PRICING STRATEGIES IN A DUAL-CHANNEL SUPPLY CHAIN UNDER DIFFERENT POWER STRUCTURES

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ABSTRACT

The development of electronic commerce has prompted more and more manufacturers to adopt a dual channel to sell their products, i.e., the traditional retail channel and the online direct channel. The channel power structure is an important factor of strategic selection of dual-channel. This paper studies a two-layer dual-channel supply chain with a pricing model based on the consumer utility and selection. In order to provide decision support for the manufactures, we focus on the pricing issues for the supply chain and profits for the supply chain members. The result shows that the manufacturer's optimal price on direct channel is not necessarily higher than the retailer's optimal price on tradition channel.

INTRODUCTION

Over the past several years, the rapid development of E-Commerce technologies has made more and more manufacturing enterprises to adopt dual-channel operation. Besides the traditional retail channel, the online direct channel has been developed by manufacturers to sell products to consumers directly. The manufacturers with dual-channel will face the competition on the price with the retailers. Firstly, the manufacturers should set the price for the online direct channel. In case of the traditional retailers, the online direct channel is viewed as the logical extension of the storefront's physical presence [1]. With the adoption of the dual-channel, a group of consumers will switch from the traditional retail channel to the online direct channel. The traditional retailers have to reset the price to avoid the loss of consumers. So the pricing issue is an extremely serious problem for both the manufacturers and the retailers in the dual-channel system.

Earlier research has examined the dual-channel pricing strategies from the perspective of game theory. The channel members' pricing strategies mostly depend on their positions in the channel power structure. The channel power structure refers to the relative abilities of channel members to control the decision making process in the channel operation system [2]. The manufacturers and retailers in different channel power structures will have different pricing strategies to maximize their profits. In this paper, we consider the pricing strategies of the manufacturers and retailers under three channel power structures:

1 the manufacturer and the retailer making their own decisions independently;

2 the manufacturer is the channel leader and the retailer is the channel follower;

3 the retailer is the channel leader and the manufacturer is the channel follower.

Comparing the equilibrium prices and profits of the manufacturer and retailer under all the three channel power structures, we obtain the best pricing strategies for the manufacturer and retailer in the three different scenarios.

For a very long time, the dual-channel operation has attracted much attention in the research community of supply chain management. Concerning the conflicts between members in dual-channel supply chain, Tsay and Agrawal [3] pointed that the addition of a direct channel is not necessarily detrimental to the retailer; the reduction of wholesale price retains the retailer's selling effort and makes both parties better. Kurata et al. [4] analyzed channel conflicts in dual-channel under competition in both channel and brand perspectives. They pointed out that the price markup coordination can mitigate the channel conflicts and lead a win-win outcome. In our model, we ignore the corporation relationship and only consider the conflicts relationship between the manufacturer and retailer in the dual-channel system.

With the development of the online direct channel, the conflicts between the manufacturer and retailer tend to be much more serious. Previous research mainly focuses on pricing strategies for the members in the dual-channel supply chain. These results show that the online direct channel could be the exerting potential competition pressure on the existing retailer [5]. From a strategic perspective, Chiang et al. [6] analyzed a pricing game between manufacturer and retailer by developing a consumer choice model. The research indicated that the addition of a direct channel allowed the manufacturer to constrain the retailers' pricing strategies. Hou and Zhao [7] thought that the change in the price strategies of the online direct channel would influence the consumer demand, and then result in the coordination of the dual-channel operation system. The most research about the pricing strategies is from Game theory perspective. Different from the former research that only adopt one kind of game model, in our study, we model Bertrand Game and two-stage Stackelberg Games to analyze the pricing strategies under different channel power structures.

In addition to the pricing strategies, our study also considers the impact of channel power structures of the channel system. Considering the channel power structures, Geyskens et al. [8] compared the different performance between companies and found that the powerful companies with direct channel perform better than the less-powerful companies. Cai et al. [9] analyzed the influence of channel power structures and pricing schemes on the dual-channel system from supplier-Stackelberg, retailer-Stackelberg, and Nash game theoretic perspectives, and they obtained that the contract of price discount could reduce the channel conflicts. Also considering the power in Stackelberg Game, Chen and Bell [10] studied the manufacturer's pricing strategies in a dual-channel supply chain where the manufacturer is the leader and the retailer is the follower. The former research mainly focuses on part of the possible channel power structures. In our model we develop a model considering all the three possible power structures in the dual-channel operation system.

