ISSN: 2688-9323

Research on Competitive Pricing of Dual Channel Firms based on Transfer Cost

Yunfu Huo, Huiyi Wu*

School of Liaoning, Dalian University, Dalian 116622, China

*448976715@qq.com

Abstract

In this article, we establish a model to study the dynamic pricing of duopoly firms when consumers have transfer costs and duopoly firms provide both online and offline sales.The results show that when the oligopoly firms share the market equally, the oligopoly firms adopt the same pricing strategy online and offline to obtain higher profits, and the two firms implement synchronous pricing.To a certain extent, the increase of transfer cost can make the firmer obtain higher profit, but when the transfer cost reaches the critical point, the profit will decrease.Therefore,firms should adjust their pricing at any time with different transfer costs.

Keywords

Transfer Cost; Two Channels; Homogeneous Products.

1. Introduction

With the improvement of network popularity and the rapid development of e-commerce, great changes have taken place in the way of consumers' shopping. Consumers can achieve shopping at home and without time constraints through the online shopping platform. Businesses and enterprises also see the benefits of the development of the Internet. In order to cater to consumers' purchase behavior, they open online sales channels at the same time as the traditional sales channels in the past, and realize the "Online + offline" sales mode. But at the same time, for firms, how to deal with online and offline pricing, as well as the impact of competition between homogeneous enterprises on businesses, these are how to solve the main problems of businesses. In order to solve this problem, many scholars have analyzed and solved it from many angles.

There are many advantages in introducing online channels. For example, the strategy of "same price for the same product online and offline" proposed by Suning is to adapt to the multi-channel mode. The sales performance of e-buy from Suning also shows the success of this strategy. the success of this strategy has also attracted the attention of competitors. But there are also other strategies, such as Gome that due to the channel construction cost, sales cost and other factors, the online and offline same price strategy cannot be realized. So put forward the strategy of different products with the same price. These two models have also attracted the attention of scholars. Therefore, some scholars believe that the online and offline same price strategy is the best. Sheng Zhaohan and Xu Feng (2010)[1] have shown that whether the differential pricing is right or not is related to the region where it is implemented, and the implementation of differential pricing in different regions can obtain higher profits. Chen Weihua (2017) [2]found that supply chain members with different risk sensitivities have differentiated pricing. Sun Shushen et al. (2019) [3] research shows the influence of manufacturers' offline channel rights structure on online models, and believes that whether online and offline price differential pricing is related to the manufacturer's dominant supply

ISSN: 2688-9323

chain. These scholars explain from multiple angles that different pricing strategies are implemented in different situations.

There are many companies producing homogeneous products. This makes it possible for consumers to switch brand purchases, and in this process, it also makes consumers pay for the transfer costs. Chen (2005) [4]established a duopoly dynamic competitive pricing model for two-stage production of homogeneous products to study howfirms price when consumers pay transfer costs in the market. Jiang Chuanhai and Tang Dingxiang (2012)[5] studied discriminatory pricing strategies based on consumer purchase history. Stan V et al. (2013)[6] studied the impact of consumer transfer cost on customer loyalty. Research shows that the greater the transfer cost, the higher the consumer's loyalty to the firmer's products.

Based on previous research, this article analyzes the dual-channel pricing of duopoly firms that produce homogeneous products, while considering the transfer costs required for consumers to switch between brands. This is not the case in previous studies. What is involved is also the focus of this article.

2. Model Building

In this article, the two dynamic game model based on utility function, discussed pricing and revenue of dual channel Duopoly.

Hypothesis 1: there are two oligarchs A and B in the market, both of which are two period pricing. In the first phase, the firmer chooses the online and offline consistent pricing $p_{1i}(i=A,B)$;In the second phase, the firmer carries out inconsistent pricing based on online and offline pricing, online pricing is $p_{2i}^{1}(i=A,B)$, offline pricing is $p_{2i}^{2}(i=A,B)$.The market share of the first phase is $Q_{1i}(i=A,B)$ and $Q_{1A}+Q_{1B}=1$.

Hypothesis 2: consumers have the behavior of consumption transfer.If consumers choose to buy another firmer; s products in the second phase of purchase, there will be consumer transfer cost, which obeys the uniform distribution $[0,\delta]$, and the cumulative probability distribution is $F(s)=s/\delta$.

