Dual-channel Supply Chain Sale Strategies with Return Guarantee

Jingshi HE
Logistic department, Dong Guan Polytechnic, Dong Guan, Guangdong, 523808
Corresponding author’s e-mail: hejings@163.com

Abstract. This paper explores the optimal pricing strategies under the centralized and decentralized dual-channel supply chain concerning customer returns and return guarantee. The influence of parameters on the optimal value such as optimal price, return policies, return guarantee, market share was analyzed. It shows that the profit of the enterprise is reduced with the increase of the return rates, and the return guarantee price is positively related to the profit of the enterprise. Enterprises can actively use the means of return guarantee and increase its price in order to obtain more supply chain profit, and increasing the size of the network direct sales is also effective to supply chain.

1. Introduction

With the development of online retailers, more and more manufacturing enterprises sell their products by combining traditional retail channels with online direct marketing, and formed the dual channel supply chain. Retail enterprises such as GOME and SUNING also adopted the method of combining traditional retail channels with online marketing. International famous brands opened e-commerce marketing while selling goods in traditional retail channels such as Estee Laud, Nike, Dell, Cisco. Dual-channel sales not only keep the consumers who like shopping in traditional channels but also attract new consumers and those consumers whom traditional sales difficult to cover, so it can expand the market scope, control sales prices, and improve supply chain’s profits[1].

In order to maintain a high degree of customer satisfaction and attract more consumers in the market full of fierce competition, more and more companies introduced a loose return policy, and false failure returns become the popular way of the market. Returning products without giving reasons within seven days for customers are not only popular in online shopping, but also prevalent in physical store. False failure returns will attract more consumers, but it also causes product re-inspection, repackaging, and cost incensement of reverse logistics. Baiman[2] showed that false failure returns increase consumer satisfaction, but it will bring unnecessary returns. Partial returns policy makes it difficult for consumers to be satisfied, and reduce consumer loyalty in his research. So some businesses use cost hassle to replace partial of the return policy such as fixed term return, self-freight, holding invoices, etc[3]. Return guarantee is a new model of network sales in recent years. Customers who purchase return guarantees are provided with a full refund. Elong and other booking site agents provide insurance of cancel order, and TMALL also provide insurance of return shipping. If customers purchase their freight fee insurance, then return freight fee will be paid by the third party, and that is to say, customers enjoy full return policy. Insurance of cancel order and insurance of return shipping can be regarded as a kind of return guarantee.

Return guarantee has just started in the practice, and the theoretical research in this field is rare. This paper build the supply chain pricing model considering the return guarantee, the influence of
supply chain pricing strategies and return strategies under return guarantee. ZHENG Chun-dong[3] using questionnaire method show that insurance of return shipping can significantly reduce the perceived risk of consumers, improve the level of trust, and then have a positive impact on the purchase intention of consumers. Mukhopadhyay[4] analyzed the optimal price and return policy in the online marketing from the perspective of reverse logistics. Yan[5] studied the influence of the retail service on pricing and profit distribution under dual-channel supply chain. CHEN Chong-ping[6] built the model of refund and pricing based on return guarantee in online sale environment, and optimal decision was analyzed in two cases of return and no return option, where goods price, return policies and return guarantee were seen as variables.

2. The Model Description

This paper considering manufacturers produce a single product to sale in the dual-channel supply chain (figure 1). The notations and the parameters are defined as follows:

- $\rho_d$ the online direct channel price.
- $\rho_r$ offline traditional retail channels price.
- $c_c$ manufacturer’s product cost.
- $c_r$ offline retailer selling cost.
- $\omega$ the wholesale price of manufacturer to the retailer.
- $\theta$ the market share of retailers, $0 < \theta < 1$.
- $1 - \theta$ the market share of online direct marketing,

where $\alpha$ is the potential market scale, $\alpha_r = \theta\alpha$ represents the basic market demand of retail channels, $\alpha_r = (1 - \theta)\alpha$ represents the basic market demand of online direct channels and $\alpha_r > 0, \alpha_r > 0[7]$.

