

Consider Retailer Dual-channel Supply Chain Pricing Strategies with Grey Market Speculation

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Abstract

in view of gray market speculation in offline market of manufacturer-led dual-channel supply chain, retailers adopt pricing strategies to deal with the influence of gray market speculation on dual-channel product prices and their own profits, and construct a three-stage game model composed of manufacturers, retailers and independent gray market speculators. Considering that manufacturers do not participate in the market competition, the same or different wholesale prices are adopted for retailers and grey market speculators. By constructing the linear demand function and profit model of manufacturer, retailer and independent grey market speculators, the optimal dual-channel pricing of retailers in two cases is given. The analysis shows that when there is gray market speculation in the offline market, retailers have a strong control over the online market and their control over the offline market is affected. Moreover, retailers' pricing strategy for the online market can obtain more profits from the online market. Under the same wholesale price, the offline market share of gray market products is within a certain range, and the retailer's pricing strategy makes its profit reach the optimal level. Under different wholesale prices, when the offline market share of gray market products is increasing, retailers' pricing strategies can only minimize their profit loss.

Keywords

gray market speculation; Manufacturer-led; Dual channels for retailers; Pricing strategy.

1. Introduction

Grey market, referred to as grey market, refers to an "informal" sales channel that sells the products of the brand without authorization of the brand owner [1][2]. Gray market products are genuine products with correct trademarks produced by brand owners or manufacturers on their behalf, with low prices and sales channels outside the supervision of relevant national authorities [3]. For example, a sohu article in July 2018 wrote that although authoritative data showed that samsung mobile phones shipped 2.14 million units in China in the first quarter, the actual shipments were more than 6 million units, indicating that a large number of samsung mobile phones were sold to customers through gray market speculators, and the domestic gray market still exists. Nowadays, with the development of e-commerce, many retail enterprises, such as gome and suning, continue to maintain traditional physical stores while opening up online sales channels, that is, adopting a dual-channel sales model, which can help retailers seize more market shares and occupy a favorable position in market competition [4]. Still, still exist in real life some grey market speculators to participate in market competition, such as grey market speculators will advent of food, cosmetics, etc. At a lower price through gray market sales, but grey market products into the market will erode retailer's market share [1], and thus affect the retailer's sales and price [5].

Manufacturers as a dual channel supply chain leader if rely on retailers to sell their products in the market, when inventory pressure larger manufacturers sometimes have to through the grey market to alleviate the pressure of the inventory [6][7], the manufacturer to bring down the wholesale price of its products to reduce the cost of grey market speculation[8], and lower wholesale prices will induce the participation of grey market speculators speculation, resulting in a large number of products into the grey [9]. Retailers, meanwhile, strive to provide consumers with products display, promotion and other services makes grey market speculators do not need to undertake any cost can be obtained from retailer's advertising and marketing consumer's perception of grey market product [10], consumers will be in the process of price comparison because grey market products and low prices to grey market purchase, eventually grey market speculators by a retailer's "free ride" grab market share [11] of the retailers, retailers in the market caused by the loss of customers, to a certain extent undermined the relationship between supply chain members [12]. Ahmadi [1] points out that it is more effective to control the quantity of gray market products than to reduce the availability of products by adjusting the price of products. Therefore, it is of great significance to study how retailers adopt pricing strategies to deal with gray market speculation in a manufacturer-led dual-channel supply chain environment for retailers.

2. Literature Review

Now regarding the research on pricing of dual-channel supply chain led by manufacturers, some scholars have taken into account the factors influencing dual-channel pricing strategy. For example, Li [13] studied how risk-averse retailers affected retail prices and profits of members of the supply chain by responding to risks. Zhang xuelong et al. [14] considered the influence of pricing differences and return risk on the pricing strategies of manufacturers and retailers from the perspective of consumer behavior. This paper considers the existence of grey market speculation in the market can also be regarded as a class of factors affecting the pricing strategy of dual-channel supply chain, and studies the pricing strategy in the context of manufacturer dominated retailer dual-channel supply chain. At present, there are few researches on the pricing of the retailer's dual-channel supply chain led by manufacturers. By establishing a Stackelberg model, Fang qing [15] and Zhong kaixuan [16] obtained the optimal dual-channel price of retailers by using the reverse induction method. Similarly, some scholars have taken into account the factors that influence retailers' pricing strategies. For example, Yang jiaquan et al. [17] have taken into account retailers' strategic inventory holdings. Gong yonghua et al. [18] studied the effect of free-rider effect on the price of dual-channel products and the level of service effort of retailers, taking into account the free-rider effect of service between retailers' dual-channel products. The research in literature [13-18] belongs to the pricing problem of dual-channel supply chain under the same market condition, and considers the factors influencing the pricing strategy of dual-channel supply chain. Among them, literature [15-18] discussed the pricing problem of dual-channel supply chain led by manufacturers under the influence of different factors, which was similar to the market environment studied in this paper, but did not consider how retailers set dual-channel prices in the presence of grey market speculation.

