Research on Pricing Strategy Based on Consumer Behavior

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Abstract. The rapid development of e-commerce has changed consumers' consumption behaviour, the most significant of which is the change of channels. The traditional retail channels can choose online direct sales channels. In order to adapt to this change, enterprises adopt a dual channel sales model. This paper establishes a two-stage dynamic pricing game model through the method of game theory to analyse the impact of the transfer cost caused by the change of consumer behaviour on the manufacturer's product pricing with the increase of transfer cost. On the contrary, the pricing of retailers decreases with the increase of transfer cost.

Keywords: Game theory · Transfer cost · Pricing strategy

1 Introduction

In the context of the rapid development of e-commerce, many enterprises have established e-commerce direct sales channels while retaining the traditional distribution channels, which has formed a sales model of dual channel supply chain, and this sales model is initially to adapt to the development of the times and meet the transformation of consumers' shopping behavior. The opening of online direct selling channels makes enterprises play a dual role in the dual channel supply chain, that is, they are not only the supplier of retailers' products, but also the competitor of retailers. At present, the research on dual channel pricing has been published by a lot of literature. Sheng and Xu (2010) discussed four pricing strategies in the dual channel supply chain: manufacturers keep the retail price unchanged and maximize the benefits in combination with online direct sales channels; Unified retail price for all sales channels; Implement differentiated pricing among different sales channels; The pricing goal is to maximize the overall profit of the supply chain. Pan et al. (2010) studied the optimal ordering strategy and optimal price adjustment strategy of manufacturers with dual channel supply chain considering that physical retail stores and online stores usually share one ordering channel (Fang 2011). Fang (2011) studied the two-stage pricing strategy to solve the pricing problem under the condition of uncertain demand. Its meaning is that before the product is put into the market, that is, when the demand is uncertain, the manufacturer first formulates the preliminary production plan and pricing strategy of the first stage, and changes the strategy of the first stage when the product enters the market and the demand is gradually clear, So as to maximize profits. Hsieh et al. (2014) considered two manufacturing

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methods This paper studies the optimal pricing strategy and ordering strategy of each decision-maker at this time. Zhou et al. (2016) studied the role of transfer costs in free riding behavior and analyzed the price impact of transfer costs in dual channels. Cheng et al. (2019) studied the impact of strategic consumers' consumer transfer behavior on product pricing in dual channels.

At the same time, due to the change of consumer channels, consumers incur costs in this process, which also makes consumers consider how to select channels. Jones et al. (2002) pointed out when studying the transfer cost in the banking field that the transfer cost is a combination of the costs customers feel when switching from one bank to another. Burnham et al. (2003) pointed out that the transfer cost is the cost incurred in the process of customers converting credit card service providers, that is, evaluation cost, learning cost, benefit loss cost, interpersonal relationship cost and brand related loss cost. He believes that transfer costs have a significant impact on customers to maintain existing product suppliers, that is, there is a positive correlation between transfer costs and customer loyalty. Generally speaking, transfer cost is the sum of various explicit or implicit costs paid by customers from one enterprise to another, which can be divided into three categories. The first category is the transfer cost of time and energy, which mainly refers to the learning cost. The second category is the economic transfer cost, that is, the monetary cost paid by the conversion service provider. It mainly refers to the cost of default. The third category is the emotional transfer cost. The boundary of this cost is very vague and depends more on the customer's personal psychological feelings. It mainly refers to the interpersonal relationship cost and brand relationship paid by the customer in changing the compan.

From the existing literature, the research on dual channel involves many factors, but there is little literature on the impact of transfer cost on dual channel parties. Therefore, this paper mainly studies the pricing of all parties in the dual channel supply chain under the transfer cost and the impact of the transfer cost on the manufacturer's wholesale price.

