. The results show that product heterogeneity and asymmetric customer return rate will have a significant impact on business decision-making and performance. The above research and cases lead to the author's some thoughts: the return rate of sales prices and store aids affect? How does the return rate affect retailer and manufacturer profits? Can companies decide whether to invest in store support services based on the return rate?

2. Model

This article considers a dual-channel supply chain consisting of manufacturers and retailers. Manufacturers sell products to retailers at wholesale price w, while selling the products to consumers online at price p, retailers provide high-cost services in physical stores and eventually sell at traditional price p, and $p > w$. Where A_e denotes the basic demand of the network channel at a price of 0, and $A_r$denotes the basic demand of a traditional retail channel at a price of 0. b represents the market demand elastic coefficient of price, λ represents the service level, r is the product's return rate, $0 < r < 1$, it is determined by the quality of the product itself. If you do not consider the free-riding behavior of consumers, η indicates the sensitivity of the retail channel market demand to service, m, k to increase the unit of service can increase the traditional channel and network channel product matching degree, and $0 < k < m < 1$. Use q_e and q_r to represent the demand of online channels and offline retail channels.

To facilitate analysis, we can make the following assumptions:

1. Supposing manufacturers and vendors are both rational and risk-neutral. Manufacturers generate a single product, in order to reduce the channel conflict caused by the channel price differences, retailers take online and offline the same price decision

2. Retailers provide new retail services λ only in traditional physical channels. The new retail services include: reducing consumer uncertainty about product awareness and reducing the likelihood of customer returns through instant customer support, on-site lectures, in-store advertising and promotions, on-site experience and other services to play a role in reducing product returns. The cost of store-ancillary services for offline retail channels is $C_s = \frac{1}{2}h\lambda^2$ for Ofek(Ofek Katona & Sarvary, 2011). Considering that service can reduce the return rate of products to a certain extent, the return rate of products in retail channels is $(1 - m\lambda)r$.

3. In order to simplify the model, it is assumed that there is no quality problem in the returned product, and the customer's return causes the retailer and the manufacturer to have the same expenses, which is represented by R. This article does not consider the production cost of the product and the channel sales cost.

2.1 Demand and Profit Function

Suppose the demand function is linear, the demand is affected by the channel price and service level, and the linear relationship between channel price and service level:

$$q_e = A_e - bp \quad (1)$$

$$q_r = A_r - bp + \eta\lambda \quad (2)$$

Manufacturers have online direct sales channels, while wholesale products are sold to traditional retailers in traditional channels. The profit function of the manufacturer and the profit function of the retailer are:

$$\pi_e = wq_r + pq_e - (1 - k\lambda)Rrq_e \quad (3)$$

$$\pi_r = (p - w)q_r - (1 - m\lambda)Rrq_r - \frac{1}{2}h\lambda^2 \quad (4)$$

3. Supply Chain Model under Decentralized Decision

3.1 Regardless of the Impact of the Return Rate, Is the Return Rate $r = 0$

In the case of decentralized decision making, consider the manufacturer-led Stackelberg model. First, the retailer determines the service level, and the manufacturer determines the wholesale price and channel price based on the retailer's response. In this paper, subscripts f and d are used to indicate the state of decentralized and centralized decision making. The superscript * indicates optimality. The retailer's profit function is as follows:

Available by reverse induction:

$$\max_{\lambda} \pi_r = \left(p_f - w\right) q_r - \frac{1}{2} h \lambda_f^2 \tag{5}$$

Given the price and channel price available, the best level of service available:

$$\lambda_f = \frac{(p_f - w)\eta}{h} \tag{6}$$

The manufacturer profit function is as follows:

$$\max_{p} \pi_e = w q_r + p_f q_e \tag{7}$$

We can conclude the best channel available p_f^* and λ_f^*

$$p_f^* = \frac{A_e - wb}{2b} \tag{8}$$

$$\lambda_f^* = \frac{[A_e - (b-2)w]\eta}{2b} \tag{9}$$

Nature 1: Wholesale prices are inversely proportional to sales prices and service levels, regardless of the decentralized effect of return rate considerations. As the wholesale price of the manufacturer increases, the sales price and service level will increase.

Proof: Derived from equations (8) and (9):

$$\frac{\partial \lambda_f^*}{\partial w} = \frac{-(b+2)\eta}{2h} < 0 \quad , \quad \frac{\partial \lambda_f^*}{\partial w} = -\frac{1}{2} < 0$$

3.2 There is a Return Rate Effect, That Is, the Return Rate $r \neq 0$

The optimal service level can be obtained by the inverse induction method:

$$\lambda_{f_r}^* = \frac{(p_{1r} - w - rR)\eta + \mathrm{mrR}(A_r - \mathrm{b}p_{1r})}{h - 2\eta \mathrm{mrR}} \tag{10}$$

Substituting equation (10) into equation (3) leads to the best price:

$$p_{fr}^* = \frac{(\eta w + krRA_e)(\eta - mbrR) - krRb[mrRA_r - (w + rR)\eta] + (h - 2\eta mrR)(A_r - \mathrm{wb} + \mathrm{rRb})}{2b(h - 2hmrR) + 2krRb(\eta - mbrR)} \tag{11}$$