Hypothesis 3: due to the rapid development of e-commerce and the rise of online shopping, some consumers choose to stay at home online shopping.Suppose that the proportion of consumers shopping online is $0<\theta<1$.

Hypothesis 4: The number of online consumers who purchased from firmer i in the first period, and the number of consumers who purchased from firmer j in the second period is denoted by $Q_{ij}^{1}(i,j=A,B)$. Therefore, the market share of the firmer in the second period of online sales is composed of two parts, one part is still consumed by firmer i, the number of people is $Q_{ii}^{1}(i=A,B)$, and the other part is transferred to another firmer to buy the number of people $Q_{ij}^{1}(i,j=A,B;i\neq j)$. The number of offline consumers purchased at firmer i in the first period, and the number of consumers who purchased at firmer j in the second period is represented by $Q_{ij}^{2}(i,j=A,B)$. Therefore, the market share of the firmer's offline sales in the second phase is composed of two parts, one part is still consuming at firmer i as $Q_{ii}^{2}(i=A,B)$, and the other part is transferred to another firmer's number of people to buy $Q_{ij}^{2}(i,j=A,B;i\neq j)$.

Hypothesis 5: Consumers purchase products online, and the first time they purchase products, they will be eligible for product praise cashback, where the cashback amount is c_1. Consumers purchase the product for a second time through online purchases. firms can obtain information about consumers' repeated purchases through shopping records, so as to give consumers a

ISSN: 2688-9323

chance to return cash with a probability $k(0<k<1)$. At this time, the consumer's expectation of cashback is kc_1. If the consumer's consumption is shifted and the product of another firmer is purchased online, the expected cash back amount will be c_2, that is (c_1-kc_1).

This article will analyze the consumer effect of consumers in the second phase.Then price competition is carried out according to the profit maximization offirms.The utility of the second period is shown in Table 1.

Table 1. Utility function of consumers in the second period

utility function	Phase I	Phase II	
		Repeat purchase	Transfer purchase
Online consumption	$U_{1i}^1=v-p_{1i}+c_1$	$U_{2ii}^1=v-p_{2i}^1+kc_1$	$U_{2ii}^1=v-p_{2j}^1-s+c_2$ $(i,j=A,B;i\neq j)$
Offline consumption	$U_{1i}^2=v-p_{1i}$	$U_{2ii}^2=v-p_{2i}^2$	$U_{2ii}^2=v-p_{2j}^2-s$ $(i,j=A,B;i\neq j)$

3. Pricing Research

3.1. Second Phase Pricing

The model established in this article is a dynamic game model based on complete information. The Nash equilibrium is refined according to the sub game, and the reverse inductive analysis method is adopted, so the second equilibrium pricing is obtained first.According to the utility function of the second period of consumers.If the consumer purchases at firmer A in the first phase and at firmer A and B in the second phase, the conditions for online consumers to have no difference are as follows:

$$U_{2AA}^1=U_{2AB}^1 \text{ which is } s=p_{2A}^1-p_{2B}^1+c_2-kc_1 \tag{1}$$

The conditions for offline consumers to have no difference are as follows:

$$U_{2AA}^2=U_{2AB}^2 \text{ which is } s=p_{2A}^2-p_{2B}^2 \tag{2}$$

Therefore, consumers may have two purchase behaviors in the second period regardless of online or offline purchases, repeat purchases or transfer purchases.

From Hypothesis 4, $Q_{ij}^1(i,j=A,B)$ means that online consumers buy at firmer i in the first period, and buy at firmer j in the second period. Therefore, in the first period, the number of online consumers who purchased from firmer A may be Q_{AA}^1 in the second period, and the number of consumers who purchased from firmer B in the second period may be Q_{AB}^1.