2 Model Assumptions

2.1 Model Assumptions

This paper studies the situation that manufacturers of the same brand sell to consumers not only through online store direct sales, but also through traditional retail channels. In our model, there are two stages: in the first stage, the manufacturer needs to predict the scale of consumers in two sales channels in advance, and then wholesale to traditional retailers at a certain wholesale price. Then the manufacturer's online stores and retailers price the goods at the same time, and the manufacturer's online stores must be priced higher than the wholesale price, otherwise, the retailer will buy and then sell to consumers through online stores, which violates the original intention of the manufacturer. In the second stage, consumers may choose different channels to buy due to their consumption experience and curiosity hunting psychology. At this time, consumers transfer. At this time, there is competition between online stores and traditional retailers again, and both need to consider the transfer cost of consumers. At the same time, they price the products at the same time.

According to the Hotelling model, retail stores and online stores are located at both ends of the segment with length of 1, retail store R is located at the end of segment 0, and online store D is located at the end of segment 1. The total number of consumers is 1 and evenly located on the line segment with length 1. We assume that the maximum utility of consumers' initial perception of the product is v. To simplify the analysis, we assume that the unit distance cost of the consumer is 1 and the production cost of the manufacturer is set to 0. In the two-stage selection, it is assumed that consumers, retailers and manufacturers of online stores are faced with discount factors $\delta = 1$. In the two-phase selection, the transfer cost s incurred by consumers by the transfer of purchase path in the first phase and in the second phase. In the market, the output of manufacturers is far greater than the demand of consumers, and there is no shortage of supply. Whether it is online store sales or retailer sales, there is no small inventory, which leads to the loss of some consumers and transfers them to other channels.

2.2 Model Establishment

When a new consumer has not yet chosen the purchase channel, retailers and manufacturers of online stores have insufficient understanding of consumers' main purchase intention. Because retailers need to buy goods at a certain wholesale price before they can be sold to consumers, and the cost of opening online stores is ignored, the manufacturer's profit comes from two parts: one part is the profit from online store direct sales, and the other part is wholesale to retailers through wholesale price. Therefore, the pricing of retailers and online stores may be different. Therefore, in the first phase of pricing, the scale of consumers will be divided into two parts, one part will choose retailers to buy, and the other part will choose online stores to buy.

In the second phase, retailers and online stores use technology and other means to record the differences of consumers' transfer of old books according to the purchase behaviour of consumers in the first phase, and carry out the pricing in the second phase. Therefore, the utility function of consumers' two-phase purchase is shown in Table 1.

Because retailers, manufacturers and consumers are risk neutral, when making decisions in the first phase, retailers and manufacturers consider two phases in the first phase, and their expected profit is the largest, while consumers consider two phases with the greatest utility. Therefore, the expected utility function obtained by consumers choosing to buy at retailers in the first phase is:

$$\hat{u}_{1r} = u_{1r} + \delta E[u_{2ij}](i, j = r, d)$$

Table 1. Consumer utility function in two periods

utility function	Phase I	Phase II	
		Repeat purchase	Transfer purchase
Traditional retail	$u_{1r} = v - p_{1r} - x$	$u_{2rr} = v - p_{2r} - x_1$	$u_{2rd} =$ $v - p_{2d} - s - (1 - x_1)$
Network direct selling	$u_{1d} = v - p_{1d} - (1 - x)$	$u_{2dd} = v - p_{2d} - (1 - x_2)$	$u_{2dr} = v - p_{2r} - s - x_2$

Similarly, the expected utility function obtained by consumers in the first phase of online store purchase:

$$\hat{u}_{1\mathrm{d}} = u_{1d} + \delta E[u_{2ij}](i, j = r, d)$$

3 Competitive Pricing Equilibrium

3.1 Phase II Pricing Decision

According to the above basic model, firstly, the market demand of retailers and online stores in the second phase is determined based on the consumer utility function. If a consumer purchases from a retailer in the first phase, and purchases from a retailer in the second phase and from an online store, the conditions under which the consumer has no difference are as follows:

$$x_1 = \frac{p_{2d} - p_{2r} + s}{2} + \frac{1}{2}$$

Where, x_1 represents G_r the proportion of consumers still purchasing from retailers in the second phase, and it is the proportion of consumers transferring to online stores in the second phase.