At present, there are researches on the influence of gray market speculation on the pricing of supply chain members in the same market. Altug [19] studied the gray market established by gray market speculators. In the MSRP (suggested retail price) environment, manufacturers adjust the prices of retailers and gray market products by implementing wholesale pricing contracts. Wu han [20] studied a market composed of the government, manufacturers, grey market speculators and consumers. By establishing the demand model affected by the degree of consumer recognition and the profit model of manufacturers and grey market speculators,

he proposed the price decision and optimal service strategy of manufacturers. Studies in literature [19-20] have shown that the existence of gray market can affect the decision-making of supply chain members, but the influence of gray market on their own profits can be reduced by adjusting product prices, which is consistent with the view in literature [1]. From the perspective of channel, the grey market belongs to a kind of new channels into the problems, and for the consumers in the market to provide additional consumer channels, when grey into the retailers in the market, will compete with retailers double channel, but [19-20] is the study of the grey literature into the offline market compete with traditional channels. In the study on the influence of gray market invasion on the pricing of supply chain members, Huang Fuling et al. [21] pointed out that remanufacturing by brand owners can effectively reduce the speculative behavior of gray market speculators and improve the profits of manufacturers, and used the consumer utility function to give the sales prices of manufacturers' products, remanufactured products and gray market products. Xu [22] et al. studied the grey market competition between two independent retail channels, and also used the consumer utility function to give the optimal pricing strategy of two channel retailers. [21-22] and market situation of this study are similar, but the difference is that retailers implement double channel sales mode, the invasion of grey market provides consumers with a new consumer channels, namely, consumer can through online, offline and grey three channels to purchase products, and now studies of grey market is rarely mentioned in double channel exists under the environment of supply chain with grey speculative question how to develop the channels of different prices.

In addition, gray market products can not only be sold through traditional physical stores, but also promoted by the rise of cross-border e-commerce providers such as JD global shopping and Tmall international. However, after the e-commerce law is officially implemented on January 1, 2019, online trading of gray market products will be subject to strict supervision and supervision, and the online market will be more standardized [23]. On the other hand, compared with general online products, the price of gray market products sold online will be lower. If consumers can easily find gray market products online, they will be misled into thinking that the price of gray market products is the reasonable price of general products, leading to the loss of significance of retailers' pricing strategies for products. Therefore, this paper only considers how retailers set dual-channel prices when there is gray market speculation in the offline market. Shao, etc. [24] pointed out that although the existence of the gray market is expected to hurt manufacturers, but manufacturers sometimes tolerate or even encourage grey market speculation, in view of this, this article research is composed of a manufacturer and a retailer of dual channel supply chain, the manufacturer is the leader in the supply chain but not participate in the market sales, and retailers are followers have online and offline sales channels, at the same time there is supply chain nodes outside of the grey market speculators to participate in market competition, constructed by manufacturers, retailers and independent three stages game model of grey market speculators. Altug [19] pointed out that when manufacturers, as supply chain leaders, encourage gray market speculation, they should first establish an optimal wholesale price to ensure that gray market speculators can enter the market. However, in order to control the impact of gray market speculation on retailers, flexible wholesale prices can be set to control gray market activities. And make sure that grey market speculators into the market wholesale price is the special case of the wholesale price of its flexible, therefore, this article first considers the grey market speculators can enter the offline market can accept the largest wholesale price, then further consideration manufacturers to retailers and grey market speculators flexible wholesale price, research on the retailers and manufacturers under the grey market speculators to implement two wholesale prices retailers how to develop the double channel, the optimal pricing strategy.

3. Dual-channel Supply Chain Model with Grey Market Speculation

A retailer's dual-channel supply chain considering the existence of gray market speculation in the offline market is composed of a manufacturer M and a retailer F. In this model, the manufacturer provides products to retailer F and gray market speculator T but does not participate in market sales. The retailer sells products to customers through online and offline channels. In the model, manufacturers sell products to retailers and grey market speculators at wholesale price w and wholesale price w_i respectively, and the wholesale price given by manufacturers to grey market speculators is kept secret from retailers. The online and offline sales prices of retailers are p_e and p_r , $p_i > w, (i = r, e)$, and the price of grey market products is p_i , $(w_i < p_i < p_r)$.

