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Pricing Strategies in Dual-channel for Small and Medium-Sized Manufacturers

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Abstract: For the Small and Medium-Sized Manufacturers who are in the weak position in dual-channel marketing, they are often faced with channel price conflict. Therefore, it is necessary for the Small and Medium-Sized Manufacturers to formulate effective pricing strategies. This paper modeled pricing strategies for two scenarios, which involved the manufacturer and retailer make decisions individually and a retailer Stackelberg game. Then we investigated the impacts of digital attribute of product and power structure on the optimal pricing strategies. Besides, we considered the change both of manufacturer and retailer's profits when the digital attribute of product is heterogeneous and the power structure is difference using computational studies. Our analyses show that, the non-dominant manufacturer decides online direct price according to the dominant retailer's pricing strategy is a win-win strategy, both manufacturer and retailer are better off, and the dual-channel's total profits also improve.

Keywords: dual-channel, pricing strategies, Small and Medium-Sized Manufacturers, digital attribute of product

1. INTRODUCTION

With the rapid development of E-commerce technology, more and more Small and Medium-Sized Manufacturers are increasingly adopting dual-channel to sell their products, i.e., the traditional retail channel and the online direct channel. But the Small and Medium-Sized Manufacturers are restricted by the scale of operation, the dual-channel brings more profit and more challenges simultaneously. With the expansion of online direct marketing, the manufacturers and traditional retailers will compete for the common customers, such as Levis is forced to give up the online direct channel for the resistance of the retailer partners. In addition, some traditional retailers' business scale is larger than the Small and Medium-Sized Manufacturers and they can contact with consumers directly, the Small and Medium-Sized Manufacturers' power is relatively weaker than traditional retailers, for example, ELADE must paid 40% of retail sales to B&Q as a "slotting allowance" when it sells its products in the large building materials retail supermarket B&Q. But for ELADE, in order to improve sales and profits, the price of online direct channel is much lower than traditional retailer B&Q. In view of these price conflicts, what pricing strategies should the Small and Medium-Sized Manufacturers take to alleviate channel conflict and maintain the dual-channel?

In the study on dual-channel, Kurata^[1] pointed out that when the channel competition and brand competition coexistence, price subsidy policy can coordinate the supply chain. Gangshu (George)Cai^[2] assessed the impact of price discount contract on dual-channel supply chain and indicated that the price discount contract can appease channel conflict. Hou.J,Zhao.L.d^[3] showed that the change of price strategy in direct channel can achieve the coordination of the supply network. The above documents show that, price is a key factor in coordinate of dual-channel. On the study of pricing strategy in dual-channel, Chiang^[4] examined a price-setting game between a manufacturer and its independent retailer based on the consumer choice model. Yao and Liu^[5] looked at price competition between the two channels using Bertrand and Stackelberg game models. Gila E. Fruchter^[6] assumed that the consumers' acceptance to online shopping was heterogeneity, and he examined the dynamic pricing strategy of dual-channel, where manufacturer as leader in the Stackelberg game. Dumrongsiri^[7]

studied the dominant manufacturer's pricing strategy in the condition that market demand was affected by the price and consumer perceived service. Huang and Swaminathan^[8] assumed that the demand was only affected by price, the degrees of substitution of two channels and the potential market demand, and they studied the optimal pricing strategy when manufacturer had the same power to control the two channels. Guowei Hua^[9] studied the pricing strategy from two perspective, concentrated pricing and distributed pricing. Yajun Guo^[10] considered the internal reason that caused the channel conflict when the manufacturer is a leader, while they designed a dual-channel coordination strategy in a manufacturer Stackelberg game. Hong Wang^[11] discussed the influence of retailer's degree of risk aversion on pricing strategy in a manufacturer Stackelberg game. In summary, the previous research mainly considered that manufacturer is a leader or manufacturer has equality with retailer. However, how to develop a reasonable pricing strategy when the manufacturer falls in a weak position in dual-channel, this issue has been rarely concerned, and it seems to be worthy of study.

In addition, compares with large retailers, the Small and Medium-Sized Manufacturer's bargaining power is very limited. In order to sell its products in the large retail store and promote its brand image, the Small and Medium-Sized Manufacturer has to accept the retailer's price discount. That is, the retailer sets a price discount for each product, and extracts some share of the retail sales as its own income, and the remaining profit is for the manufacturer. This pricing pattern is widely used in the practice of the Small and Medium-Sized Manufacturers, so the previous literature ([5],[7],[8],[9],[10],[11]) discussed the dual-channel pricing strategy by wholesale price is not suitable for the Small and Medium-Sized Manufacturers.

