International Journal of u- and e- Service, Science and Technology
Vol.9, No. 10 (2016), pp.23-38
http://dx.doi.org/10.14257/ijunesst.2016.9.10.03

Channel Selection in a Gray Market Setting: Considering the Export Tax Rebate

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Abstract

This paper examines the influence of gray market on manufacturer's channel selection when considering the export tax rebate. A two-country, three-stage model is used to investigate manufacturer's optimal operation strategy. We get the equilibrium outcomes through a Stackelberg game in different scenarios. The results show that the Company U may have incentive to encourage gray market if market demand ratio and product differentiation satisfied some condition. In a gray market setting the manufacturer prefers external sales channel with the two-part tariff contract first, a direct channel second, and external sales channel with wholesale price contract third. The study also shows that the policy of the export tax rebate will enhance manufacturer's profit and increase sales volume of gray market goods. In the extension, if manufacturer selects the direct channel, he can achieve optimal profit by giving decision power to sales department to determine retail quantity. Because the transfer price given by the manufacturer can convey signals of domestic market competition.

Keywords*: gray market; channel selection; export tax rebate; transfer price; price gap*

1. Introduction

Gray markets, also known as parallel imports, have been received considerable attention in theory and practice fields since the late 20th century. Gray market goods are genuine products which are sold through unauthorized channels. According to estimation, the size of international gray market reaches billions of dollars each year. The transaction and search costs are decreasing with the rapid development of Internet. So gray market goods are easily found in electronics, jewelry, automobile parts, IT products, and so on. Under the doctrine of international exhaustion, gray-market trade is permitted. For example, in the European Union (EU), products sold in gray market are legal and encouraged. There have court rulings which support that the first purchasers who buy a legal product can transfer it without the copyright holder's permission (Autrey *et. al.*, 2012). In fact, we find that there exist considerable gray market channels across countries all over the world. For example, according the South China Morning Post 09/17/2012, more than 3,000 parallel traders are crossing the border many times every day between Shenzhen and Hong Kong.

The main reason why gray markets exist is that there has a price gap between different markets. In the seminal papers, the price differentials is caused by monopoly manufacturer's strategy of the international third-degree price discrimination (Malueg and Schwartz, 1994). We find that the policy of export tax rebate is another important factor with which manufacturers charge different prices across countries. According to investigation, billions of dollars' worth of semiconductor (such as chips, CPU, memory modules) are exported to Hong Kong. Manufacturers get export tax rebates from their government. Then, products are flowed into gray market and then re-imported back to China. The value is up to ¥68 billion and accounts for 13.6% of China Semiconductor

ISSN: 2005-4246 IJUNESST

Market in 2006 (China Business News, 04/23/2009). For exporters, export tax rebate is a very important policy to balance domestic taxes already paid. To the best of the author's knowledge, less formal literature consider the export tax rebate.

Our reference point is previous articles on gray market. In these literatures, scholars usually assume that manufacturers sell products in two markets through different channels, i.e. subsidiary, sales department and external sales channel. This paper focuses on two issues: (1) manufacturer's equilibrium strategy of transfer pricing, and (2) whether gray market damages manufacturer's profit.

But our starting point is different from the extant literatures. We assume that the manufacturer sells goods through an independent distributor in foreign market, and he can't observe foreign distributor's behavior. Moreover, we consider the export tax rebates policy. In the existing literature, there has a theoretical gap in manufacturer's decision of channel selection in home market. So, in a gray market setting, manufacturer's decision of selecting distribution channel is a practical problem. Our motivation is very clear: how does manufacturer make decision of selecting his distribution channel within this setup?

The extant literature on manufacturer's channel selection in a gray market setting is scarce. And it is mainly from the point of dual-channel supply chain (Cai, 2010). Researches on gray markets and parallel imports mainly focus on a discriminating monopolist directly or through subsidiary sell goods in two geographically separated markets. In general, literatures of gray-marketing can be divided into two categories. A stream of studies concludes that gray market is beneficial for manufacturer and social welfare. Thompson (1981) and Shepherd (1997) pointed out that manufacturers were more profitable if they implemented price discrimination according to demand elasticity. So gray market may have the positive effect if we consider it as manufacturers' strategy of price discrimination such as Banerji (1990) and Mayers (1999). Raff *et. al.,* (2007) and Dasu *et. al.,* (2012) study gray markets (parallel imports) from the point of demand uncertainty. The findings in Raff *et. al.,* (2007) implied that allowing retailer's products to "leak" into gray market can bring high profits to the manufacturer. Furthermore, Li *et. al.,* (2006), Valletti (2006), Li and Robles (2007) *et. al.,* examined the gray market from the view of investment. These studies show that gray markets do not generate a negative effect for manufacturers. So the manufacturers would tolerate gray market at some level.