Assume that the linear demand function of the retailer's online market and offline market is $q_e = (1 - \theta)a - p_e$ and $q_r = \theta a - p_r$, where a is the total potential demand for the product in the market, θ ($0 < \theta < 1$) is consumers' choice preference of offline market, q_i is the actual demand for products in online or offline markets. Assuming that gray market speculators only sell gray market products to the offline market and compete with the offline regular channel products in quantity, the dual-channel supply chain structure with gray market speculation is shown in figure 1:

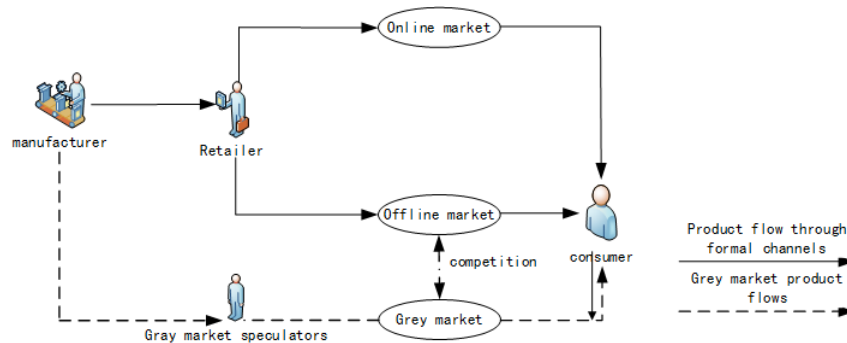


Figure 1. retailer dual-channel supply chain structure with grey market speculation in offline market

Furthermore, this paper describes the demand function of retailers in regular channel products and gray market products under the condition of gray market speculation in offline market as follows:

$$\begin{cases} q_e = (1 - \theta)a - p_e \\ q_r = \theta a(1 - s) - p_r \\ q_i = s\theta a - p_i \end{cases} \quad (1)$$

Among them, the regular channel product price is the wholesale price plus the premium part in the regular channel Δw_i ($i = r, e$), that is $p_i = w + \Delta w_i$; The price of gray market products is the manufacturer's wholesale price of gray market products plus the premium of gray market products in gray market Δw_i , that is $p_i = w_i + \Delta w_i$. p_i ($i = e, r, t$) is the price of corresponding channel products, q_i ($i = e, r, t$) is the actual sales volume of the corresponding channel products; s ($0 < s < 1$) represents the market share of gray market products in the offline market [1][25]. In the above model, sub index 1 represents the manufacturer led retailer dual-channel,

sub index 2 represents the manufacturer led retailer dual-channel with gray market speculation, and π_{sc} represents the profit of all dual-channel supply chains.

Assuming that consumers who choose to buy products in the online market have good loyalty, the gray market only provides other consumption channels for consumers who choose to buy products in the offline market. It is pointed out here that retailer F determines the price of regular channel products by competing with grey market speculator T in quantity. In order to analyze the problem more intuitively, this paper further assumes (hypothesis 1-4[15]) : 1) the manufacturer's production capacity is infinite and there is no shortage of goods; 2) products of different channels have the same quality; 3) certain demand in the market; 4) sales costs of retailers and grey market speculators are ignored; 5) the mutual influence between regular channels is ignored; 6) when there is no gray market speculation in the market, the profits of manufacturers and retailers are regarded as the best.

3.1. No Gray Market Speculation by Manufacturers Led by Retailers through Dual Channels

In this case, the sequence of events in the model is: Manufacturers decide on wholesale prices w_1 to retailers first, Based on the manufacturer's wholesale price, retailers decide the price of products sold through the formal channels online and offline is p_{e1} and p_{r1} , aiming to maximize profits respectively.

Referring to literature [15], the demand function of retailer's dual-channel supply chain in regular channels can be described as:

$$\begin{cases} q_{e1} = (1-\theta)a - p_{e1} + bp_{r1} \\ q_{r1} = \theta a - p_{r1} + bp_{e1} \end{cases} \quad (2)$$

Among them, the price sensitivity coefficient between regular channel products is set as $1, b$ ($0 < b < 1$) is the cross price elasticity coefficient between two channels to reflect the degree of substitutability between regular channel products. The profit function of the retailer and the manufacturer is:

$$\begin{cases} \pi_{f1} = (p_{e1} - w)q_{e1} + (p_{r1} - w_1)q_{r1} \\ \pi_{m1} = w_1(q_{e1} + q_{r1}) \end{cases} \quad (3)$$

The reverse induction method was used to solve the model, and the solution process of reference [16] showed that the wholesale prices of manufacturers and the product prices of retailers through online and offline formal channels were as follows: $w_1 = \frac{a}{4(1-b)}$,