The number of online consumers who bought the products of firmer A in the first stage, and who bought the products of firmer B in the second stage is as follows:

$$Q_{AB}^1=Q_{1A}[\theta F(s<p_{2A}^1-p_{2B}^1+c_2-kc_1)] \tag{3}$$

The number of repeat purchases by online consumers is:

ISSN: 2688-9323

$$Q_{AA}^{1} = \theta Q_{1A} - Q_{AB}^{1} \tag{4}$$

Similarly, it can be concluded that online consumers buy from firmer B in the first phase, and consumers in the second phase are divided into two parts:

The number of consumers who purchase from firmer B in the first phase and firmer A in the second phase is as follows:

$$Q_{BA}^{1} = Q_{1B}[\theta F(s < p_{2B}^{1} - p_{2A}^{1} + c_2 - kc_1] \tag{5}$$

The number of consumers who purchase from firmer B in the first and second phases is as follows:

$$Q_{BB}^{1} = \theta Q_{1B} - Q_{BA}^{1} \tag{6}$$

Under the expected conditions, the second phase market share of firms A and B through online sales is as follows:

$$Q_{2A}^{1} = Q_{AA}^{1} + Q_{BA}^{1} \qquad Q_{2B}^{1} = Q_{BB}^{1} + Q_{AB}^{1} \tag{7}$$

Similarly, we can get the market share of the second phasefirms caused by the number of offline consumers in the first phase. The market share of online and offline consumers is shown in Table 2 and Table 3:

Table 2. The second period of the market share composition of detail

Firms	Phase II			
	Repeat purchase		Transfer purchase	
	online	offline	online	offline
Firm A	$Q_{AA}^{1} = \theta Q_{1A} - Q_{AB}^{1}$	$Q_{AA}^{2} = (1-\theta)Q_{1A} - Q_{AB}^{2}$	$Q_{AB}^{1} = \frac{\theta Q_{1A}(p_{2A}^{1} - p_{2B}^{1} + c_2 - kc_1)}{\delta}$	$Q_{AB}^{2} = \frac{(1-\theta)Q_{1A}(p_{2A}^{2} - p_{2B}^{2})}{\delta}$
Firm B	$Q_{BB}^{1} = \theta Q_{1B} - Q_{BA}^{1}$	$Q_{BB}^{2} = (1-\theta)Q_{1B} - Q_{BA}^{2}$	$Q_{BA}^{1} = \frac{\theta Q_{1B}(p_{2B}^{1} - p_{2A}^{1} + c_2 - kc_1)}{\delta}$	$Q_{BA}^{2} = \frac{(1-\theta)Q_{1B}(p_{2B}^{2} - p_{2A}^{2})}{\delta}$

Table 3. Market share of firms A and B in the two phases

	Phase I	Phase II		
		online	offline	Total number
Firm A	Q_{1A}	$Q_{2A}^{1} = Q_{AA}^{1} + Q_{BA}^{1}$	$Q_{2A}^{2} = Q_{AA}^{2} + Q_{BA}^{2}$	$Q_{2A} = Q_{2A}^{1} + Q_{2A}^{2}$
Firm B	Q_{1B}	$Q_{2B}^{1} = Q_{BB}^{1} + Q_{AB}^{1}$	$Q_{2B}^{2} = Q_{BB}^{2} + Q_{AB}^{2}$	$Q_{2B} = Q_{2B}^{1} + Q_{2B}^{2}$

According to the online and offline demand of the two firms in the second period in the above Table, the total revenue of the second period of firms A and B can be obtained (for ease of analysis, assume that the marginal cost of the two firms is 0):

$$\pi_{2A} = p_{2A}^{1} Q_{2A}^{1} + p_{2A}^{2} Q_{2A}^{2} \qquad \pi_{2B} = p_{2B}^{1} Q_{2B}^{1} + p_{2B}^{2} Q_{2B}^{2} \tag{8}$$

ISSN: 2688-9323

According to the revenue functions of firms A and B, we can obtain the firmer's second-period online and offline pricing strategy, that is, the first-order derivative of the firmer's revenue function with respect to online and offline prices, as follows:

$$\begin{aligned}
&\frac{\partial \pi_A}{\partial p_{2A}^1} = \theta Q_{1A} - \frac{p_{2A}^1 \theta}{\delta} - \frac{\theta Q_{1A}(p_{2A}^1 - p_{2B}^1 - kc_1 + c_2)}{\delta} + \frac{\theta Q_{1B}(p_{2B}^1 - p_{2A}^1 - kc_1 + c_2)}{\delta} = 0 \\
&\frac{\partial \pi_A}{\partial p_{2A}^1} = (1-\theta)Q_{1A} - \frac{(1-\theta)}{\delta} p_{2A}^2 - \frac{(p_{2A}^2 - p_{2B}^2)(1-\theta)}{\delta} = 0 \\
&\frac{\partial \pi_B}{\partial p_{2B}^1} = \theta Q_{1B} - \frac{p_{2B}^1 \theta}{\delta} + \frac{\theta Q_{1A}(p_{2A}^1 - p_{2B}^1 - kc_1 + c_2)}{\delta} - \frac{\theta Q_{1B}(p_{2B}^1 - p_{2A}^1 - kc_1 + c_2)}{\delta} = 0 \\
&\frac{\partial \pi_B}{\partial p_{2B}^2} = (1-\theta)Q_{1B} - \frac{(1-\theta)}{\delta} p_{2B}^2 + \frac{(p_{2A}^2 - p_{2B}^2)(1-\theta)}{\delta} = 0
\end{aligned} \tag{9}$$

Simultaneous equation(9) get the optimal equilibrium solution $(p_{2A}^{1*}, p_{2A}^{2*}, p_{2B}^{1*}, p_{2B}^{2*})$.

$$\begin{cases}
p_{2A}^{1*} = \dfrac{\delta(1+Q_{1A})}{3} + \dfrac{(kc_1 - c_2)(Q_{1A} - Q_{1B})}{3}, p_{2A}^{2*} = \dfrac{\delta(1+Q_{1A})}{3} \\
p_{2B}^{1*} = \dfrac{\delta(1+Q_{1B})}{3} + \dfrac{(kc_1 - c_2)(Q_{1B} - Q_{1A})}{3}, p_{2B}^{2*} = \dfrac{\delta(1+Q_{1B})}{3}
\end{cases} \tag{10}$$

Firms will adopt different ways of online and offline pricing through different ways of shopping for consumers. And through the analysis of the equilibrium solution, two conclusions can be drawn: (1) Online pricing is only related to the cost of consumer transfer, the market share of the two firms in the first phase, and the amount of cash back for consumers' praise, and it is related to consumers' online shopping The proportion is irrelevant. (2) Offline pricing is not only related to consumer transfer costs and the market share of the two firms in the first phase.

3.2. First Phase Pricing

The two firms implemented a consistent online and offline pricing strategy in the first phase of pricing. Therefore, consumers can buy from firmer A and firmer B in the first stage. Consumers should consider the two periods to be the most effective when purchasing the first period.

Consumers buy from firmer A in the first period, and the expected utility of consumers' online purchases and offline purchases in the second period is $E[U_{2A}^1], E[U_{2A}^2]$ respectively. The two-phase utility obtained by consumers through online and offline purchases is as follows:

$$U_A^1 = U_{1A}^1 + E(U_{2A}^1) \quad U_B^2 = U_{1B}^2 + E(U_{2B}^2) \tag{11}$$

In the same way, the consumer purchases from firmer B in the first period, and the expected utility of the consumer's online and offline purchases in the second period are $E[U_{2B}^1], E[U_{2B}^2]$ respectively. The two-phase utility obtained by consumers through online and offline purchases is as follows:

$$U_B^1 = U_{1B}^1 + E(U_{2B}^1) \quad U_B^2 = U_{1B}^2 + E(U_{2B}^2) \tag{12}$$

ISSN: 2688-9323

According to the firm's equilibrium price in the first period, consumers choose firm A and firm B to obtain the same principle of utility. The conditions for indifference between online purchases and offline purchases by consumers are as follows:

$$U_A^1 = U_B^1 \text{ which is } y_1 = \frac{(Q_{1B} - Q_{1A})(\delta^2 + 4c_2^2 + 4k^2c_1^2 - 4\delta c_2 + 4\delta kc_1 - 8kc_1c_2)}{3\delta} - p_{1A} + p_{1B} \tag{13}$$

$$U_A^2 = U_B^2 \text{ which is } y_2 = \frac{(Q_{1B} - Q_{1A})\delta}{3} - p_{1A} + p_{1B} \tag{14}$$