Assmus *et. al.,* (1995) classify various market structures into three categories, such as parallel importation, re-importation, and lateral gray importation. It argued that gray market may have great effect on the firm's internal transfer price between related parties. So they proposed several strategies for manufacturers to deter and combat gray market. The strategies were centralization, economic measures, formalization and informal coordination. Multinationals should select strategies according to their actual situation to prevent gray market.

Ahmadi *et. al.,* (2000) proposed a two-country, two-stage model to examine the effects of gray market and related strategies. They solved manufacturer's optimal pricing strategy in each scenario and found that gray markets should be allowed under some circumstances and should be prevented under other circumstances. The authorized price gap of two markets narrows with the increased number of parallel importers. If the manufacturer has other means to effectively control parallel imports, the optimal price gap will be widen. They hold that parallel imports can help manufacturers to extend global market share and boost their overall profit.

Chen *et. al.,* (2009) treat the gray market dealer as one type of retailers. It shows that manufacturers' attitude toward gray market may depend on their product characteristics, such as good penetration ration, price elasticity, demand convexity and so on. The finding illustrates that manufacture's profit will increase if the cross-price elasticity is lower than price elasticity of demand. They also infer that producers whose goods have lower good penetration ration, highly convex demands, or lower price elasticity are willing to ban gray marketing.

Autrey *et. al.,* (2012) consider that multinational sells products through domestic parent in domestic market and sells products through a wholly owned foreign subsidiary. And gray market goods leak from the downstream to upstream. The finding shows that the optimal transfer price to foreign subsidiary exceeds marginal cost and decreases with the competitiveness of the domestic market. If there has restrictions on arm's length transfer pricing rules, domestic consumer surplus may erode by making the gray market less competitive. Meanwhile, they also find that domestic tax revenues are higher when there are gray markets.

It's our impression that gray market goods usually lack warranty and product information service. Matsui (2014) examines gray market from the point of product information service. The paper considers that potential consumers are segmented by their taste. Under the equilibrium strategies, manufactures don't provide information service if gray marketing exists. And consumer welfare is lower when banning gray markets. If consumers are less segmented, the government should ban gray marketing in order to improve domestic consumer welfare.

Meanwhile, more and more brand owners, manufacturers, authorized distributors complain about the harm caused by gray market. Many studies analyze gray markets' negative impact on profits, investment motivation, distributor relations and brand equity (Myers *et. al.,* 1999; Corey *et. al.,* 1989; Iravani *et. al.,* 2011). Antia *et. al.,* (2004) suggest some prevention methods for multinational to preclude and combat gray market.

While the existing literature has made significant contributions to the studies of parallel imports, they miss two practical aspects of gray market. Firstly, manufacturers can usually get export tax rebate from the government when products enter into global market. The trade policy of export tax rebate is widely accepted by the rules of WTO. The export tax rebate must have great effects on manufacturers' strategies and social welfare. Secondly, the models in their findings mainly consider multinationals directly sell goods in two different countries (or through a wholly owned subsidiary). Actually, many companies expand foreign market through a foreign independent distributor. Generally speaking, manufacturer can't observe foreign distributor's behavior because the cost is very high. This is the second aspect which they miss. Additionally, we assume that manufacturer can decide the level of product differentiation.

The main contribution of this paper is to introduce export tax rebate in a gray market setting. Note that the basic assumption of market structure is based on Autrey *et. al.,* 2011. But the foreign independent distributor makes decisions for maximizing its own profits. The manufacturer must balance domestic retail profits and wholesale profits when gray market goods undermine the domestic market. The findings in the paper show that company U will have incentive to encourage gray market trade in some cases. And an interesting implication of the equilibrium is that manufacturer will choose an external distribution channel with a contract in a gray market setting. The three-stage model in our paper is: firstly, the manufacturer sets price (wholesale price) and gets export tax rebate; secondly, price in foreign market is decided, and gray market good is leaked to domestic market; thirdly, consumers purchase and profits realized

The rest of the paper is as follows. Section 2 describes the basic model and presents the third-stage problem. Section 3 solves equilibrium outcomes without gray market. Section 4 solves equilibrium outcomes in gray market, and provides a preliminary analysis of our model. Section 5 concludes this paper.