$p_{e1} = \frac{a(5+b) - 4\theta a(1-b)}{8(1+b)(1-b)}$ and $p_{r1} = \frac{4\theta a(1-b) + a(1+5b)}{8(1+b)(1-b)}$; The sales volume of the retailers' products in the

formal channels are as follows: $q_{e1} = \frac{a(3-4\theta)}{8}$ and $q_{r1} = \frac{a(4\theta-1)}{8}$; By substituting the equilibrium solution of w_1, p_{e1} and p_{r1}, q_{e1} and q_{r1} into equation (3), the profit of manufacturer, retailer and dual-channel supply chain is obtained as follows:

$$\pi_{m1} = \frac{a^2}{16(1-b)}, \pi_{f1} = \frac{a(3-4\theta)[a(3-b) - 4\theta a(1-b)] + a(4\theta-1)[4\theta a(1-b) + a(3b-1)]}{64(1+b)(1-b)},$$

$$\pi_{sc1} = \frac{a(3-4\theta)[a(3-b) - 4\theta a(1-b)] + a(4\theta-1)[4\theta a(1-b) + a(3b-1)] + 4a^2(1+b)}{64(1+b)(1-b)}.$$

3.2. There are Dual Channels of Gray Market Speculation by Manufacturer-Led Retailers

Scenario 1: when there is gray market speculation in the offline market, manufacturer M adopts the same wholesale price to the regular channel retailer F and gray market speculator T.

In this case, the sequence of events in the model is: As the leader of the dual-channel supply chain, manufacturer M gives priority to the decision of an optimal wholesale price w_2 ; Second, retailers F as followers, on the basis of a manufacturer's M wholesale prices to determine the optimal online and offline channels for product sales prices p_{e2} and p_{r2} formal; Finally, grey market speculators T F in the offline market pricing strategy based on retailers to determine its own profit maximization of grey market product price p_{i2} .

From the above analysis, the profit functions of manufacturer M, retailer F and grey market speculator T can be obtained as follows:

$$\text{Max}_{q_e, q_r, q_i} \pi_{m2} = (q_{e2} + q_{r2} + q_{i2}) w_2 \tag{4}$$

$$\begin{aligned} \text{Max}_{q_e, q_r} \pi_{f2} &= (p_{e2} - w_2) q_{e2} + (p_{r2} - w_2) q_{r2} \\ &= [(1 - \theta)a - q_{e2} - w_2] q_{e2} + (\theta a - s\theta a - q_{r2} - w_2) q_{r2} \end{aligned} \tag{5}$$

$$\text{Max}_{q_i} \pi_{i2} = (p_{i2} - w_2) q_{i2} = \Delta w_{i2} q_{i2} = (s\theta a - q_{i2} - w_2) q_{i2} \tag{6}$$

Proposition 1 When manufacturer M adopts the same wholesale price for retailer F and grey market speculator T in the offline market, the optimal pricing strategy of retailer F in the formal channel and grey market speculator T is as follows:

$$\begin{cases} p_{e2} = \frac{a(7 - 6\theta)}{12} \\ p_{r2} = \frac{6\theta a(1 - s) + a}{12} \\ p_{i2} = \frac{6s\theta a + a}{12} \end{cases} \tag{7}$$

Proposition 2 When the manufacturer adopts the same wholesale price for the retailer and grey market speculator T, the profits of the manufacturer, retailer, supply chain and grey market speculator T are as follows:

$$\begin{cases} \pi_{m2} = \frac{a^2}{24} \\ \pi_{f2} = \frac{a^2 [26 - 12\theta(6 - s) + 36\theta^2(2 - 2s + s^2)]}{144} \\ \pi_{i2} = \frac{a^2 (36\theta^2 s^2 - 12\theta s + 1)}{144} \\ \pi_{sc2} = \frac{a^2 [17 - 36\theta + 18\theta^2(2 - 2s + s^2)]}{72} \end{cases} \tag{8}$$

Theorem 1 when $\theta \in \left(\frac{1}{3}, \frac{5}{6}\right), s \in \left(\frac{1}{5}, \frac{1}{2}\right), \frac{\partial \pi_{f2}}{\partial s} < 0, \frac{\partial \pi_{sc2}}{\partial s} < 0,$ there are $s_1 \in \left(\frac{1}{5}, \frac{1}{2}\right),$ make when $s \in \left(\frac{1}{5}, s_1\right), \frac{\partial \pi_{f2}}{\partial s} < 0,$ when $s \in \left(s_1, \frac{1}{2}\right), \frac{\partial \pi_{f2}}{\partial s} > 0.$

Theorem 1 manufacturer M F for formal channels of retailers is given, and the grey market speculators T take the same wholesale price, regular channel products, as well as the basic condition of grey market product sales is greater than zero, shows that grey market speculation is offline market, the retailers and double channel of the supply chain profit with the grey market product line of increasing market share. Theorem 1 also gives the threshold for grey market speculator T to enter grey market, indicating that the minimum market share of profits of grey market speculator T in the offline market is determined by consumers' preference for offline channels. When $\frac{1}{5} < s < \frac{1}{6\theta},$ The declining profits of gray market speculators indicate that gray market products are not attractive to consumers, and gray market speculators are likely to be squeezed out of the offline market. When $\frac{1}{6\theta} < s < \frac{1}{2},$ At this time, gray market products to consumers more and more attractive, gray market speculators will continue to increase the profits.