![Figure 1 The model of dual-channel supply chain](image)

Considering the impact of price and cross price effects on traditional retail and online direct selling in the market, it is assumed that $b_1 > b_2 > 0$, $b_1$ is the price elasticity of demand, and $b_2$ is the cross-price elastic.

According to the above descriptions, the sales function of offline traditional retail ($D_r$) and sales function of online sale ($D_d$) can be given as follows:

$$D_r = \theta \alpha \rho_r - b_1 \rho_r + b_2 \rho_d; \quad D_d = (1 - \theta) \alpha \rho_d - b_1 \rho_d + b_2 \rho_r \quad (1)$$

Customer returns have become one of the effective channels to attract customers either offline traditional retail or online direct marketing channels, we assume that return function $R = \lambda Y_l (l = d, r)$, where $\lambda$ represents basic return rate. The return amount is $\phi$ when customer do not purchase return guarantee, and return factor accord with $0 < \phi \leq 1$.

Generally speaking, the offline traditional retailers return rate is less than the rate of the network direct sales channel, i.e. $\lambda_d \leq \lambda_r$, since the store customers can touch the production in entity stores.
We assume that $G$ represents the return guarantee price. Customer enjoy a full refund when their purchase return guarantee, and there is $\phi = 1, g = 0$ represents the customers don’t purchase the return guarantee, so they enjoy partial return refund.

The self pay freights in actual business when not purchase return guarantee also be viewed as partial return refund. Where $\phi$ represents the proportion amount which purchase return guarantee accounted for the market sales.

Profit function of offline traditional sale channels is follows:

$$\pi_c = (p_r - \omega - c_p)D_r + \theta g \phi_r - \lambda_\phi D_r - \lambda_\phi \phi_r D_r = (\theta \alpha - b_1 p_r + b_2 p_r \phi g + \omega - c_r - (\lambda_\phi + \lambda_\lambda g - 1) p_r)$$

(2)

Where $D_r(p_r - \omega - c_r)$ is the sales revenues, $\theta g \phi_r$ is the revenues of purchase return guarantee, $\lambda_\phi D_r$ is the amount return back to consumers who purchase return guarantee (full refund when purchase the return guarantee). $\lambda_\phi \phi_r D_r$ is the amount return back to consumers who don’t purchase the return guarantee.

Profit function of manufacturer direct sale online as follows:

$$\pi_d = D_d(\omega - c_d) + \theta g \phi_d - \lambda_\phi D_d - \lambda_\phi \phi_d D_d = (\lambda_\lambda \alpha - b_1 p_d + b_2 p_d \phi g)$$

(3)

We assume the $k_r = \lambda_\lambda g + \lambda_\phi - 1 < 0, k_d = \lambda_\phi + \lambda_\lambda g - 1$, so we get the supply chain profit function:

$$\pi_{sc} = (\lambda_\lambda \alpha - b_1 p_d + b_2 p_d) \phi g = (\lambda_\lambda \alpha - b_1 p_d + b_2 p_d) (\phi g - c_r - (\lambda_\phi + \lambda_\lambda g - 1) p_d)$$

(4)

3. Analysis of the Centralized Supply Chain Decision

We get the first derivative of price $p_r$ with respect to supply chain profit function ($\pi_{sc}$):

$$\frac{\partial \pi_{sc}}{\partial p_r} = 2 \lambda_\lambda h_1 p_r - b_1 (k_r + k_d) p_r - \theta \alpha h_1 + b_2 (b_1 - b_2) (\phi g - c_r)$$

(5)

Then second derivative of $\pi_{sc}$ get follows: $\frac{\partial^2 \pi_{sc}}{\partial p_r^2} = 2 \lambda_\lambda h_1$.

We assume that $k_r = \lambda_\lambda g + \lambda_\phi - 1 < 0, k_d = \lambda_\phi + \lambda_\lambda g - 1$, So the supply chain profit function is a convex function of $p_d, p_r$, and the supply chain profit function has the maximum value.

**Proposition 1:** There is an optimal price $p_r, p_d$ to maximize the profit of the supply chain. That is when the selling price is less the optimal price, the supply chain profit increases with the rise selling prices both offline retail and online direct. When the price is greater than the optimal price, the supply chain profit is decreases as the price.