MODEL SETUP

In this section, we analyze the basic model of dual-channel operation. Firstly, we must define the basic process of different channels in the dual-channel operation system. In the traditional channel, the manufacturer wholesales the products to the retailers with a wholesale price ω, then the retailer sales the products to the consumers with a retail price p_r. And in the online direct channel, the manufacturer sales the products to the consumers online directly with a price p_d.

For simplicity, we assume that there are only one manufacturer and one retailer in this dual-channel operation system, and the manufacturer produces only one kind of products. All the consumers in this dual-channel system are considered rational and risk-neutral. The whole market scale is modeled as 1, and we assume that all the consumers are distributed uniformly on the line [0, 1] where the traditional retailer store is located at the point zero.

In the traditional retail channel, consumers have to pay some material cost and time cost for finding and buying the products. The farther from the retailer store, the higher costs customers need to pay. Consumers incur a utility loss of t per unit distance between their location and the location of the retailer store, so the purchasing cost for the consumers at point s will be noted as ts. In the online direct channel, consumers who purchase products from online direct store incur a searching and delivery cost b except for the product price. In this model, we assume that this utility cost is homogeneous for all consumers.

All the notations used in the dual-channel model are listed as follows:

θ: the reservation price of the product.
ω: the wholesale price of the product
c: the cost of the fixed product
p_r: the retail price of the products in the traditional channel
p_d: the direct price of the product in the online channel
t: the unit distance cost due to the consumers' position
s: the consumers' psychological distance to the traditional retail channel
λ: the degree of perception that consumers have on products in online channel
b: other cost except for price in the online direct channel
d_r: the market demand for traditional retail channel
d_d: the market demand for online direct channel
π_m: the total profit of the manufacturer
π_r: the total profit of the retailer

The utility of a consumer located at s can be expressed as follows:

$$u(\theta)=\begin{cases}\theta-p_r-ts, & \text{purchase from traditional channel}\\ \lambda\theta-p_d-b, & \text{purchase from online direct channel}\end{cases} \tag{1}$$

For risk-neutral consumers, their purchasing decisions only depend on the perceived utilities of products purchased through different channels. We assume that the reservation price of the product θ is large enough that every consumer realizes a nonnegative surplus from purchasing through any channel.

PRICE EQUILIBRIUM

As the manufacturer develops online direct channel, the consumers can not only purchase products from the traditional retail stores but also can purchase from online direct stores. Consumers will prefer the online direct channel only when the utility of purchasing online is nonnegative and larger than the utility of purchasing from retail channel. That is $u_d(\theta)=\lambda\theta-p_d-b\geq 0$ and $\lambda\theta-p_d-b\geq\theta-p_r-ts$. So, the consumer, indifferent between retail store and online store, is located at

$$\hat{s}=\frac{(\theta-p_r)-(\lambda\theta-p_d-b)}{t}=\frac{(p_d-p_r)+(1-\lambda)\theta+b}{t}.$$

The demands for traditional retail and online direct channels are determined to be

$$d_r=\left[(p_d-p_r)+(1-\lambda)\theta+b\right]/t, \tag{2}$$

$$d_d=1-\left[(p_d-p_r)+(1-\lambda)\theta+b\right]/t. \tag{3}$$

The profit of retailer contains only one part, revenue from retailing products. But the manufacturer's profit contains two parts, revenue from wholesaling products to retailer and that from selling product online. So the profit for retailer and manufacturer can be written as

$$\pi_r=(p_r-\omega)\cdot\frac{(p_d-p_r)+(1-\lambda)\theta+b}{t}, \tag{4}$$

$$\pi_m=(\omega-p_d)\cdot\frac{(p_d-p_r)+(1-\lambda)\theta+b}{t}+p_d-c. \tag{5}$$

Firstly, we consider the first power structure of dual-channel, in which the manufacturer and retailer set the price independently to maximize the interests of their respective. So they play a Bertrand game and reach their own Nash equilibrium under first-order conditions $\partial\pi_m(p_d)/\partial p_d=0$ and $\partial\pi_r(p_r)/\partial p_r=0$.