Different from previous studies, we consider the form of transaction between manufacturer and retailer by price discount, and we also examine the impact of digital attribute of product on the demand of distribution channels. This paper is organized as follows. Section 2 introduces the notation and formulates the decision models for manufacturer and retailer, respectively. In section 3 and 4, we examine the pricing strategies in different scenarios and analyze the impacts of parameters on pricing strategies. In section 5, we report the results of computational experiments carried out to examine the relationships between power structure and pricing strategies and investigate the influence of digital attribute of product on these relationships. We conclude the results and suggest topics for future research in Section 6.

2. THE BASIC MODEL

We assume that all retailers are homogeneous, the dual-channel system includes one manufacturer, one retailer and consumers. The manufacturer produces only one product, the consumers are risk-neutral, and they choose the purchase channel according to their perceived utility. The manufacturer decides the price of online direct channel, the retailer decides the price of traditional channel and the commission percentage of retail sales, and retailer pays the rest of retail sales to manufacturer as the wholesale price. The variable symbols involved in this system are as follows:

R : the reservation price of the product.

t : the unit psychological cost caused by the consumers' psychological preferences.

s : the consumers' psychological preferences, $s \in [0,1]$.

p_d : the price of online direct channel.

p_r : the price of traditional channel.

r : the share of the retail sales that the retailer extract from the traditional distribution channel.

d_d : the demand of online direct channel.

d_r : the demand of traditional channel.

c : the manufacturer's unit cost of product.

π_m : the manufacturer's total profit.

π_r : the retailer’s total profit.
 Π : the dual-channel’s total profit.

Our model builds on the familiar linear Hotelling model. Suppose there is a linear city of length 1, the traditional retailer’s store is at 0, and the online direct store is at 1. Assuming that consumers uniformly distributed in $[0,1]$, for all of the consumers in $s \in [0,1]$, their psychological cost for purchase the product from retailer’s store is ts . Suppose that each consumer has a unit demand, and they choose the channel which they can get more utility. To ensure that consumers will choose any one of the two channels to purchase product, we let R is sufficiently large, both the utility that consumers can obtain from the two channels are positive.

In reality, there are a variety of factors (for example: price, brand, outward appearance, etc) will affect consumers’ perceived utility. In particular, the most significant factor is the digital attribute of product in dual-channel marketing^[12]. The digital attribute of product is some product attribute information which can be described by text, graphics, images, etc and can be transferred through the web. For different types of products, the digital attribute of product shows obvious difference, for instance, the digital attribute of clothing and footwear is significantly lower than books and audio/video products. In traditional channel, consumers can obtain a clear perceived utility by experience the goods personally, so they generally prefer to buy the lower digital attribute goods from traditional channel. In contrary, online direct channel can provide more convenient search tools and review information about products, it also helps consumers reduce search time and transportation costs, so consumers prefer to buy the higher digital attribute goods from online direct channel. Liang and Huang’s empirical study also showed that the higher the digital attribute of product, the more consumers prefer online direct channel, the lower the digital attribute of product, the more consumers prefer traditional channel^[13]. Therefore, we consider the influence of digital attribute of product on consumers’ perceived utility, the consumer’s utility function is as follows:

$$\begin{cases} u_d(R) = \alpha R - t(1-s) - p_d, & \text{purchase from online direct channel} \\ u_r(R) = (1-\alpha)R - ts - p_r, & \text{purchase from traditional channel} \end{cases} \quad (1)$$

where α denote the digital attribute of product, $0 \leq \alpha \leq 1$. The bigger α , the bigger perceived utility of online direct channel αR , otherwise, the smaller the perceived utility of online direct channel.

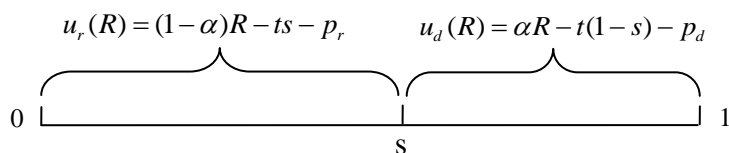


Figure 1. the market share of traditional channel and online direct channel respectively

For risk-neutral consumers, they usually choose the purchase channel according to the principle of utility maximization. Fig.1 describes the market share of traditional channel and online direct channel respectively, where s is the point of no difference, that is, $(1-\alpha)R - ts - p_r = \alpha R - t(1-s) - p_d$, then $s = [(1-2\alpha)R + p_d - p_r + t] / 2t$ established. When $s < [(1-2\alpha)R + p_d - p_r + t] / 2t$, $u_r(R) > u_d(R)$, consumers will choose the traditional channel. When, $u_d(R) > u_r(R)$, consumers will choose the online direct channel. To ensure s in $[0,1]$, we focus on the digital attribute of product that satisfy $\frac{1}{2} - \frac{p_r - p_d + t}{2R} \leq \alpha \leq \frac{1}{2} - \frac{p_r - p_d - t}{2R}$, and this interval is contained in $[0,1]$ (proved in Appendix 1).