We assume the first derivative (5) (6) equal to zero and get the optimal supply chain price.

$$p_{d_{opt}} = \frac{h_1 k_r}{b_1} - \frac{b_2 (b_1 - b_2) (\phi g - c_r)}{4 b_1^2 (k_r + k_d)^2}$$

(7)

$$p_{r_{opt}} = \frac{h_1 k_d}{b_2} - \frac{b_2 (b_1 - b_2) (\phi g - c_r)}{4 b_1^2 (k_r + k_d)^2}$$

(8)

According to the previous research it can be known that $b_1 > b_2, \lambda_\lambda g, \leq \lambda_\lambda g$, so $k_r < k_d$, we get the follows:
\[
\frac{4b_1^2 k_j k_j}{b_2^2(k_j + k_y)^2} > \frac{4b_1^2 k_j k_j}{b_2^2(k_j + k_y)^2} = \frac{4k_j k_j}{(k_j + k_y)^2} > \frac{k_j^2}{k_y^2} \quad \text{(1)}
\]

The first derivative of \( g \) with respect to optimal price of offline traditional sale and online sale get results as:

\[
\frac{\partial \rho^*}{\partial \theta} = \frac{ak_j [(2b_1 - b_2)k_y - b_2 k_y]}{4b_1^2 k_j k_y - b_2^2(k_y + k_y)^2} > 0 \quad \text{(9)}
\]

\[
\frac{\partial \rho^*}{\partial \theta} = \frac{ak_j [(b_1 - 2b_2)k_y + b_2 k_y]}{4b_1^2 k_j k_y - b_2^2(k_y + k_y)^2} < 0 \quad \text{(10)}
\]

Proved as follows:

\[
\begin{align*}
ak_j [(2b_1 - b_2)k_y - b_2 k_y] > ak_j [(2b_1 - b_2)k_y - b_2 k_y] = ak_j [(2b_1 - b_2)k_y] > 0 \\
\end{align*}
\]

Proposition 2: Retailers’ optimal prices increase with the increase of the offline retailer’s market share, where the optimal price of the online selling channel decreases with the increase of the retailer’s market share under centralized supply chain decision.

With the increase of the offline retailer’s market share, retailers will get more supply chain power and then making higher retail prices to gain more profits. On the contrary, with the increase in the proportion of online direct sales, the seller of online can also set higher prices to obtain greater profits.

\[
\begin{align*}
\frac{\partial \rho^*}{\partial g} &= \frac{(2b_1 k_j + b_2 k_j + b_2 k_y)\phi}{4b_1^2 k_j k_y - b_2^2(k_y + k_y)^2} < 0 \\
\frac{\partial \rho^*}{\partial g} &= \frac{(2b_1 k_j + b_2 k_y + b_2 k_y)\phi}{4b_1^2 k_j k_y - b_2^2(k_y + k_y)^2} < 0 \\
\end{align*}
\]

Proposition 3: The optimal price in online direct channel and offline traditional retail channels are inversely proportional with return guarantee. The profit under the centralized supply chain is directly proportion to return guarantee revenue.

The result of take partial derivative of \( \lambda \) with respect to the supply chain profit function \( \pi_{sc}^* \) as:

\[
\begin{align*}
\frac{\partial \pi_{sc}^*}{\partial \lambda} &= \phi + \phi \pi_{sc} \theta \alpha \theta - b_1 \lambda \theta + b_2 \pi_{sc} = -\phi + \phi \pi_{sc} \theta \alpha > 0 \\
\end{align*}
\]

Proposition 4: Supply chain profit decreases with the increase of the return rate. Therefore, enterprises should reduce the return rate can thorough the following measures: strengthen the analysis of the reasons for customer returns, improve product quality, strengthen the pre-sale and after-sales service, provide a more detailed description of the goods, etc.