2. Model Setup

Consider a monopoly manufacturer (denoted U) who produces product in domestic. The product is sold to foreign market through a foreign independent distributor (denoted F). And foreign distributor's behavior cannot be controlled by manufacturer when selling goods in foreign market. In home market, he can choose to establish his own sales

channel like sales department and select an independent retailer. And the manufacturer can implement a contract like two-part tariffs. We assume that all decision makers are risk-neutral. Our model is consistent with the traditional model of gray market: a one-manufacturer, two-distributor and two market model.

If the manufacturer selects to his own sales channel in home market, he will directly make decisions of sales quantity in domestic market, corresponding to the strategy of centralization. This channel structure is denoted as channel I. If the manufacturer selects an external retailer (downstream partner noted R), he sets transfer price (w_D) to R. The retailer makes decision of sales quantity in domestic market. This channel structure is denoted as channel II. If the manufacturer selects an external retailer and simultaneously implements a contract, this situation is denoted as channel III. We assume that q_D represents the sales volume in home market.

The manufacturer provides inputs to foreign distributor at wholesale price w_F per unit. Meanwhile, he can apply for export tax rebates from the government after F finishes his purchase. In this paper, we consider the foreign distributor is also the gray market entrant (Ganslandt 2007). This is justified in that the manufacturer cannot observe or control foreign independent distributor's activities. So F sells products in foreign market and sells the good to gray market. The company U and gray market traders are engaged in Cournot competition in the home market. Variables are denoted with subscript "G" when products are sold back to domestic market. The case that products leak from the downstream to upstream market is consistent with Autrey *et. al.*, (2011).

We assume that demand in domestic market is deterministic and given by a linear demand function $p_i = a_D - q_i - \gamma q_j$, where $i, j = D, G$ and $i \neq j$. The quantity sold through the authorized (unauthorized) channel in domestic market denotes q_{DG} (q_G). The products sold in the gray market are differentiated from the authorized products by γ ($\gamma \in (0,1]$). The values of $\gamma = 0$ represents that two products are independent, and $\gamma = 1$ represents that they are perfectly substitutable. The assumption is justified because it is based on empirical observation.

For F, his purchase cost is w_F per unit set by manufacturer. Since the efficiency of U and F may not be the same (*e.g.*, Arya 2008). We assume that each unit of the good of downstream partner needs one unit of U's input, each unit of the goods of the foreign distributor needs $\tau > 0$ unit of U's input. Where $\tau = 1$ indicates that the two sellers are the same efficient firms. Where $\tau > 1 (\tau < 1)$ represents that D (F) is more efficient (*e. g.*,Yoshida 2000). The inverse demand function in foreign market is $p_F = a_F - q_F$. We assume that the foreign market size is strictly smaller than the domestic market size, $a_F < a_D$ (Autrey and Bova 2011). For tractability, we normalize the marginal cost of U's production to 0 per unit. Besides, we assume that c represents each seller's per-unit selling cost for each market; and let $\alpha_i = a_i - c$ $(i = D, F)$ denotes the resulting demand intercept net of cost.

After F purchasing products, manufacture gets export tax rebates from the government (Export tax rebates = FOB price × the quantity × export rebate rate). We use ξ to represent the export rebate rate. From the empirical observation, we assume that the export rebate rate satisfies $\xi \in (0,0.2)$.

With these basic assumptions, we solve the model under different channel structures and compare the equilibrium outcomes. We also investigate the role of transfer pricing, the effect of the export rebate rate and the retail price gap of two markets. We adopt the usual fashion which belongs to the game theory to solve the model, starting in the last stage and working backwards to the first stage.

3. Equilibrium Outcomes

3.1. Equilibrium Outcomes in Sealed Market

In this subsection, we begin by analyzing the sealed market as a benchmark, and give equilibrium outcomes of sealed market setting. As we all know that centralization can eliminate the double marginalization, the transfer price will be equal to the marginal cost. We will list outcomes under the three situations of sealed market setting.

With self-built sales channel, the sequence of events is as follows: firstly, in the domestic market, U sets the wholesale price w_F and chooses its domestic quantities q_D to maximize his overall profits; secondly, given the wholesale price w_F, F chooses its quantity q_F for maximizing its profit in the foreign market; finally, demand and profits are realized. The manufacturer's profit function of is (1). And foreign distributor's problem is (2).

$$\max_{q_D,w_F} \pi_u(q_D,q_F,w_F) = q_D(a_D - q_D) - cq_D + \tau w_F q_F + \xi \tau w_F q_F \quad (1)$$

$$\max_{q_F} \pi_F(q_F,w_F) = q_F(a_F - q_F) - \tau w_F q_F - cq_F \quad (2)$$

In the expression of (1), the first term, $q_D(\alpha_D - q_D) - cq_D$, represents U's retail profit in the domestic market, and the second term, $\tau w_F q_F$, is U's wholesale profit; and $\xi \tau w_F q_F$ represents export tax rebates. Under the situation of the sealed market setting, the U's two choices, q_D and w_F in Eq. (1), are independent of each other. So manufacturer can make decisions separately. The F can choose its optimal order quantity after the wholesale price is given.