Scenario 2 When there is gray market speculation in the offline market, manufacturer M adopts different wholesale prices to the regular channel retailer F and gray market speculator T. Use * for manufacturers to adopt different wholesale price of the variable.

In this case, the sequence of events in the model is: Manufacturer M takes precedence in determining wholesale prices for retailer F and grey market speculator T as w_2^* and $w_{i2}^*;$ Secondly, retailer F determines its optimal online and offline formal channel product sales as price p_{e2}^* and $p_{r2}^*,$ and according to the wholesale price of manufacturer ;Finally, the gray market speculator T is based on the manufacturer's wholesale price w_{r2}^* and retailer F's product prices p_{r2}^* in the offline market and determine their own profit maximization of grey market product sales price $p_{i2}^*.$

From the above analysis, the profit function of manufacturer M can be expressed as:

$$\text{Max}_{q_e, q_r, q_i} \pi_{m2}^* = (q_{e2}^* + q_{r2}^*) w_2^* + q_{i2}^* w_{i2}^* \tag{9}$$

The profit functions of retailer F and grey market speculator T can still be expressed by equations (5) and (6).

Proposition3 In the case of gray market speculation in the offline market in the dual-channel supply chain led by manufacturers, when manufacturer M adopts different wholesale prices for retailer F and gray market speculator T, the optimal pricing strategies of retailer F in the formal channel and gray market speculator T are as follows:

$$\begin{cases} p_{e2}^* = \frac{5a - 4\theta a - s\theta a}{8} \\ p_{r2}^* = \frac{4\theta a + a - 5s\theta a}{8} \\ p_{i2}^* = \frac{3s\theta a}{4} \end{cases} \tag{10}$$

Proposition4 When manufacturer M adopts different wholesale prices for retailer F and grey market speculator T, the profits of manufacturer, retailer, supply chain and grey market speculator T are as follows:

$$\begin{cases} \pi_{m2}^* = \frac{a^2(1-2s\theta^2+3s^2\theta^2)}{16} \\ \pi_{f2}^* = \frac{a^2(5-16\theta+6s\theta)+\theta^2a^2(16-16s+5s^2)}{32} \\ \pi_{r2}^* = \frac{s^2a^2\theta^2}{16} \\ \pi_{sc2}^* = \frac{a^2(7-16\theta+2s\theta)+\theta^2a^2(16-16s+7s^2)}{32} \end{cases} \quad (11)$$

Theorem2 make $s \in (\frac{1}{5}, \frac{1}{2})$, when $b = 0$, and $\theta \in (\frac{2}{5}, \frac{2}{3})$, $\pi_{m2} < \pi_{m2}^* < \pi_{m1}$, $w_2 < w_2^* < w_1$; when

$$s \in (\frac{1}{5}, \frac{1}{3}), \frac{\partial \pi_{m2}^*}{\partial s} < 0, s \in (\frac{1}{3}, \frac{1}{2}), \frac{\partial \pi_{m2}^*}{\partial s} > 0.$$

Theorem 2 gives the basic condition that when the manufacturer adopts different wholesale prices to regular retailers and grey market speculators T, the manufacturer gains more profits from the market than it does at the same wholesale price. It shows that when consumers' preference for offline channels is within a certain range, manufacturers' profits are always greater than those obtained at the same wholesale price. When $\frac{1}{3} < s < \frac{1}{2}$, manufacturers' profits will increase as the share of gray market products in the offline market increases, which is different from scenario 1.

Conclusion 1 When there is a certain demand in the market, manufacturers providing products to grey market speculators cannot improve their profits and affect the overall efficiency of the supply chain, but retailers can enjoy lower wholesale prices [8][19]. When the manufacturer adopts the same wholesale price for regular channel retailers and grey market speculators, the manufacturer's profit is only related to the market potential demand. When manufacturers adopt different wholesale prices for regular channel retailers and grey market speculators, they can reduce the loss of their own profits by formulating strategies for wholesale prices under the condition of theorem 2.