Form Fig.1, the demand of traditional channel and the demand of online direct channel are as follows:

$$d_r = s = \frac{(1-2\alpha)R + p_d - p_r + t}{2t} \quad (2)$$

$$d_d = 1 - s = \frac{-(1-2\alpha)R - p_d + p_r + t}{2t} \quad (3)$$

As a result, the retailer's profit and the manufacturer's profit are determined respectively by

$$\begin{aligned} \pi_m(p_d) &= (p_d - c) \cdot d_d + [(1-r)p_r - c] \cdot d_r \\ &= \frac{(1-r)p_r(1-2\alpha)R - p_d(1-2\alpha)R - (1-r)p_r^2 + (1-r)p_r t + (2-r)p_r p_d - p_d^2 + p_d t - 2ct}{2t} \end{aligned} \quad (4)$$

$$\pi_r(p_r) = r \cdot p_r \cdot d_r = r \cdot p_r \cdot \frac{(1-2\alpha)R + p_d - p_r + t}{2t} = \frac{rp_r(1-2\alpha)R + rp_r p_d - rp_r^2 + rtp_r}{2t} \quad (5)$$

where r denotes the share of retail sales that the retailer extract from the traditional distribution channel, and the rest $1-r$ is manufacture's retail profit from the traditional channel.

3. DUAL-CHANNEL PRICING STRATEGY OF DIFFERENT POWER STRUCTURE

In our dual-channel system, the Small and Medium-Sized Manufacturers will be in the relatively disadvantaged position when they are often faced with large retailers. We will examine the pricing strategy of the scenario that manufacturer and retailer make decisions individually (scenario 1) and the retailer Stackelberg game(scenario 2)in the next section.

3.1 Manufacturer and retailer make decisions individually.

In this section we consider an uncooperative dual-channel, in which both the manufacturer and the retailer make their own decisions to maximize their individual profits simultaneously. Manufacturer and retailer will reach the Nash equilibrium under the condition $\frac{\partial \pi_m(p_d)}{\partial p_d} = 0$ and $\frac{\partial \pi_r(p_r)}{\partial p_r} = 0$ respectively. In this case, the manufacturer and the retailer maximize their own profit with the optimal channel price

$$p_d^{*1} = \frac{-r(1-2\alpha)R - rt + 4t}{2+r} \quad (6)$$

$$p_r^{*1} = \frac{(1-2\alpha)R + 3t}{2+r} \quad (7)$$

Substituting (6)and(7)into (2),(3),(4),(5) and simplifying, we obtain (8),(9),(10),(11)and(12). Therefore, in this scenario, the demand of online direct channel, the demand of traditional channel, the manufacturer's optimal profits , the retailer's optimal profits and the dual-channel's total profit are given, respectively, by

$$d_d^{*1} = \frac{-(1-2\alpha)R + 2rt + t}{2t(2+r)} \quad (8)$$

$$d_r^{*1} = \frac{(1-2\alpha)R + 3t}{2t(2+r)} \quad (9)$$

$$\pi_m^{*1}(p_d) = \frac{[(1-2\alpha)R]^2 - 2t(r^2 + 3r - 1)(1-2\alpha)R - 2r^2 t^2 - 2rt^2 + 13t^2}{2t(2+r)^2} - c \quad (10)$$

$$\pi_r^{*1}(p_r) = \frac{r[(1-2\alpha)R]^2 + 6rt(1-2\alpha)R + 9rt^2}{2t(2+r)^2} \quad (11)$$

$$\Pi^{*1} = \frac{(1+r)[(1-2\alpha)R]^2 - 2t(r^2 - 1)(1-2\alpha)R - 2r^2 t^2 + 7rt^2 + 13t^2}{2t(2+r)^2} - c \quad (12)$$

Since the digital attribute of product significantly affects customers' perceived utility, in the dual-channel system, when manufacturer and retailer make their own decisions to maximize their individual profits,

$p_d^{*1}, p_r^{*1}, \pi_m^{*1}(p_d)$ and $\pi_r^{*1}(p_r)$ are affected by R, t, r and α , in addition, $\pi_m^{*1}(p_d)$ also affected by c .