With external sales channel, the manufacture determines wholesale prices (w_D, w_F) at the same time. If the two-part tariffs contract is implemented, he will charge a fixed fee T. Distributors both in home and foreign market determine their sales volume for maximizing profits. The expression (3) is the profit function in scenario *II* with no contract. The expression (4) is the profit function in scenario *III* with a two-part tariffs contract. The expression (5) is the distributor F's profit function.

$$\max_{w_D,w_F} \pi_u(w_D,w_F) = w_D q_D + \tau w_F q_F + \xi \tau w_F q_F \qquad \max_{q_D} \pi_R(q_D) = p_D q_D - (w_D + c)q_D \quad (3)$$

$$\max_{w_D,w_F} \pi_u(w_D,w_F) = w_D q_D + \tau w_F q_F + \xi \tau w_F q_F + T \qquad \max_{q_D} \pi_R(q_D) = p_D q_D - (w_D + c)q_D - T \quad (4)$$

$$\max_{q_F} \pi_F(q_F,w_F) = q_F(a_F - q_F) - \tau w_F q_F - cq_F \quad (5)$$

The game is solved in a backward fashion. Solving the first-order conditions jointly yields equilibrium outcomes. Then, substitute q_D, q_F which is a function of wholesale prices into the manufacturer's objective function. Equilibrium outcomes in each scenario in sealed market are as follows.

Scenario *I*: $q_D = \frac{\alpha_D}{2}$, $w_F = \frac{\alpha_F}{2\tau}$, $\pi_F = \frac{{\alpha_F}^2}{16}$, $\pi_u = \frac{{\alpha_D}^2}{4} + \frac{(1+\xi){\alpha_F}^2}{8}$,

Scenario *II*: $q_D = \frac{\alpha_D}{4}$, $w_D = \frac{\alpha_D}{2}$, $w_F = \frac{\alpha_F}{2\tau}$, $\pi_F = \frac{{\alpha_F}^2}{16}$, $\pi_u = \frac{3{\alpha_D}^2}{16} + \frac{(1+\xi){\alpha_F}^2}{8}$;

Scenario *III*: $q_D = \frac{\alpha_D}{2}$, $w_D = 0$, $w_F = \frac{\alpha_F}{2\tau}$, $\pi_F = \frac{{\alpha_F}^2}{16}$, $T = \pi_R = \frac{{\alpha_D}^2}{4}$; $\pi_u = \frac{{\alpha_D}^2}{4} + \frac{(1+\xi){\alpha_F}^2}{8}$

Lemma1. *In sealed market, the manufacturer prefers self-built sales channel first, external sales channel with a contract second, and external sales channel third,* $\pi_u(I) \geq \pi_u(III) > \pi_u(II)$.

The supply chain efficiency is the lowest in scenario *II* because of double marginalization. In scenario *III*, the manufacturer's optimal strategy is to set $w_D = c$ and he will charge a fixed fee approximately equal to the R's profit. The retailer needs to keep a little profit back to satisfy the participation constraint.

3.2. Equilibrium Outcomes in a Gray Market Setting

Unlike counterfeits, gray market products are genuine goods from authorized dealers. We assume that the manufacturer cannot observe and control F's activities. We naturally extend the main model to the gray market setting in this subsection. The manufacturer can get wholesale profit when supplying for F. However, gray market dealers may undermine retail profit in domestic market. So the company U need to effectively balance the two opposite trade-offs. To demonstrate these, we solve the equilibrium outcomes in all these scenarios. Consistent with Autrey *et. al.*, (2011), we assume that the foreign market is strictly smaller than the domestic market ($0 < \alpha_F < \alpha_D$). The related parameters in gray market setting are denoted with subscript "G".

In scenario *I*, the decision process is as follows: The company U, as the Stackelberg leader, firstly sets the wholesale price (w_F) and directly choose its sales volume (q_D). The foreign distributor, as the follower, determines his purchase volume and sells products. We assume that the gray market dealer and company U form a Cournot competition in home market. Finally, consumers make their purchases and corresponding profits are realized.