4. Analysis on the Impact of Gray Market Speculation on Retailers in Offline Market

According to the above proposition and the equilibrium solution, when the interaction between normal channels is not considered, namely $b = 0$, the following theorem can be obtained:

4.1. Comparison and Analysis of Retailers' Optimal Pricing Strategies in Different Market Environments

Theorem 3 when $\theta \in (\frac{1}{3}, \frac{5}{6})$, $s \in (\frac{1}{5}, \frac{1}{2})$, $p_{e1} > p_{e2}$, $p_{r1} > p_{r2}$, $q_{e1} < q_{e2}$, $\pi_{fe1} < \pi_{fe2}$; when $\theta \in (\frac{2}{5}, \frac{2}{3})$,

$$s \in (\frac{1}{5}, \frac{1}{2}), p_{e1} > p_{e2}^*, p_{r1} > p_{r2}^*, q_{e1} < q_{e2}^*, \pi_{fe1} < \pi_{fe2}^*.$$

Theorem 3 shows that under the condition of satisfying theorem 1 and theorem 2, offline market exists in the grey market speculation, because retailers enjoy lower wholesale prices, regular channel is always lower than the market price of the products in the product price when no grey market speculation, but retailers in the online market product sales and profits are always better than offline without grey market speculation in the market sales and profits. Gray market speculators attract consumers to buy gray market products at a low price, and their speculation will weaken retailers' control over the market to some extent.

Retail gross margins ($RGM = \frac{P_i - w}{P_i}, (i = r, e)$) are the retail gross margins of a retailer's products in a formal channel, To measure the difference of retailers' market control power in different market environments [26], theorem 4 can be obtained.

Theorem 4 when $a > 0$, and $s \in \left(\frac{1}{5}, \frac{1}{2}\right)$, $\theta \in \left(\frac{1}{3}, \frac{5}{6}\right)$, $RGM_{e1} < RGM_{e2}$; there are $s \in \left(\frac{1}{5}, s_2\right)$, $RGM_{r1} < RGM_{r2}$, when $s \in \left(s_2, \frac{1}{2}\right)$, $RGM_{r1} > RGM_{r2}$; when $\theta \in \left(\frac{2}{5}, \frac{2}{3}\right)$, $RGM_{e1} < RGM_{e2}^*$, $RGM_{r2}^* < RGM_{r1}$.

Theorem 4 shows that when there is gray market speculation in offline market in the dual-channel supply chain led by manufacturers, retailers always have stronger control over online market than offline market without gray market speculation. Manufacturers take the same wholesale price and as $\frac{1}{5} < s < \frac{1}{3}$, Retailers control the offline market more than the offline market without grey market speculation retailers control the offline market; When $\frac{1}{3} < s < \frac{1}{2}$, This indicates that the inflow of gray market products into the offline market weakens retailers' control over the offline market, and gray market speculators have stronger control over the gray market and can gain more profits. However, when manufacturers adopt different wholesale prices, retailers always have lower control over the offline market than when there is no gray market in the market.

Conclusion2 Comprehensive theorem 3 and 4, the grey market products into offline market although affected the retailers in the formal channels of product prices, but retailers in the online market pricing strategy is always good for themselves, as retailers control the online market is stronger, when the market demand increases retailer can get more profits from online market. Manufacturers take the same wholesale price as $\frac{1}{5} < s < \frac{1}{3}$, retailers' pricing

strategies in offline markets always work to their advantage, when $\frac{1}{3} < s < \frac{1}{2}$, Retailers have less control over offline markets; When manufacturers adopt different wholesale prices, their strategies for setting wholesale prices weaken retailers' control over the offline market.

4.2. Profit Comparison and Analysis of Retailers in Different Market Environments

Theorem 5 there are $\theta_1 \in \left(\frac{1}{3}, \frac{5}{6}\right)$, when $s \in \left(\frac{1}{6\theta_1}, s_2\right)$, $\pi_{f1} < \pi_{f2}$, when $s \in \left(s_2, \frac{1}{2}\right)$, $\pi_{f1} > \pi_{f2}$; there are $\theta_2 \in \left(\frac{2}{5}, \frac{2}{3}\right)$, $s_3 \in \left(\frac{1}{5}, \frac{1}{2}\right)$, make $s \in \left(\frac{1}{5}, s_3\right)$, $\frac{\partial \pi_{f2}^*}{\partial s} < 0$, when $s \in \left(s_3, \frac{1}{2}\right)$, $\frac{\partial \pi_{f2}^*}{\partial s} > 0$; when $\theta \in \left(\frac{2}{5}, \frac{2}{3}\right)$, when $s \in \left(\frac{1}{5}, \frac{1}{2}\right)$, $\pi_{f2}^* < \pi_{f1}, \pi_{f2}^* < \pi_{f2}$.