Solving the first-order conditions for the equilibrium prices simultaneously, we can get the following equilibrium prices:

$$p_d^{*1} = \omega + \frac{2t-(1-\lambda)\theta-b}{3} \text{ and } p_r^{*1} = \omega + \frac{t+(1-\lambda)\theta+b}{3}.$$

Combining with equations (2), (3), (4) and (5), the market demands and profits for traditional retail channel and online direct channel can be computed as:

$$d_d^{*1} = \frac{2t-(1-\lambda)\theta-b}{3t},\ \pi_m^{*1} = \frac{\left[2t-(1-\lambda)\theta-b\right]^2}{9t} + \omega - c,\ d_r^{*1} = \frac{t+(1-\lambda)\theta+b}{3t} \text{ and } \pi_r^{*1} = \frac{\left[t+(1-\lambda)\theta+b\right]^2}{9t}.$$

In this part, we analyze the scenario in which the manufacturer dominates over the retailer in pricing. This scenario can be modeled as a Stackelberg game, the manufacturer is the leader and the retailer is the follower. We use the backward induction procedure to derive the subgame perfect Nash equilibrium in this game.

Firstly, we start with the pricing strategy for the retailer. Given the price of online direct channel p_d, the retailer's equilibrium price can be determined by solving first-order condition $\partial\pi_r(p_r)/\partial p_r = 0$, we get

$$p_r = \frac{1}{2}\left[p_d + \omega + (1-\lambda)\theta + b\right]. \tag{6}$$

Secondly, the manufacturer maximizes the profit of itself. Also solving the first-order condition for the equilibrium price by maximizing the manufacturer's profit $\partial\pi_m(p_d)/\partial p_d = 0$. Given the retailer's price function (6), we can get the equilibrium prices of both direct channel and retail channel:

$$p_d^{*2} = \omega + \frac{2t-(1-\lambda)\theta-b}{2},\ p_r^{*2} = \omega + \frac{2t+(1-\lambda)\theta+b}{4}.$$

Substituting p_d^{*2} and p_r^{*2} into equations (2), (3), (4) and (5), we obtain the equilibrium market demands and total profit of online direct channel and traditional retail channel:

$$d_d^{*2} = \frac{2t-(1-\lambda)\theta-b}{4t},\ \pi_m^{*2} = \frac{\left[2t-(1-\lambda)\theta-b\right]^2}{8t} + \omega - c,\ d_r^{*2} = \frac{2t+(1-\lambda)\theta+b}{4t},\ \pi_r^{*2} = \frac{\left[2t+(1-\lambda)\theta+b\right]^2}{16t}.$$

Now we move on to the third power structure, which is similar to the second one. Different from the second power structure, the retailer is at the dominant status in this scenario. This satiation reflects another Stackelberg competition in which the retailer is the leader and the manufacturer is the follower. We still use the backward induction procedure to derive the subgame perfect Nash equilibrium.

We begin with the pricing strategy of the manufacture. The equilibrium price for manufacturer can be computed by solving the first-order condition $\partial\pi_m(p_d)/\partial p_d = 0$, it is found to be

$$p_d = \frac{1}{2}\left[p_r + \omega + t - (1-\lambda)\theta - b\right] \tag{7}$$

Then, given the manufacturer's price function (7), we can obtain the retailer's equilibrium price by solving the first-order condition $\partial\pi_m(p_d)/\partial p_d = 0$. So, the prices of different channels in the equilibrium are determined to be

$$p_d^{*3} = \omega + \frac{3t-(1-\lambda)\theta-b}{4},\ p_r^{*3} = \omega + \frac{t+(1-\lambda)\theta+b}{2}.$$

Substituting p_d^{*2} and p_r^{*2} into equations (2), (3), (4) and (5), we get the market demands and channel profits in this equilibrium as:

$$d_d^{*3} = \frac{3t-(1-\lambda)\theta-b}{4t},\ \pi_m^{*3} = \frac{\left[3t-(1-\lambda)\theta-b\right]^2}{16t} + \omega - c,\ d_r^{*3} = \frac{t+(1-\lambda)\theta+b}{4t},\ \pi_r^{*3} = \frac{\left[t+(1-\lambda)\theta+b\right]^2}{8t}.$$

In the scenario of dual-channel, under all the three channel power structures, the manufacturer's equilibrium price in the online direct channel p_d^* and the retailer's equilibrium price in the retail channel p_r^* are affected by ω, θ, t, λ, and b.

EQUILIBRIUM ANALYSIS

In this section, we compare equilibrium price and profit of the manufacturer and retailer under different channel power structures. By doing these comparisons we can conclude the best pricing strategies for manufacturer and retailer under each channel power structure.

Proposition 1. In the dual-channel system, (i) when the manufacturer and retailer make their decisions independently, the direct channel's price is higher than retail channel's as long as $t-2\left[(1-\lambda)\theta+b\right]\geq 0$.