In this case, company U determines the sales volume (q_D) for maximizing its direct retail profit, $\pi_u(q_D, q_G, q_F, w_F)$, given F's purchase volumes (q_G, q_F), and wholesale price (w_F). The U's total profit maximization problem is

$$\max_{q_D} \pi_u(q_D, q_G, q_F, w_F) = q_D(a_D - q_D - \gamma q_G) - cq_D + \tau w_F(q_G + q_F) + \xi\tau w_F(q_G + q_F) \quad (6)$$

The first term in expression (6) represents U's retail profit in domestic market; the second term, $\tau w_F(q_G + q_F)$, represents the wholesale profit from F; the third term, $\xi\tau w_F(q_G + q_F)$, represents export tax rebates from the government. Because of the competition, U needs to make with one eye on the domestic retail profit and the other on gray market. Simultaneously, the firm F sees its wholesale price (w_F) and U's quantity (q_D) as given when determining its sales volume (q_G, q_F) to maximize its profit. The distributor F's profit function is

$$\max_{q_G, q_F} \pi_F(q_D, q_G, q_F, w_F) = q_G(a_D - q_G - \gamma q_D) + q_F(a_F - q_F) - (c + \tau w_F)(q_G + q_F) \quad (7)$$

Corresponding to the above equivalent, the first term (second term) of expression (7) represents F's sales volume in gray market (foreign market); and the third term,(cq_i, $\tau w_F q_i$), respectively represents the selling cost and wholesale cost.

Jointly solving the first-order conditions for (6) and (7) yields induced demand as follow:

$$q_D(w_F) = \frac{(2-\gamma)\alpha_D + \gamma\tau w_F}{4-\gamma^2}, \quad q_G = \frac{(2-\gamma)\alpha_D - 2\tau w_F}{4-\gamma^2} \text{ and } q_F(w_F) = \frac{\alpha_F - \tau w_F}{2}.$$

From the quantity expressions above, we can obtain that the sales volume is increasing in each market demand and decreasing in each company's unit selling cost. Intuitively, a part of market share in domestic market will be eroded by the gray market dealer. We can also draw that the manufacturer can regulate the extent of competition in domestic market by adjusting the wholesale price. For example, the domestic retail quantity q_D is increasing with the wholesale price w_F. And the sales volume q_G is exact decreasing with the wholesale price w_F. Under centralization, U may raise the wholesale price w_F to ensure its retail profit in the domestic market. If so, the sales volume in foreign market

will also be reduced. So we substitute the induced demands and input price into manufacturer's pricing problem.

$$\max_{w_F} \pi_u(q_D(w_F), q_G(w_F), q_F(w_F), w_F) \tag{7}$$

Solving the first-order condition of equation (7) yields the wholesale price w_F. Then, substitute it into the corresponding quantity q_i. The equilibrium outcomes in scenario Ⅰ (self-built distribution channel) are presented as follows.

$$w_F = \frac{(2-\gamma)\{2\alpha_D[2\gamma+4(1+\xi)-\gamma^2(1+\xi)]+\alpha_F(2-\gamma)(2+\gamma)^2(1+\xi)\}}{2\tau[(1+\xi)(32+\gamma^4-12\gamma^2)-2\gamma^2]}, q_D = \frac{(2-\gamma)(1+\xi)[2(8+\gamma-\gamma^2)\alpha_D+\gamma\alpha_F(2+\gamma)]}{2[(1+\xi)(32+\gamma^4-12\gamma^2)-2\gamma^2]},$$

$$q_G = \frac{[(12-6\gamma-2\gamma^2+\gamma^3)(1+\xi)-2\gamma]\alpha_D-(4-\gamma^2)(1+\xi)\alpha_F}{[(1+\xi)(32+\gamma^4-12\gamma^2)-2\gamma^2]}, \quad q_F = \frac{[(48-16\gamma^2+\gamma^4)(1+\xi)-4\gamma^2]\alpha_F-2(2-\gamma)[(4-\gamma^2)(1+\xi)+2\gamma)]\alpha_D}{4((1+\xi)(32+\gamma^4-12\gamma^2)-2\gamma^2)}$$

And $\pi_u = \frac{(2-\gamma)(1+\xi)[2(5+\xi)-4(\gamma(3+\xi)]\alpha_D^2-4[2\gamma+4(1+\xi)-\gamma^2(1+\xi)]\alpha_D\alpha_F-(2-\gamma)(2+\gamma)^2(1+\xi)\alpha_F^2)}{8[(1+\xi)(32+\gamma^4-12\gamma^2)-2\gamma^2]}$

As expected, in scenario I, the optimal wholesale price w_F is higher than that in a sealed market. In other cases, manufacturer may set a low wholesale price for a greater wholesale profit. Specifically, competition from the gray market will be intensified as the wholesale price decreases.