Therefore, the number of consumers who buy from retailers in the first phase and still buy from retailers in the second phase is:

$$Q_{2rr} = aG_r$$

Similarly, the conditions for consumers to purchase in online stores in the first phase and still purchase in online stores and retailers in the second phase are as follows:

$$x_2 = \frac{p_{2d} - p_{2r} - s}{2} + \frac{1}{2}$$

Therefore, the number of consumers who purchased online stores in the first phase and still purchased online stores in the second phase is:

$$Q_{2dd} = (1 - a)(1 - G_d)$$

The number of consumers who purchased from retailers in the second phase is:

$$Q_{2dr} = (1 - a)G_d$$

Under the expected conditions of consumers, retailers and manufacturers, the market share obtained by retailers in the second phase is:

$$Q_{2r} = Q_{2rr} + Q_{2dr}$$

Similarly, the market share of online stores in phase II is:

$$Q_{2d} = Q_{2rd} + Q_{2dd}$$

According to the market demand of retailers and online stores, the total income of retailers, online stores and manufacturers in the second phase can be obtained.

The total revenue of retailers in phase II is:

$$\pi_{2r} = (p_{2r} - w)Q_{2r}$$

The total revenue of phase II online stores is:

$$\pi_{2d} = p_{2d}Q_{2d}$$

The total revenue of phase II manufacturers is:

$$\pi_{2m} = wQ_{2r} + \pi_{2d}$$

Since online stores and retailers determine the retail price at the same time, the following conditions need to be met to realize the optimal pricing equilibrium between online stores and retail stores:

$$\begin{cases} \frac{\partial \pi_{2r}}{\partial p_{2r}} = \frac{p_{2d} - 2p_{2r} - s + w + 2as}{2} + \frac{1}{2} = 0 \\ \frac{\partial \pi_{2r}}{\partial p_{2r}} = \frac{p_{2r} - 2p_{2d} + s - 2as}{2} + \frac{1}{2} = 0 \end{cases}$$

Proposition 1: In the second phase, there is a unique equilibrium solution for the pricing of retail prices by retailers and online stores: $p_{2r}^* = \frac{2w}{3} + \frac{2as-s}{3} + 1$ and $p_{2d}^* = \frac{w}{2} + \frac{s-2as}{3} + 1$.

According to the equilibrium pricing of the second phase, the pricing of retailers and online stores at this time is related to the transfer cost of consumers, the wholesale price of manufacturers and the market share of retailers in the first phase. In the second phase, retailers and online stores have different pricing, part of which is due to the cost that retailers have a wholesale price, while online stores do not have any purchase cost.

3.2 Phase I Competitive Pricing Decision

In solving the sub game refined Nash equilibrium, the reverse solution induction method is used. In the previous section, the optimal Nash equilibrium solution of the second phase has been solved. This section will continue to deduce the equilibrium results of the first phase and finally obtain the dynamic equilibrium under the complete information of the two phases.

Under the condition of realizing the expectation, because consumers are risk neutral, consumers need to predict the prices of retailers and online stores in the first phase, and predict the location distribution of consumers in the second phase. Therefore, the decision of consumers to buy more channels depends on the total expected utility of the two periods.

Therefore, the expected utility of consumers who buy from retailers in phase I to phase II is:

$$\begin{aligned} E[u_{2r}] &= E[u_{2rr}] + E[u_{2rd}] \\ &= \int_0^{G_r} v - p_{2r} - x_1 dx_1 + \int_{G_r}^1 v - p_{2d} - (1 - x_1) - s dx_1 \end{aligned}$$

Similarly, the expected utility of consumers who buy online stores in phase I to phase II is:

$$\begin{aligned} E[u_{2d}] &= E[u_{2dr}] + E[u_{2dd}] \\ &= \int_0^{G_d} v - p_{2d} - x_2 - s dx_2 + \int_{G_d}^1 v - p_{2d} - (1 - x_2) dx_2 \end{aligned}$$

Among the above conditions, due to consumers sense of purchase experience, convenience and other factors, consumers have a high proportion of repeat purchases in the second phase of purchase, which is also a method adopted by retailers and online stores to try to lock multi-functional consumers in a variety of ways.