Among them, Q_{1A}, Q_{1B} is an implicit function of the change of its own price p_{1A}, p_{1B}. Therefore, the above equation is required to find the first-order partial derivative of the price p_{1A}, p_{1B}, and it is equal to zero.

$$\begin{cases} \frac{\partial y_1}{\partial p_{1A}} = -\frac{\delta^2 + 4c_2^2 + 4k^2c_1^2 - 4\delta c_2 + 4\delta kc_1 - 8kc_1c_2}{3\delta}\frac{\partial Q_{1A}}{\partial p_{1A}} - 1 = 0 \\ \frac{\partial y_1}{\partial p_{1B}} = \frac{\delta^2 + 4c_2^2 + 4k^2c_1^2 - 4\delta c_2 + 4\delta kc_1 - 8kc_1c_2}{3\delta}\frac{\partial Q_{1B}}{\partial p_{1B}} + 1 = 0 \end{cases}, \begin{cases} \frac{\partial y_2}{\partial p_{1A}} = -\frac{\delta}{3}\frac{\partial Q_{1A}}{\partial p_{1A}} - 1 = 0 \\ \frac{\partial y_2}{\partial p_{1B}} = \frac{\delta}{3}\frac{\partial Q_{1B}}{\partial p_{1B}} + 1 = 0 \end{cases} \tag{15}$$

In the first phase of pricing, the firmer must choose the pricing that maximizes the total revenue of the two phases of the firmer. The two-period total income function of firm A and firm B is as follows:

$$\begin{aligned} \pi_A &= p_{1A}Q_{1A} + {Q_{1A}}^2\omega_1 + {Q_{1B}}^2\omega_2 + Q_{1A}Q_{1B}\omega_3 \\ \pi_B &= p_{1B}Q_{1B} + {Q_{1A}}^2\omega_2 + {Q_{1B}}^2\omega_1 + Q_{1A}Q_{1B}\omega_3 \end{aligned} \tag{16}$$

Where $\omega_1 = 4\delta^2 + 4\theta\delta bkc_1 - 4\theta\delta c_2 + \theta k^2{c_1}^2 - 2\theta kc_1c_2 + \theta{c_2}^2$,

$\omega_2 = \delta^2 - 2\theta\delta bkc_1 + 2\theta\delta c_2 + \theta k^2{c_1}^2 - 2\theta kc_1c_2 + \theta{c_2}^2, \omega_3 = 4\delta^2 - 2\theta\delta bkc_1 + 2\theta\delta c_2 - 2\theta k^2{c_1}^2 + 4\theta kc_1c_2 - 2\theta{c_2}^2$

Equilibrium pricing can be obtained by the first-order optimization condition $\frac{\partial \pi_A}{\partial p_{1A}} = 0, \frac{\partial \pi_B}{\partial p_{1B}} = 0$ in parallel with the vertical above formula.

$$\begin{cases} p_{1A}^* = \frac{\delta Q_{1A}}{3} - 2Q_{1A}\omega_1 - Q_{1B}\omega_3 \\ p_{1A}^* = \frac{\delta Q_{1B}}{3} - 2Q_{1b}\omega_1 - Q_{1A}\omega_3 \end{cases} \tag{17}$$

4. Conclusion

Assume that the online shopping proportion of the two firms is $\theta = 0.7$, and the probability of repurchasing the positive feedback obtained by repeating the purchase is $k = 0.1$. And the firmer splits the market equally, which is $Q_{1A} = Q_{1B} = 0.5$, and the cash rebate for the first purchase is $c_1 = 5$. Under the assumption of equal market share in the first period, it is observed that the expected total revenue first rises to a certain point and then decreases with the increase of consumer transfer costs. When the transfer cost is 1, it is observed that the expected total return increases with the increase in the cash back of the praise. The total revenue of firms increases with the increase in the proportion of online shopping.

ISSN: 2688-9323

If you follow the “checklist” your article will conform to the requirements of the publisher and facilitate a problem-free publication process.