3.2 The retailer Stackelberg game.

In this section we consider the retailer Stackelberg game, i.e., the retailer, as the Stackelberg leader, determines p_r and r first, then the manufacturer as the follower sets its optimal online direct price p_d based on the retailer's decisions.

Stage 1. First, we assume that the retailer's price is known, when $\frac{\partial \pi_m(p_d)}{\partial p_d} = 0$, the manufacturer maximize its individual profit, the price of online direct channel is determined by

$$p_d = \frac{-(1-2\alpha)R + (2-r)p_r + t}{2} \quad (13)$$

Stage 2. The retailer, maximize its individual profit, substituting (13) into (5), we obtain the price of traditional channel in the retailer Stackelberg game

$$p_r^{*2} = \frac{(1-2\alpha)R + 3t}{2r} \quad (14)$$

Then we obtain the price of online direct channel in the retailer Stackelberg game

$$p_d^{*2} = \frac{(2-3r)(1-2\alpha)R - rt + 6t}{4r} \quad (15)$$

Substituting (14),(15)into(2),(3),(4),(5), and simplifying, we obtain(16),(17),(18),(19)and(20). Therefore, in the retailer Stackelberg game, the demand of online direct channel, the demand of traditional channel, the manufacturer's optimal profits, the retailer's optimal profits and the dual-channel's total profit are given, respectively, by

$$d_d^{*2} = \frac{-(1-2\alpha)R + 5t}{8t} \quad (16)$$

$$d_r^{*2} = \frac{(1-2\alpha)R + 3t}{8t} \quad (17)$$

$$\pi_m^{*2}(p_d) = \frac{r[(1-2\alpha)R]^2 + (16t-26rt)(1-2\alpha)R - 23rt^2 + 48t^2}{32rt} - c \quad (18)$$

$$\pi_r^{*2}(p_r) = \frac{[(1-2\alpha)R]^2 + 6t(1-2\alpha)R + 9t^2}{16t} \quad (19)$$

$$\Pi^{*2} = \frac{3r[(1-2\alpha)R]^2 + (16t-14rt)[(1-2\alpha)R] - 5rt^2 + 48t^2}{32rt} - c \quad (20)$$

From the above analysis, in the retailer Stackelberg game, $p_d^{*2}, p_r^{*2}, \pi_m^{*2}(p_d)$ and $\pi_r^{*2}(p_r)$ are affected by R, t, r and α , in addition, $\pi_m^{*2}(p_d)$ also affected by c .

Since the solution of our model is complex, the difference of the manufacturer and the retailer's pricing strategies and profits in the two scenarios cannot be directly observed, we will analyze the impacts of digital attribute of product and power structure on pricing strategies and investigate the impacts of these two factors on the manufacturer, the retailer and the channel total profits in section 4 and 5.

4. ANALYSIS OF THE DUAL-CHANNEL MODEL

4.1 Analysis of digital attribute of product.

Proposition 1. In the scenario that manufacturer and retailer make decisions individually, the price of online direct channel p_d^{*1} increases with increasing the digital attribute of product α , the price of traditional channel p_r^{*1} decreases with increasing α .

The proof of Proposition 1, as well as the proofs of the other propositions, is given in Appendix. Proposition 1 indicates that in the scenario that manufacturer and retailer make decisions individually, the price of online direct channel and the digital attribute of product are positively correlated, the price of traditional channel and the digital attribute of product are negatively correlated.

Proposition 2. In the retailer Stackelberg game, if $2/3 < r < 1$, then the price of online direct channel p_d^{*2} increases with increasing α . If $0 < r < 2/3$, then the price of online direct channel p_d^{*2} decreases with increasing α . The price of traditional channel p_r^{*2} always decreases with increasing α .

Proposition 2 indicates that in the retailer Stackelberg game, if $2/3 < r < 1$, then $\partial p_d^{*2} / \partial \alpha > 0$, the price of online direct channel and the digital attribute of product are positively correlated. If $0 < r < 2/3$, then $\partial p_d^{*2} / \partial \alpha < 0$, the price of online direct channel and the digital attribute of product are negatively correlated. However, no matter how much the share of retail sales that the retailer extract from traditional distribution channel r changes, the price of traditional channel and the digital attribute of product are always negatively correlated. This conclusion also partially reveals price dispersion in dual-channel^[14]. In reality, the parameter r is exogenous, for different industries, the value of r is different, but r will not be over 0.5 generally, so in our model, the value of r will be in $[0, 2/3]$.