Theorem 5 indicate that manufacturers dominant retailers double channels when there is a grey market speculation in the offline market makers to take the same wholesale prices, consumers' preference must be offline market, and market share of grey market product line within a certain range, to achieve the optimal retailer's profit, grey market product line of the market share of more than a certain threshold, the retailer's profits will suffer. When manufacturers adopt different wholesale prices and consumers have certain preferences in offline channels, retailers' profits decrease first and then increase with the offline market share of gray market products. Under the condition that theorem 2 is satisfied, when the offline market share of gray market products is within a certain range, although the profit of retailers will continue to increase, it is always lower than that of scenario 1 and the market without gray market speculation.

Conclusion 3 general theorem 4 and 5 show that when the manufacturer adopts the same wholesale price for regular channel retailers and grey market speculator T, and the offline market share of grey market products is within a certain range, the retailer's pricing strategy in regular channel makes the retailer's profit reach the optimal. When manufacturers take different wholesale price, consumers' channel preference and certain market share of grey market product line within a certain range, the manufacturers and retailers and grey market speculators T profits will increase, but in fact, the manufacturers of wholesale price strategy has weakened the retailer to control of the market, create a win-win "illusion", as grey market products into the offline market impact on retailers' profit maximum.

5. The Example Analysis

5.1. The Manufacturer Takes the Same Wholesale Price

When manufacturer M adopts the same wholesale price for regular channel retailer F and grey market speculator T, according to theorem 1, set $a = 1$, $s \in \left(\frac{1}{5}, \frac{1}{2}\right)$, $\theta \in \left(\frac{1}{3}, \frac{5}{6}\right)$. make $\theta_1 = 0.45$, $\theta_2 = 0.5$, and $\theta_3 = 0.6$, to explore the impact of retailers' pricing strategies on their own profits under different channel preferences of consumers; make $s_1 = 0.25$, $s_2 = 0.35$ and $s_3 = 0.45$, Used $\Delta \pi_{f2,t2} = \pi_{f2} - \pi_{t2}$ to measure the grey market invasion offline market impact on retailers overall profits.

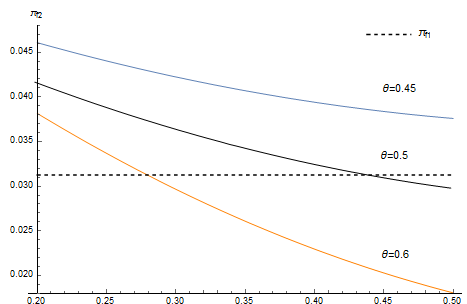


Figure 2. changes of retailers' profits under different channel preferences of consumers

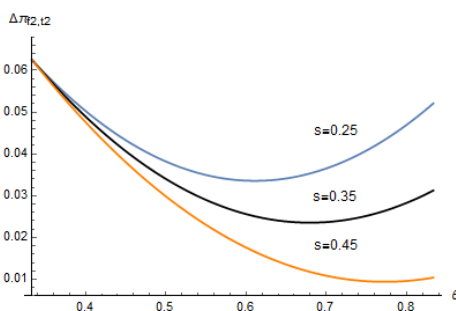


Figure 3. offline market shares of gray market products in different situations, the impact on retailers' profits

As can be seen from figure 2, when consumers' channel selection preference is certain and the offline market share of gray market products is within a certain range, retailers' profit in case 1 is higher than that in case of no gray market speculation. In this case, retailers' and gray market speculators' profit may reach the optimal level at the same time. When the offline market share of gray market products exceeds a certain threshold, retailers can reduce the loss of profits by guiding consumers to buy products in the online market. It can be seen from figure 3 that the offline market share of gray market products is small, and the impact of gray market products on retailers' profits will first increase and then decrease as consumers move to the offline market. It can be seen from the comprehensive figure 2 and 3 that consumers prefer the offline market to buy products, which to some extent lowers the threshold for gray market speculators to enter the gray market, and manufacturers adopt the same wholesale price for retailers and gray market speculators to protect the interests of retailers to some extent.

5.2. Manufacturers Adopt Different Wholesale Prices

When manufacturer M adopts different wholesale prices for regular channel retailer F and grey market speculator T, according to theorem 2, set $a = 1, s \in \left(\frac{1}{5}, \frac{1}{2}\right), \theta \in \left(\frac{2}{5}, \frac{2}{3}\right)$. make $\theta_4 = 0.45, \theta_5 = 0.5$, and $\theta_6 = 0.6$, to explore the impact of retailers' pricing strategies on their own profits under different channel preferences of consumers; make $s_4 = 0.25, s_5 = 0.35, s_6 = 0.45$, Used $\Delta\pi_{f2,t2}^* = \pi_{f2}^* - \pi_{t2}^*$ to measure the grey market invasion offline market impact on retailers overall profits.