Since consumers need to consider the expected total utility of two-stage purchase when making initial purchase:

$$\hat{u}_{1\mathrm{d}} = u_{1d} + \delta E[u_{2ij}](i, j = r, d)$$

The equilibrium price of retailers and online stores in the second phase has been given by 3–21. The market share of the second phase is not only related to the transfer cost of consumers, but also related to the market share of consumers purchased at retailers in the first phase. Therefore, the expected total utility of retailers and online stores are as follows.

For retailers, the total discount utility faced by consumers is:

$$\begin{aligned} \hat{u}_{1r} = &\frac{as(8as + 12a - 20s + 4w - 21)}{9} + \frac{aw + s - 2w}{3} \\ &+ \frac{(5s - w)^2}{18} - a - p_{1r} + 2v - \frac{3}{2} \end{aligned}$$

Similarly, for online stores, the discount utility function faced by consumers is:

$$\begin{aligned} \hat{u}_{1d} = &\frac{as(8as + 12a + s + 4w - 3)}{9} + \frac{aw - 2s - 2w}{3} \\ &+ \frac{(s + w)^2}{18} + a - p_{1d} + 2v - \frac{5}{2} \end{aligned}$$

Proposition 2: If the market share that consumers buy from retailers in the first phase is $a = \frac{1}{2} + \frac{3(p_{1d} - p_{1r} - 2sw)}{8s^2 + 6s + 6}$, the market share that consumers buy from online stores is $(1 - a)$.

According to the function a expression of indifference point, the market share of phase I is only related to the consumer transfer cost of phase II and the wholesale price set by the original manufacturer.

In order to obtain the optimal retail price of retailers and online stores in the first phase, the following conditions need to be meet:

$$\begin{cases} \frac{\partial \pi_r}{\partial p_{1r}} = \frac{81(p_{1d}-2p_{1r})+36s^3(2p_{1r}-p_{1d})+81w-30s^3w}{2(4s^3-9)^2} \\ +\frac{\eta_1+\eta_2}{2(4s^3-9)^2} = 0 \\ \frac{\partial \pi_d}{\partial p_{1d}} = \frac{81(p_{1r}-2p_{1d})+36s^3(2p_{1d}-p_{1r})-6s^3w}{2(4s^3-9)^2} \\ +\frac{\eta_1-\eta_2}{2(4s^3-9)^2} = 0 \end{cases}$$

Among them $\eta_1 = -54s - 72s^3 + 24s^4 + 16s^6 + 81$, $\eta_2 = -9(sw + 2p_{1d}s^2 - 2p_{1r}s^2 - 2s^2w)$.

By solving the above equations, we can get the optimal retail price for the first phase of retailers and online stores (p_{1r}^*, p_{1d}^*).

$$p_{1r}^* = \frac{16s + 66s^3w + \eta_3 + \eta_4}{108s^3 + 36s^2 - 243}$$

$$p_{1d}^* = \frac{36s^2w + 42s^3w - 81w + \eta_3 - \eta_4}{108s^3 + 36s^2 - 243}$$

Among them $\eta_4 = sw(8 + 9s^4)$

$$\eta_3 = 36s^2 + 192s^3 - 72s^4 - 16s^5 - 48s^6 - 243$$

By bringing the optimal retail pricing of retailers and online stores in the first phase into the formula of retailers market share a in the first phase, we can get the price only related to the market.

$$a = \frac{27s - 9w - 10sw + 32s^2 + 27}{64s^2 + 54s + 54}$$

3.3 Manufacturer's Wholesale Price Decision

According to the order of market game, the manufacturer should consider and formulate the optimal wholesale price in the early stage of the first phase of pricing, so that the retailer and the manufacturer can obtain the maximum profit.

The optimal wholesale price can be obtained from the first-order optimization conditions $\frac{\partial \pi_m}{\partial w} = 0$.

$$w^* = \frac{6656s^6 + 52208s^4 + 84864s^3 + 107568s^2 + 62856s + 29160}{848s^4 + 2280s^3 + 3584s^2 + 2628s + 1296}$$

The manufacturer's optimal wholesale price and the optimal retail price of retailers and online stores in the theorem are brought into the total expected profit function of manufacturers, retailers and online direct sales stores to obtain their respective total profits.