4.2 Analysis of power structure.

Proposition 3. Both the price of online direct channel and the price of traditional channel in the retailer Stackelberg game are always higher than the scenario that manufacturer and retailer make decisions individually.

Proposition 3 shows that, although the manufacturer is in a weak position, the price of online direct increases instead. As the Stackelberg leader, the retailer has the priority to decide the price, so the price of the traditional channel will obviously increase. Accordingly, both the manufacturer and the retailer will price higher if they choose to negotiate price rather than price respectively.

Proposition 4. The market share of online direct channel in the retailer Stackelberg game is always higher than the scenario that manufacturer and retailer make decisions individually, and the market share of traditional channel in the retailer Stackelberg game is always lower than the scenario that manufacturer and retailer make decisions individually.

Proposition 4 indicates that, although the manufacturer is in a weak position, the market share of online direct increases instead. Thus, for the Small and Medium-Sized Manufacturers, the opening of dual-channel marketing can help they increase the online direct sales. As the market share of traditional channel reduced, the retailer will raise the price of traditional channel inevitably to maintain its own interest. This property also proved proposition 3.

5. COMPUTATIONAL STUDIES

Our objective in this section is to draw managerial insights based on a numerical analysis of our model. We consider two situations related to different parties in our model. First, we consider the impacts of the digital

attribute of product on manufacturer and retailer’s profits. Second, we focus on the difference of manufacturer and retailer’s profits and dual-channel’s total profit in two scenarios. In the rest of this section, we illustrate our results with a numerical example. The parameters for this example are $R = 100, t = 10, c = 10$ and $r = 0.4$. When manufacturer and retailer make their own pricing strategies individually, $\alpha \in [0.41, 0.65]$, in the retailer Stackelberg game, $\alpha \in [0.25, 0.65]$. From Figs.2-5, the horizontal axis denotes digital attribute of product α , the vertical axis denotes profit.

5.1 Analysis of digital attribute of product.

From Fig.2, if manufacturer and retailer make their own decisions to maximize their individual profits, as α increases, the manufacturer’s profit decreases firstly, then goes up later, but the retailer’s profit decreases with increasing α . Another interesting observation from Fig.2 is that, the manufacturer’s profit is far less than the retailer’s profit if α is relatively smaller, as α increases, the manufacturer’s profit at equilibrium increases at a faster rate than the retailer’s profit and far greater than retailer finally. Thus, it is indeed possible for the manufacturer to focus on the digital attribute of product in order to be more profitable than the retailer in this scenario.

In a retailer Stackelberg game, from Fig.3 we can find that, as α increases, both manufacturer and retailer’s equilibrium profit goes down, when α reaches its maximum, the retailer’s profit closes to 0. The above results indeed show that the higher α , the lower the base level of demand in traditional channel, therefore, the retailer will be forced out of the traditional retail channel. Take the audio/video market for example, since the digital attribute of audio/video product is very high, it is obviously easy to transmit the product information through the network, thence, many audio/video stores in traditional channel are replaced by online stores. This result poses a grave threat to traditional audio/video stores, and the traditional audio/video stores become less and less.

5.2 Analysis of profit in two scenarios.

Fig.4 shows that, no matter how α changes, in a retailer Stackelberg game, both manufacturer and retailer’s profit always more than the scenario that manufacturer and retailer make decisions individually. This conclusion also validates the double marginalization effect. Accordingly, as long as the channel members adopt a cooperative manner when they negotiate, both the manufacturer and the retailer are better off.

Fig.5 shows that, no matter how α changes, the dual-channel’s total profit in the retailer Stackelberg game is