Take partial derivative of \( \phi \) with respect to optimal price and supply chain profit \( \pi_{sc}^* \) under the centralized supply chain decision

\[
\begin{align*}
\frac{\partial \pi_{sc}^*}{\partial \phi} &= \frac{(2b_1 k_j + b_2 k_j + b_2 k_y)\phi(b_1 - b_2)}{4b_1^2 k_j k_y - b_2^2(k_y + k_y)^2} < 0 \\
\end{align*}
\]

\[
\begin{align*}
\frac{\partial \pi_{sc}^*}{\partial \phi} &= \frac{(2b_1 k_j + b_2 k_j + b_2 k_y)\phi(b_1 - b_2)}{4b_1^2 k_j k_y - b_2^2(k_y + k_y)^2} < 0 \\
\frac{\partial \pi_{sc}^*}{\partial \phi} &= \phi + \phi \pi_{sc} \theta \alpha > 0 \\
\end{align*}
\]
Proposition 5: The profit of supply chain is proportional to scales of purchase return guarantee under centralized decision, the optimal price of the online direct selling channel and the offline retail channel is inversely proportional to the scales of purchase return guarantee. Therefore, in order to obtain a higher profit enterprise should to strengthen the sale of return security options.

4. Analysis of the Decentralized Supply Chain Decision

According to the profit of traditional retail function, we get follows:

$$\frac{\partial \pi}{\partial p_r} = 2b_i k_r p_r - b_i k_r p_r - b_i (\phi_g - \omega - c_r) - \theta c_k k_r$$

According to the previous reasoning we know that $k_r < 0$, so $\frac{\partial^2 \pi}{\partial p_r^2} < 0$. We deduce that the profit of offline traditional retail function is a convex function of $p_r$, and it has the maximum value.

According to the profit of manufacturer’s online sale:

$$\frac{\partial \pi}{\partial p_o} = 2b_i k_o p_o - b_i k_o p_o - b_i (\phi_g - c_r) - \theta c_k k_o = 2b_i k_o$$

According to the previous we know that $k_o < 0$, so there is $\frac{\partial^2 \pi}{\partial p_o^2} < 0$. We deduction that the profit of offline traditional retail function is a convex function of $p_o$, and it has the maximum value.

According to $\frac{\partial \pi}{\partial p_r} = \frac{\partial \pi}{\partial p_o} = 0$, we get follows results:

$$p_r^* = \frac{b_i b_o (\phi_g - \omega - c_r) k_o + (2b_i \alpha - 2\theta a_i + \theta a_o) k_r k_o + b_i (\phi_g - c_r) k_r - b_i b_o (\omega - c_r) k_o}{(4b_i^2 - b_o^2)} k_r k_o$$

$$p_o^* = \frac{2b_i^2 (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r}{(4b_i^2 - b_o^2)} k_r k_o$$

Take partial derivative of $\beta, \gamma, \phi$ with respect to optimal price of offline traditional and online seals, the result follows:

$$\frac{\partial p_o^*}{\partial \beta} = 2b_i^2 (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r$$

$$\frac{\partial p_o^*}{\partial \beta} = \frac{2b_i^2 (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r}{(4b_i^2 - b_o^2)} k_r k_o$$

$$\frac{\partial p_o^*}{\partial \gamma} = 2b_i (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r$$

$$\frac{\partial p_o^*}{\partial \gamma} = \frac{2b_i (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r}{(4b_i^2 - b_o^2)} k_r k_o$$

$$\frac{\partial p_o^*}{\partial \phi} = b_i b_o (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r$$

$$\frac{\partial p_o^*}{\partial \phi} = \frac{b_i b_o (\phi_g - \omega - c_r) k_o + (2\theta a_i + \alpha b_o - \theta a_o) k_r k_o + b_i b_o (\phi_g - c_r) k_o - b_i^2 (\omega - c_r) k_r}{(4b_i^2 - b_o^2)} k_r k_o$$
\[
\frac{\partial \sigma_n}{\partial \sigma} = \beta, \phi > 0, \frac{\partial \sigma_n}{\partial \sigma} = \beta, \phi > 0
\]  
(28)

Proposition 6: Retailers’ optimal prices increase with the increase of the offline retailer’s market share, where the optimal price of the online selling channel decreases with the increase of the retailer’s market share under decentralized supply chain decision.

Proposition 7: The profit of supply chain is proportional to scales of purchase return guarantee under decentralized decision, the optimal price of the online direct selling channel and the retail channel is inversely proportional to the scales of purchase return guarantee.