According to the equilibrium result in Theorem 1, the dual channel oligopoly manufacturer forms a competitive relationship with retailers while opening online store direct sales, and in order to occupy a certain market, retailers and online stores do not maintain the online and offline consistent pricing principle in the early stage of the market.

4 Numerical Simulation

In order to more intuitively show the two-stage optimal pricing and the relationship between the expected profits of retailers, online stores and manufacturers and consumerism's transfer costs. In this section, numerical simulation is adopted for simulation analysis. At the beginning of this chapter, it has been assumed that the manufacturer's production cost is $c = 0$. At the same time, in order to facilitate the analysis, the discount factor is assumed $\delta = 1$.

From the observation in Fig. 1, it can be seen that the retailer's optimal pricing in the second phase shows a decreasing trend with the increase of transfer cost. The optimal retail pricing of the manufacturer's online direct selling stores in the second phase shows

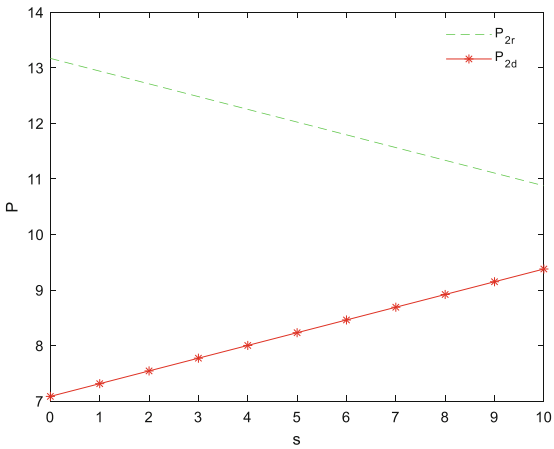

Fig. 1. The change of the optimal price in the second period with s

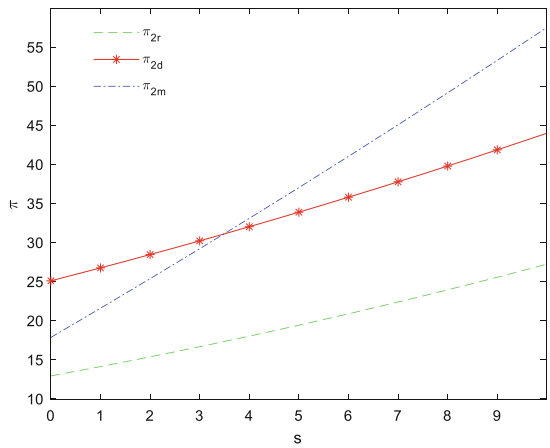

Fig. 2. Changes in optimal pricing and expected profits of retailers, online stores and manufacturers in the second phase

an increasing trend with the increase of transfer cost. No matter how the transfer cost of consumers changes, the agreed retail price is always greater than the online store price in the second phase of pricing. The reason is that there is no additional cost besides production cost in online stores, and retailers need to obtain products from manufacturers at a certain wholesale price. Therefore, generally, the retail price of retailers is higher than that of manufacturer's; online direct selling.

From the observation in Fig. 2, it can be seen that both retailers, online direct selling stores and manufacturers show an increasing trend with the increase of consumer transfer costs. When in the range [3.5,1], the manufacturer's total profit in the second phase is greater than that of online direct selling stores, indicating that the manufacturer's wholesale price is high at this time. Moreover, due to the low price of retailers, some online consumers transfer to retailers to buy, and the market share of retailers in the second phase increases, so that manufacturers can obtain more wholesale price profits from retailers. Therefore, the manufacturer's total profit in the second phase increased.

5 Conclusions

In the current era of rapid development of e-commerce, the expansion of sales channels, dual channel sales have become the current mainstream sales model, which makes the competition between channels more and more incentive. Manufacturers need to take a series of measures to retain their original customers' profits in the market. In any case, the manufacturer has two aspects of income, wholesale income and online store retail income. Therefore, manufacturers do not need to form vicious competition with retailers.

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