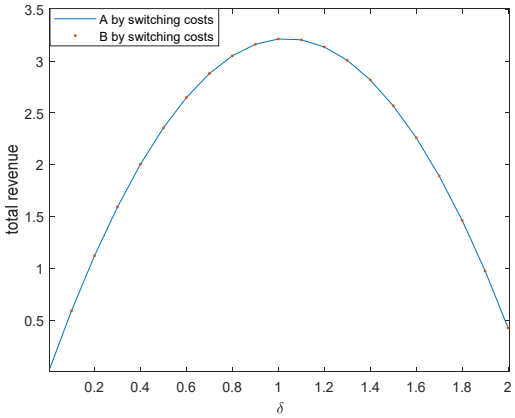

Figure 1. The effect of transfer cost on expected total revenue

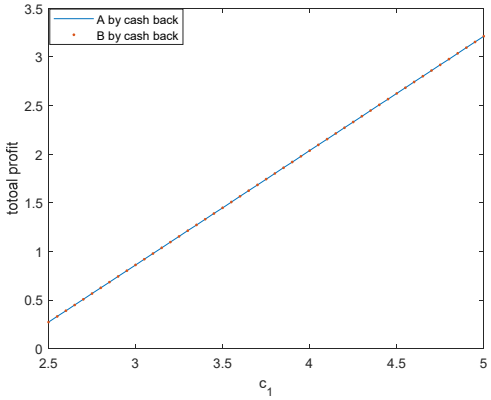

Figure 2. The effect of cash back on expected total income

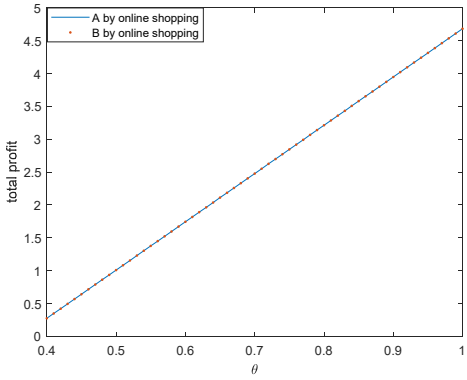

Figure 3. The effect of network coverage on expected total revenue

This article assumes that consumers have two shopping choices and two manufacturers can choose at the same time. When the two manufacturers share the market equally, the manufacturers should abide by the principle of consistent online and offline pricing. At the same time, in the case of the two manufacturers selling homogeneous products, in order to ensure the maximization of their respective interests, the prices of the two manufacturers are the same. Through the consumer's two-period utility function, analyze the impact of consumer transfer costs, network coverage, and online shopping praise rebate on the total benefits of manufacturers, and the following enlightenment can be obtained:

ISSN: 2688-9323

(1) Product enrichment, improve consumer purchases of product's demand keeps consumers' transfer costs within a certain range. In the era of rapid network development, consumers' pursuit of products meets the needs of the products themselves, while their pursuit of added value is also increasing. Therefore, firms can track consumer purchase records and analyze consumer purchase intentions and the reasons for the transfer. In this way, the transfer cost of consumers is kept within a certain range, enabling firms to obtain more profits.

(2) To increase the online shopping rate, firms can use offline promotion and product promotion to enable more consumers to choose online purchases in a certain market size.

References

[1] Sheng Zhaohan, Xu Feng. Research on manufacturers' dual-channel pricing strategy under the background of regional differentiation[J]. Journal of Management Science, 2010, 13(06):1-10.

[2] Chen Weihua, Yuan Hongtao, Li Kai. Research on the Pricing Strategy of Risk Aversion Supply Chain Considering the Time Value of Funds[J]. Logistics Technology, 2017, 36(02): 126-131+141.

[3] Sun Shusheng, Pu Xujin, Han Guanghua. Research on the choice of manufacturers' online sales model considering offline power structure[J]. Chinese Management Science, 2019, 27(05): 119-129.

[4] Cheny Y .Oligopoly Price Discrimination by Purchase History,in Pros and Cons of Price Discrimination, Swedish Competition Authority, Stockholm.2005.

[5] JIANG Chuanhai,TANG Dingxiang.Manufacturers' dynamic competitive differential pricing and realization of competitive advantage--Based on the analysis of consumers seeking diversified purchasing behavior[J].Journal of Management Science,2012,15(03):44-53.

[6] Stan V , Caemmerer B , Cattanjallet R . Customer loyalty development: The role of switching costs[J]. Metalurgia International, 2013, 18(1):95-99.