With external sales channel in gray market setting, the manufacturer must rely on the downstream distributor to sell products in the home market. Firstly, the manufacture determines the wholesale prices *(w_D, w_F)* at the same time. If the two-part tariffs contract is implemented, he will charge a fixed fee T. Secondly, the gray market dealer and domestic distributor form a Cournot competition in home market. Simultaneously, F takes w_F as given when choosing its sales volume q_F in foreign market. Finally, consumers make their purchases and corresponding profits are realized. So the objective functions in scenario *II* and *III* are as follows.

In Scenario *II*:

$$\begin{cases} \max\limits_{w_D, w_F} \pi_u(w_D, w_F) = w_D q_D(w_D, w_F) + (1+\xi)\tau w_F[q_G(w_D, w_F) + q_F(w_D, w_F)] \\ \max\limits_{q_D} \pi_D(q_D) = q_D(a_D - q_D - \gamma q_G) - w_D q_D - c q_D \\ \max\limits_{q_G, q_F} \pi_F(q_D, q_G, q_F, w_F) = q_G(a_D - q_G - \gamma q_D) + q_F(a_F - q_F) - (c + \tau w_F)(q_G + q_F) \end{cases} \tag{8}$$

In Scenario *III*:

$$\begin{cases} \max\limits_{w_D, w_F} \pi_u(w_D, w_F) = w_D q_D(w_D, w_F) + (1+\xi)\tau w_F[q_G(w_D, w_F) + q_F(w_D, w_F)] + T \\ \max\limits_{q_D} \pi_D(q_D) = q_D(a_D - q_D - \gamma q_G) - w_D q_D - c q_D - T \\ \max\limits_{q_G, q_F} \pi_F(q_D, q_G, q_F, w_F) = q_G(a_D - q_G - \gamma q_D) + q_F(a_F - q_F) - (c + \tau w_F)(q_G + q_F) \end{cases} \tag{9}$$

Jointly solving the first-order conditions yields induced demand as follows:

$q_D(w_D, w_F) = \frac{(2-\gamma)\alpha_D - 2w_D + \gamma\tau w_F}{4-\gamma^2}$, $q_G(w_D, w_F) = \frac{(2-\gamma)\alpha_D + \gamma w_D - 2\tau w_F}{4-\gamma^2}$, $q_F(w_F) = \frac{\propto_F - \tau w_F}{2}$.

From expressions of induced demand, the sales volume is increasing in w_F and decreasing in w_D. The sales volume in gray market is increasing in w_D and decreasing in w_F. With external sales channel, the manufacturer has two ways to regulate the competitiveness in domestic market. So we substitute the induced demands and input prices into the manufacturer's pricing problem in (8) or (9).

Solving the first-order conditions of w_D and w_F in each scenario yields equilibrium outcomes in gray market as follows.

In Scenario *II*:

$$w_D = \frac{(2-\gamma)(1+\xi)[(16-2\gamma^2+2\gamma(2+\xi))\alpha_D+\gamma\alpha_F(2+\gamma)(2+\xi)]}{2[32(1+\xi)-\gamma^2(8+8\xi+\xi^2)]}, \quad w_F = \frac{(2-\gamma)[(4(1+\xi)+\gamma(2+\xi))\alpha_D+2(2+\gamma)(1+\xi)\alpha_F]}{[32(1+\xi)-\gamma^2(8+8\xi+\xi^2)]\tau}$$

$$q_D = \frac{(1+\xi)(8-4\gamma-\gamma\xi)\alpha_D-\gamma\xi\alpha_F)}{32(1+\xi)-\gamma^2(8+8\xi+\xi^2)}, \quad q_G = \frac{2\alpha_D[12(1+\xi)-\gamma^2(1+\xi)-\gamma(4+3\xi)]-(1+\xi)(8-2\gamma^2-\xi\gamma^2)\alpha_F}{2[32(1+\xi)-\gamma^2(8+8\xi+\xi^2)]}$$

$$q_F = \frac{[24(1+\xi)-\gamma^2(6+6\xi+\xi^2)]\alpha_F-(2-\gamma)[4(1+\xi)+\gamma(2+\xi)]\alpha_D}{2[32(1+\xi)-\gamma^2(8+8\xi+\xi^2)]}$$

$$\pi_u = \frac{(2-\gamma)(1+\xi)[(6-\gamma+2\xi)\alpha_D^2+(4(1+\xi)+\gamma(2+\xi))\alpha_D\alpha_F+(2+\gamma)(1+\xi)\alpha_F^2]}{2[32(1+\xi)-\gamma^2(8+8\xi+\xi^2)]}$$