5. Numerical Studies

Numerical analysis will be carried out to verify the previous theoretical analysis. We use the following numbers as the base values of the parameters and take MATLAB as the tool.

\[\alpha = 200, \quad \theta = 0.5, \quad b_1 = 3, b_2 = 2, c_r = 6, c_o = 8, \quad \omega = 10, \phi = 0.2, \varphi = 0.95, \lambda_r = \lambda_c = 0.2\]

Figure 2 indicates the relationship between supply chain profit and price of online direct selling or offline retail channel. It shows that supply chain profit function is a convex function of \(p_r, p_u\), and it has the maximum value. The optimal price under centralized supply chain decision is higher than the price under decentralized supply chain decision, and the supply chain profit under centralized decision is also greater than decentralized decision.

With the increase of return rate, the profit of retail and online direct model is decreased, the return rate reach one point and the profit is zero as figure 3 indicates. Enterprises should reduce the return rate by the following measures: strengthening the analysis of the reasons for customer returns, improving product quality, strengthening the pre-sale and after-sales service, or providing a more detailed description of the goods, etc.

As the figure 4 indicates, with the prices of return guaranteed increased, the supply chain profit increased slowly. So it is beneficial to increase the profit of the supply chain and the offline traditional retail and the online direct sales when raise the price of return guarantee.

As figure 5 indicates that the retailer’s price increases with the raise of offline market share, while decreases with the online direct selling share whether it is centralized decision or decentralized decision. This shows that with the offline market share increase, the seller has a greater right to develop market prices.

But the profit of supply chain decreases with the offline market share increase according figure 6. In order to achieve greater profits, manufactures can reduce the offline traditional retail market share and expand the market share of online direct sales under the dual channel sales.
6. Conclusions
Return guarantee is a new model of network sales in recent years, such as insurance of cancel order, insurance of return shipping, etc. Return guarantee can ensure the buyer obtain a full return service at a lower cost, which has been applied in practice and has been gradually extended.

It can be expected that return guarantee will be put in more further applications in the future no matter in the network store or entity stores. By now it has not been studied deeply in theoretical research.

The influence of parameters on the optimal value such as optimal price, return policies, return guarantee, market share was analyzed. We show that the profit of the enterprise is reduced with the increase of the return rates, and the return guarantee price is positively related to the profit of the enterprise. In order to obtain more supply chain profit. Enterprises can actively use the means of return guarantee and increase its price, Increasing the size of the network direct sales is also effective to supply chain.

Further research maybe done considering service level and return policy is different under the dual channel, and the risk aversion’s supply chain strategy.

Acknowledgements
This research was financially supported by the team of Logistics management research and service innovation. (Grant No. CXTD201803).

REFERENCES
[1] Ofek E, Katona Z, Sarvary M. (2011)“Bricks and clicks”: the impact of product returns on the strategies of multichannel retailers. Marketing Science. 30 : 42-60.
[2] Baiman s, Fischer P E, Rajan M v. (2000)Information contracting, and quality costs. Management Science, 46:776-289.
[3] Cachon G P, Swinney R. (2009) Purchasing, pricing, and quick response in the presence of strategic consumers. Management Science, 55:497-511.
[4] ZHENG Chun-dong, LIU Yi-fan, ZOU Meng. (2016) Influence of insurance of return-of-goods freight on purchase intention of online consumers. Journal of Shenyang University of Technology (Social Science Edition), 4:150-156.
[5] Mukhopadhyay S K, Setoputro R. (2007) A dynamic model for optimal design quality and return policies. European Journal of Operational Research, 180:1144-1154.
[6] Yanr R, Pei Z. (2011) Information asymmetry, pricing strategy and firm’s performance in the retailer-multi-channel manufacturer supply chain. Journal of Business Research, 64:377-384.
[7] CHEN Chong-ping, CHEN Zhi-xiang. (2016) Return Guarantee and Pricing Decision in Online Sales[J]. Chinese Journal of Management Science, 6:52-60.
[8] LIU Yong-mei, LIAO Pan, HU Jun-hua, CHEN Xiao-hong. (2015) Pricing Strategies in Dual-channel Supply Chain with Retail Services and Customer returns. Operations Research and Management Science, 6:79-87.