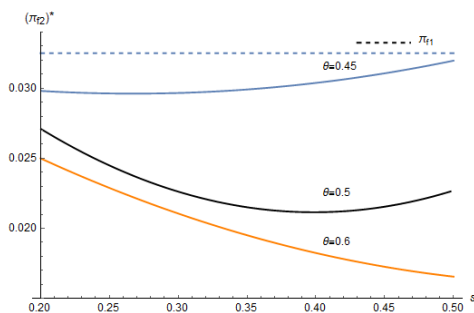


Figure 4. changes of retailers' profits under different channel preferences of consumers

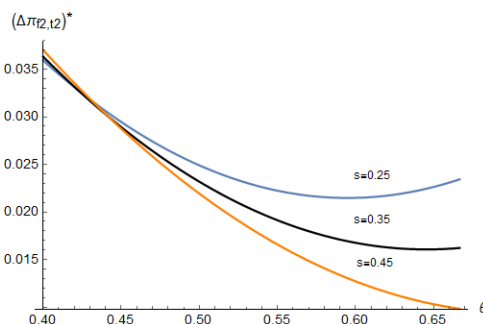


Figure 5. offline market shares of gray market products in different situations, the impact on retailers' profits

As can be seen from figure 4, consumers' preference to buy products in the online market is conducive to the promotion of retailers' own profits, but retailers' profits are always lower than the profits when there is no gray market speculation in the market. As can be seen from figure 5, when consumers prefer to buy products in the offline market, the greater the offline market share of gray market products, the greater the impact on retailers' profits. On the contrary, when consumers prefer to buy products in the online market, the impact of gray market products on retailers' profits will be reduced.

To sum up, it can be seen that in case 1, when consumers have certain preference for offline channel selection and the offline market share of gray market products is within a certain range, retailers' pricing strategy makes their profits reach the optimal level, and retailers are tolerant to the speculative behavior of gray market speculators. Case 2, the retailer can purchase products through the guide consumers turn to the online market to reduce the loss of profits, but the pricing strategy of retailers are unable to make their own profits to achieve optimal, shows that manufacturers of wholesale price strategy seems good for retailers, weakened the retailer actually control of the market, to a certain extent encouraged the existence of the gray market.

6. Conclusion

This paper considers the is composed of a manufacturer and a retailer of dual channel supply chain system, manufacturers are dominant but not participate in the market sales, and retailers are followers opened online direct marketing channels, to study the offline when there is a grey market speculation market for retailers, the influence of the regular channel product prices and profits get the following conclusion:

1) when there is a certain demand in the market, manufacturers cannot provide products to grey market speculators to improve their own profit level, which affects the overall efficiency of the dual-channel supply chain, but retailers can enjoy lower wholesale prices; Under

certain conditions, manufacturers can reduce the loss of their own profits by adopting different wholesale prices for regular channel retailers and grey market speculators.

2) when there is gray market speculation in the offline market, retailers have a strong control over the online market although the price of products in the formal channels is affected. When the demand in the market increases, retailers can gain more profits. At the same wholesale price, when the offline market share of gray market products is within a certain range, retailers have a strong control over the offline market. When the offline market share exceeds a certain threshold, retailers' control over the offline market is weakened. Under different wholesale prices, retailers have less control over the offline market.

3) under the same wholesale price, the consumer channel preference and certain market share of grey market product line within the scope of the retailers' tolerance, the retailer's pricing strategy to achieve the optimal profits themselves and show the same manufacturer for retailers and grey market speculators to take the wholesale price of a certain extent can protect the interests of the retailer; When the offline market share of gray market products exceeds the threshold tolerated by retailers, retailers can guide consumers to purchase products in the online market to improve their profits, raise the threshold for gray market speculators to enter the gray market, and restrain the speculative behavior of gray market speculators. Under different wholesale price, the manufacturer of the wholesale price strategy seems to be good for retailers, but actually weaken the control of retailers to the market, caused the appearance of win-win manufacturers and retailers, and retailers' pricing strategy is always cannot make profits to achieve optimal, manufacturers to a certain extent, to encourage the existence of the gray market.

This paper studies the influence of gray market speculation in the offline market of manufacturer-led retailers' dual-channel supply chain on retailers' prices and profits in the formal channel. In the future, we can consider how manufacturers or retailers adopt strategies to control gray market activities in the case of manufacturers' opening online market and gray market speculation, and further expand the model in terms of coordination mechanism.

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