Substitute:

$$\lambda_{fr}^* = \frac{(\eta \mathrm{w} + \mathrm{krR}A_e)(\eta - \mathrm{mbrR})^2 + (A_r - wb + rRb)(\eta - \mathrm{mbrR})(h - 2\eta \mathrm{mrR}) + [2b(h - 2\eta \mathrm{mrR}) + krRb(\eta - \mathrm{mbrR})][mrRA_r - (w + rR)\eta}{2b(h - 2\eta \mathrm{mrR}) + 2krRb(h - 2\eta \mathrm{mrR})(\eta - \mathrm{mbrR})} \tag{12}$$

Nature 2: The return rate is proportional to the service level. As the return rate increases, the retailer's service level is higher. At this time, the retailer needs to improve the service level to reduce the profit loss caused by the high return rate.

Proof: Derived from the return rate in (10):

$$\frac{\partial \lambda_{f_r}^*}{\partial r} = \frac{2\eta \mathrm{m} R^2 (mA_r - mbp_{1r} - \eta)}{(h - 2\eta \mathrm{mrR})^2} > 0$$

Nature 3: The threshold returns M_1 and M_2 , $M_1 < M_2$, if the return rate $\mathrm{r} < M_1$, the manufacturer's profit is greater than the retailer's profit, if $M_1 < \mathrm{r} < M_2$, the retailer's profit is greater than the manufacturer's profit, but the total supply chain profit is greater than 0; if $\mathrm{r} > M_2$, Total supply chain profit is less than 0.

Proof: Substituting equations (11) and (12) into equations (3) and (4), we can get the optimal solution $\pi_e^{f*}(r)$ and $\pi_r^{f*}(r)$.

We can make $\mathrm{f(r)} = \pi_e^{f*}(r) - \pi_r^{f*}(r)$.

We need $\mathrm{f(r)}$ to maximize profits, calculate M_1 and M_2, to make $\mathrm{f}(M_1) = 0, \mathrm{f}(M_2) = 0$

4. Dual-Channel Supply Chain Model under Centralized Decision

Retailers and manufacturers form a supply chain as a whole. Manufacturers and retailers are vertically integrated in traditional channels. The supply chain profit function is:

$$\pi_t^d = p(D_e + D_r) - [(1 - k\lambda)D_e + (1 - m\lambda)D_r]Rr - \frac{1}{2}h\lambda^2 \tag{13}$$

4.1 Regardless of the impact of the return rate, the return rate is $\mathbf{r = 0}$

Supply chain profit function is:

$$\pi_t^d = p_d(D_e + D_r) - \frac{1}{2}h\lambda_d^2 \tag{14}$$

Nature 4: When $4\mathrm{bh} - \eta^2 > 0$, π_t is a joint concave function of $p_d\ and\ \lambda_d$; when $4\mathrm{bh} - \eta^2 < 0$, π_t is a concave function of p_d, π_t is a concave function of λ_d, but π_t is not a joint concave function of $p_d\ and\ \lambda_d$.

Proof: Hessian matrix $\frac{\partial \pi_t^d}{\partial p_d^2} = -4d < 0, \frac{\partial \pi_t^d}{\partial \lambda_d^2} = -h < 0,\ \begin{vmatrix} -4b & \eta \\ \eta & -h \end{vmatrix} = 4\mathrm{bh} - \eta^2$. Its size is uncertain.

Therefore, when $4\mathrm{bh} - \eta^2 > 0$, π_t is a joint concave function of $p_d\ and\ \lambda_d$, the maximum and minimum of the profit function exist.

When $4\mathrm{bh} - \eta^2 < 0$, π_t is a concave function of λ_d, but π_t is not a joint concave function of $p_d\ and\ \lambda_d$.

Deriving p and λ separately can be obtained:

$$p_d^* = \frac{h(A_e + A_r)}{4bh - \eta^2} \tag{15}$$

$$\lambda_d^* = \frac{\eta(A_e + A_r)}{4bh - \eta^2} \tag{16}$$

Nature 5: Under the influence of no return rate, the optimal price of the supply chain and the optimal service level are as shown in equations (15) and (16).

4.2 Consider the Impact of Return Rate, Return Rate $\mathbf{r \neq 0}$

In order to maximize the objective function π_t, we first explore some properties of π_t and find the second-order partial derivative of $p_d\ and\ \lambda_d$ to obtain Hessian matrix.

$$\max_{p_{dr},\ \lambda_{dr}} \pi_t^{dr} = p_d(D_e + D_r) - [(1 - k\lambda_d)D_e + (1 - m\lambda_d)D_r]Rr - \frac{1}{2}h\lambda_{dr}^2 \tag{17}$$