In Scenario*III*:

$$w_F = \frac{2\alpha_F(2-\gamma^2)(1+\xi)-\alpha_D[2\xi\gamma+\gamma^2-(1+\xi)(4-\gamma^2)]}{[8(1+\xi)(2-\gamma^2)-\gamma^2\xi^2]\tau}, \quad w_D = \frac{\gamma(1+\xi)\{2\alpha_D[\gamma^2+(2-\gamma)(1+\xi)-3\gamma]+\alpha_F[(4-\gamma^2)(1+\xi)-\gamma^2]\}}{2[8(1+\xi)(2-\gamma^2)-\gamma^2\xi^2]}$$

$$q_D = \frac{(1+\xi)[(8-4\gamma-\gamma\xi)\alpha_D-\gamma\xi\alpha_F]}{8(1+\xi)(2-\gamma^2)-\gamma^2\xi^2} \quad ; \quad q_G = \frac{2\alpha_D[(1+\xi)(6-\gamma^2-3\gamma)-\gamma]-(1+\xi)(4-2\gamma^2-\xi\gamma^2)\alpha_F}{2[8(1+\xi)(2-\gamma^2)-\gamma^2\xi^2]};$$

$$q_F = \frac{[6(1+\xi)(2-\gamma^2)-\gamma^2\xi^2]\alpha_F-[4(1+\xi)-2\gamma\xi-\gamma^2(2+\xi)]\alpha_D}{2[8(1+\xi)(2-\gamma^2)-\gamma^2\xi^2]} \quad ; \quad T = \pi_D = \frac{(1+\xi)^2[(8-4\gamma-\gamma\xi)\alpha_D-\gamma\xi\alpha_F]^2}{[16(1+\xi)-\gamma^2(8+8\xi+\xi^2)]^2}$$

$$\pi_u = (1+\xi)\frac{[\gamma^2+2+2(1-\gamma)(4+\xi)]\alpha_D^2+[(4-\gamma^2)(1+\xi)-2\gamma\xi-\gamma^2]\alpha_D\alpha_F+(2-\gamma^2)(1+\xi)\alpha_F^2}{2[8(1+\xi)(2-\gamma^2)-\gamma^2\xi^2]}$$

Lemma 2. *In a gray market setting, the manufacturer prefers external sales channel with the two-part tariff contract first, the self-built sales channel second, and external sales channel with wholesale contract third,* $\pi_u(III) \geq \pi_u(I) > \pi_u(II)$.

In a gray market setting, the overall supply chain efficiency in scenario *II* is the lowest. The overall supply chain efficiency in scenario *III* is higher than that in scenario *I*. The retailer also needs to keep a little profit back to satisfy the participation constraint. The Impacts of the export tax rebate rate on whole sale prices, sales quantities and price gaps are analyzed in the next section.

4. Analysis of the Model

4.1. Sealed Market Setting VS Gray Market Setting

As pointed out in the introduction subsection, previous studies mainly characterized organization structure as parent- subsidiary company. In this paper, we consider F as the foreign independent distributor. He makes decisions to maximize department interests. Intuitively, the optimal situation for the manufacturer is that he can get monopoly profits in both two markets. We assume that the manufacturer can supply a differentiated version to foreign market. So his attitude toward gray market is vague. We denote the sealed market setting as $(S\ \ i)$, the gray market setting as $(G\ \ i)$.

We compare the wholesale price of scenario *III* in gray market setting and wholesale price of scenario *I* in a sealed market. There exists $\mu^* = f(\xi,\gamma)$ $(\mu^* \in (0,1])$. If the market demand ratio is $\frac{\alpha_F}{\alpha_D} \in (0,\mu^*)$, the whole price in gray market setting is higher than that in sealed market setting,$w_F(G\,III) > w_F(S\ I)$, for a given (ξ,γ). Otherwise, the market demand ratio $\frac{\alpha_F}{\alpha_D} \in (\mu^*,1]$ and the whole price in gray market setting are lower than those in sealed market setting, $w_F(G\,III) < w_F(S\ I)$. Intuitionally, we can explain that if foreign market is so small relative to the domestic market, $\frac{\alpha_F}{\alpha_D} \in (0,\mu^*)$, foreign distributor will be profitable from the gray market. The manufacturer will loss more in home market as more goods "leak" into gray market. Observing this, the manufacturer will raise wholesale price above it in sealed market to protect the domestic retail market. If foreign market is large enough, i.e., $\frac{\alpha_F}{\alpha_D} \in (\mu^*,1]$, company U will benefit more from foreign market by decreasing wholesale price below it in sealed market. Meanwhile, the manufacturer will

lost its monopoly position in domestic market.