(ii) In the manufacturer leading and retailer following situation, the direct channel's price is higher than retail channel's as long as $2t-3\left[(1-\lambda)\theta+b\right]\geq 0$.

(iii) In the retailer leading and manufacturer following situation, the direct channel's price is higher than retail channel's as long as $t-3\left[(1-\lambda)\theta+b\right]\geq 0$.

For particular product's reservation price θ and unit distance cost t, when the degree of perception for online channel λ is large enough and other purchasing cost b is small enough, the equilibrium price for the online direct channel is always higher than that for the traditional retail channel.

As for the manufacturer, even though the price of online direct channel is higher, the manufacturer can still get higher profit because of the impact of the λ and b. As for the retailer, if the λ is small enough and b is large enough, then the retail channel will have the higher price and profit.

The analysis above suggests that lowering the price for more profit is not a smart move in the dual-channel supply chain. Proper price should be set under specific situation.

Proposition 2. As for the manufacturer in the dual-channel system, (i) when the retailer and manufacturer make decision independently, the equilibrium price of online direct channel is the lowest. In the retailer leading and manufacturer following situation, the equilibrium price of online direct channel is the highest as long as $t-\left[(1-\lambda)\theta+b\right]\leq 0$.

(ii) The profit of manufacturer is highest when retailer is the leader while lowest when retailer and manufacturer make decision independently. That is $\pi_m^{*3}\geq\pi_m^{*2}\geq\pi_m^{*1}$.

Proposition 2 investigates the detail of manufacturer's price and profit. When the manufacturer and retailer have equal status, online direct channel has the lowest price. Given the reservation price θ and unit distance cost t, when λ is large enough and b is small enough, the manufacturer's price in the direct channel will be the highest under the power structure in which the retailer is the dominator. Another interesting finding is that the manufacturer gets the highest profit when the retailer is the leader in the channel. Along with the rapid development of world famous large-scale retailers such as Carrefour and Wal-Mart, the dominance of the supply chain has been transferred from the manufacturers to the retailers. This is good for the manufacturer that adopts dual-channel because of more profit.

Proposition 3. As for the retailer in the dual-channel system, (i) the equilibrium price of the traditional retail channel is the highest when manufacturer is the leader while the lowest when retailer and manufacturer make decision independently. That is $p_r^{*3}\geq p_r^{*2}\geq p_r^{*1}$.

(ii) When the retailer and manufacturer make decision independently, the profit of retailer is the lowest. In the retailer leading and manufacturer following situation, the profit of traditional retail channel is the highest when $\sqrt{2}t-\left[(1-\lambda)\theta+b\right]\leq 0$.

The equilibrium price for the retailer in the traditional channel is always the highest when the retailer is at the dominant status, but the profit of the retailer not always reaches the peak. For the given reservation price θ and unit distance cost t, when λ is large enough and b is small enough, the retailer can get the maximal profit in the retailer leading situation. On the other hand, when λ is small enough and b

is large enough, then the retailer gets the maximal profit in the manufacturer leading situation.
With the analysis above, the retailer should realize that the transfer of power mentioned above doesn't mean the growth of profit. The retailer's profit will decrease with the rise of λ and the decline of b.

CONCLUSIONS

In this paper, we develop a double-floor dual-channel supply chain pricing model to investigate the pricing strategies of dual-channel supply chain. Considering three channel power structures, we focus on the impacts of consumer's online perception degree and other online purchasing cost on the equilibrium prices and profits for the retailer and manufacturer.
The analysis of the model indicates that, for all the three channel power structures, the direct channel price of the manufacturer is not always higher than the retail price in traditional channel. Given the specific value of the reservation price of the product and the unit distance cost, the direct channel price will be higher than the retail channel only when the degree of perception for online channel is large enough and other purchasing cost is small enough.
The equilibrium price and profit of manufacturer have different levels under different channel power structures. When the manufacturer and retailer have equal status, the equilibrium price of online direct channel reaches the lowest and the manufacturer gets the minimum profit. The manufacturer's profit reaches the highest point when the retailer is at the leading status. As for the retailer, its equilibrium price and profit are both the lowest when retailer is independent with manufacturer. And the price of traditional retail channel reaches the highest when the retailer is the leader of the supply chain.
There are several limitations to our model. One critical assumption of our model is that all the consumers can purchase the products they want from both retail channel and direct channel. We ignore the situation that some consumers can only purchase from the traditional channel. A worthwhile extension to our model would be to consider the new market segmentation. This model would provide us additional insights into the pricing strategies of dual-channel supply chain.

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