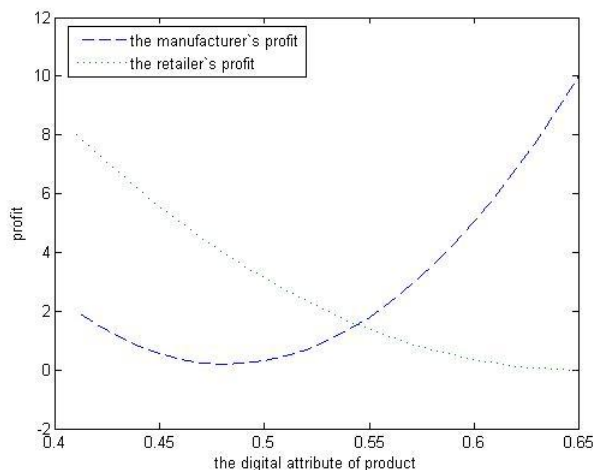


Figure 2. the manufacturer and the retailer's profit when

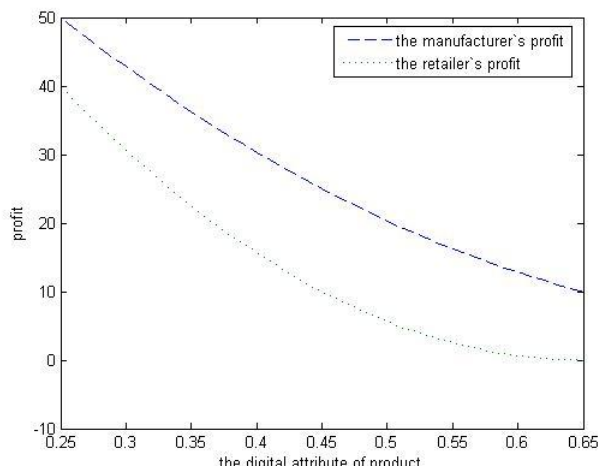


Figure 3. the manufacturer and the retailer's profit in a retailer Stackelberg game

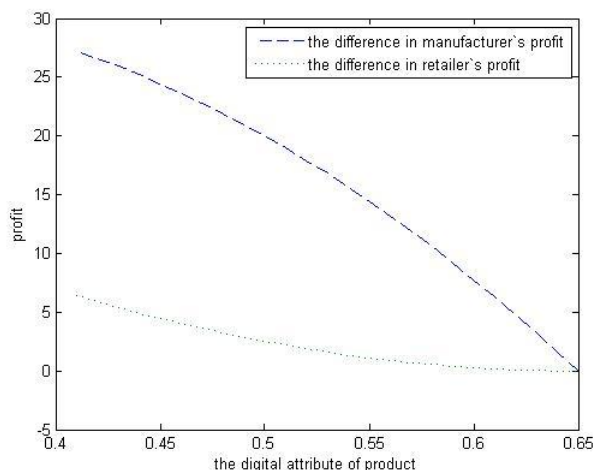


Figure 4. the difference in manufacturer's profit
 $\pi_m^{*2}(p_d) - \pi_m^{*1}(p_d)$ **and the difference in retailer's profit**
 $\pi_r^{*2}(p_r) - \pi_r^{*1}(p_r)$ **in two scenarios.**

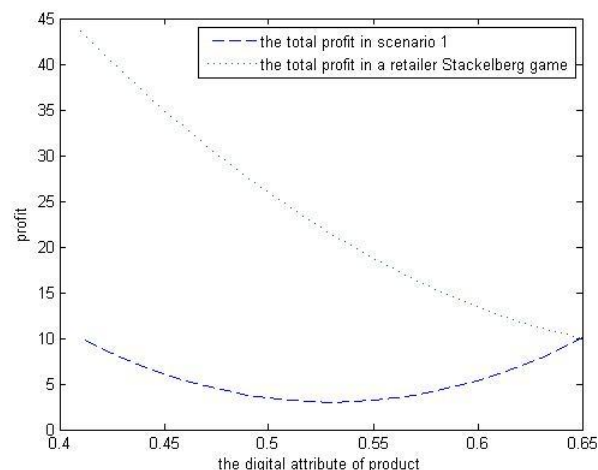


Figure 5 .the dual-channel's total profit in two scenarios

we investigated the impacts of digital attribute of product and power structure on optimal pricing strategies. Besides, we considered the change both of manufacturer and retailer's profits when the power structure is difference and the digital attribute of product is heterogeneous using computational studies. The analyses show that, when the manufacturer and the retailer make decisions individually, with the digital attribute of product increasing, the price of online direct channel increases and the price of traditional channel decreases. In the retailer Stackelberg game, the relationship between the price of online direct channel and the digital attribute of product is affected by r , but the price of traditional channel always decreases with the increasing digital attribute of product. Our studies also show that manufacturer decides price according to retailer's pricing strategy is a win-win strategy, both the manufacturer and the retailer are better off, and the dual-channel's total profits also improve.

Note that the decision-making situation is more complicated in practice, there may be more than one manufacturer and more than one retailer in supply chain, in the future, we can consider the model with more complicated supply chain structures and a number of potential parameters.

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