The Hessian matrix is:

$$\pi_t = \begin{pmatrix} \frac{\partial \pi_t}{\partial p_{dr}^2} & \frac{\partial \pi_t}{\partial p_{dr}\partial \lambda_{dr}} \\ \frac{\partial \pi_t}{\partial p_{dr}\partial \lambda_{dr}} & \frac{\partial \pi_t}{\partial \lambda_{dr}^2} \end{pmatrix} = \begin{pmatrix} -4b & \eta - (\mathrm{m+k})\mathrm{rRb} \\ \eta - (\mathrm{m+k})\mathrm{rRb} & 2\eta\mathrm{mrR} - \mathrm{h} \end{pmatrix}$$

We can conclude $\frac{\partial \pi_t}{\partial p_{dr}^2} = -4b < 0, \frac{\partial \pi_t}{\partial \lambda_{dr}^2} = 2\eta\mathrm{mrR} - \mathrm{h}$, if $2\eta\mathrm{rR} - \mathrm{h} < 0$,

$\begin{vmatrix} -4b & \eta - (\mathrm{m+k})\mathrm{rRb} \\ \eta - (\mathrm{m+k})\mathrm{rRb} & 2\eta\mathrm{mrR} - \mathrm{h} \end{vmatrix} = -4b(2\eta\mathrm{mrR} - \mathrm{h}) - [\eta - (\mathrm{m+k})\mathrm{rRb}]^2$ cannot determine if the answer is Positive or negative.

Nature 6: When $2\eta rh < h$, π_t^{dr} is a concave function of p_{dr} ; π_t^{dr} is a concave function of λ_{dr}, but π_t^{dr} is not a joint concave function of p_{dr} and λ_{dr}.

Prove: Deriving p and λ, and parallel solution

$$\lambda_{dr}^* = \frac{[\eta-(m+k)rbR](A_e+A_r+2rRb)+4bRr(mA_r+kA_e-\eta)}{4b(h-2m\eta rR)-[\eta-(m+k)rbR]^2} \tag{18}$$

$$p_{dr}^* = \frac{4b(h-2\eta mrR)(A_e+A_r+2rRb)+\left[\eta-(m+k)rbR\right]4bRr(mA_r+kA_e-\eta)}{4b\left\{4b(h-2\eta mrR)-\left[\eta-(m+k)rbR\right]^2\right\}} \tag{19}$$

Nature 7: Under the condition of centralized decision-making, the return rate is directly proportional to the sales price and service level. As the return rate increases, the sales price rises. Similarly, as the return rate increases, the retailer improves the service level by raising the higher. The service to reduce the profit loss caused by the return rate.

Proof:

$$\frac{\partial\lambda_{dr}}{\partial_r} = \frac{2m\eta R^2[mA_r + kA_e - (m+k)bp - \eta]}{(h-2m\eta rR)^2} > 0, \quad \frac{\partial p_{dr}}{\partial_r} = \frac{[2-(m+k)\lambda]}{4} > 0$$

Nature 8: Under centralized conditions, given the service level, the return rate has a threshold r_0. If $r < r_0$, the total profit of the supply chain decreases with the increase of r. When $r \geq r_0$, the total profit of the supply chain increases with the increase of r , The total profit of the supply chain increases.

Proof: Substituting equation (18) into the total profit function of the supply chain:

$$\pi_t^d = p(D_e + D_r) - [(1-k\lambda)D_e + (1-m\lambda)D_r]Rr - \frac{1}{2}h\lambda^2$$

$$= \frac{\{A_e + A_r + \eta\lambda + [2-(m+k)rRb]\}^2 - 8rRb[(1-k\lambda)A_e + (1-m\lambda)(A_r - \eta\lambda)]}{8b}$$

It can be obtained that when $r = r_0$, $\frac{\partial\pi_t}{\partial r_0} = 0, \frac{\partial\pi_t}{\partial {r_0}^2} = 0$, so $r = r_0$ is the minimum value of the function

$$r_0 = \frac{4[(1-k\lambda)A_e + (1-m\lambda)(A_e - \eta\lambda)] - [2-(m+k)\lambda](A_e + A_r + \eta\lambda)}{2-(m+k)\lambda}$$

Given the service level, if $r_0 < 0$, the total profit of the supply chain increases as r increases.

Given the service level, if $r_0 > 0$

$$\pi_t^d = \begin{cases} \text{The total profit of the supply chain decreases as r increases} & r < r_0 \\ \text{The total profit of the supply chain increases as r increases} & r \geq r_0 \end{cases}$$

5. Conclusion

This paper considers the impact of return rate on services and dual channels by establishing a centralized dual-channel supply chain and a decentralized dual-channel supply chain model. Finding a return rate has a significant impact on service and price. As the return rate increases, manufacturers increase sales prices to reduce the risk of return rates, while service levels increase. However, under the decentralized decision model, there is a threshold for the return rate. When the return rate is less than a certain threshold, the profit of the manufacturer is greater than the profit of the retailer, but when the return rate is greater than a certain threshold, the profit of the retailer is greater than the manufacturer, and the return is high. The rate has brought negative profits to the online sales channel, and by increasing the sales price, it has been unable to reduce the losses caused by the return. Therefore, in actual production and operation activities, manufacturers must not only encourage retailers to improve service levels, but also take effective measures to minimize product return rates.

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