As is to be expected, the sales volume at home market in a gray market setting is lower than it in sealed market. Gray market erodes the company U's domestic market share, $q_D(S\ I) > q_D(G\ III)$. However, products sold by authorized channel and gray market are soaring, $q_D(S\ I) < q_D(G\ III) + q_G(G\ III)$. And gray market quantity (q_G) is increasing with export rebate rate ($\frac{\partial q_G^i}{\partial \xi} > 0$). The effect of gray market on the company U's profit is still rather vague. At the extreme case, $\xi = 0$, i.e., zero tax refund from government, it's a necessary condition. Company U's attitude toward gray market depends on the profit margin. Comparing manufacturer's profits in two market settings, the profit gap (Δ^d) is

$$\Delta^d = \Pi_U(G\ III) - \Pi_U(S\ I) \tag{10}$$

Because scenario *III* in a gray market setting is dominated by other two scenarios, the relation between $\frac{\alpha_F}{\alpha_D}$ and γ is a tight constraint if the profit gap, $\Delta^d > 0$. Actually, if the foreign market is too small relative to the domestic market, company U may not provide products to F and get monopoly profits in domestic market. For tractability, we assume export rebate rate is zero ($\xi = 0$). Mathematically, if the conditions exist, ($q_G^d > 0 \& q_G^c > 0 \& q_{FG}^d > 0 \& q_{FG}^c > 0$), gray market does exist. Then, we summarize the following proposition.

Proposition 1.

(i) The company U may have incentive to encourage gray market, if market demand ratio satisfies $max(0, \frac{2-\gamma^2-2\sqrt{2-4\gamma+\gamma^2+2\gamma^3-\gamma^4}}{2-\gamma^2}) \le \frac{\alpha_F}{\alpha_D} \le 1$ ($\gamma \in (0,1]$).

(ii) If the market demand ratio $\frac{\alpha_F}{\alpha_D}$ *and the product differentiation* γ *satisfy the condition* $min\left(\frac{1}{3}, \frac{2(2-\gamma)(4+2\gamma-\gamma^2)}{48-20\gamma^2+\gamma^4}\right) \le \frac{\alpha_F}{\alpha_D} \le 1$, *there exist products which "leak" into gray market.*

Broadly speaking, gray market erodes profits of authorized channels. As is shown in Proposition 1, gray market may have positive effects on the manufacturer's profit if some conditions are satisfied. If there is no product differentiation, gray market must be harmful to authorized channels. In reality, manufacturers can't forbid gray market and the cost is too high. So the optimal strategy for manufactures is to provide differentiated products. Figure 1 reflects the manufacturer's profit gap between scenario *III* in gray market setting and scenario *I* in sealed market with γ and $\frac{\alpha_F}{\alpha_D}$.

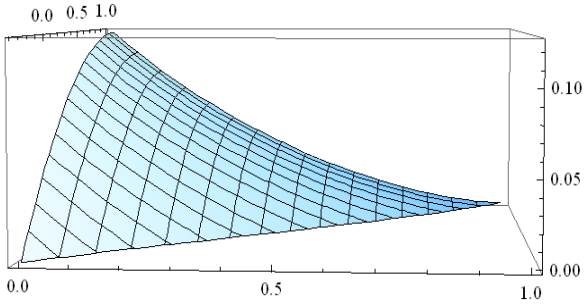

Figure 1. The Profit Gap of $\Pi_U(G\ III) - \Pi_U(S\ I)$

4.2. Scenario Ⅲ vs Scenario Ⅰ in Gray Market Setting

In the classical literatures, parent company set transfer price equal to marginal cost in order to offset double marginalization. Following Hirshleifer (1956), transfer price is above the marginal cost under decentralization. And it will lead to low efficiency.

However, in this paper, the company U sells products to foreign distributor F which is also the gray market dealer. There arise additional tradeoffs between the double marginalization and the increased competition. The wholesale price set for the domestic distributor can convey signals of market competition. The company U may ignore foreign wholesale profit in scenario I. Expecting this, F may choose lower wholesale quantity as the given wholesale price.

The overall profits of the company U rely on both two markets. It may be less aggressive in domestic market when manufacturer sets a higher w_D. Additionally, if a lower wholesale price w_F is set, gray market goods will be more competitive. By expecting this, F will procure more inputs for maximizing its profit. The reduced profits from domestic market may restore by boosting demand in gray market and foreign market. We summarize the following features by comparing the equilibrium outcomes.

Proposition 2. *(i) In scenario III, the domestic wholesale price is irrelevant to foreign firm's efficiency τ; and it's above marginal cost, i.e. $w_D(GIII) \geq 0$.*

(ii) In a gray market setting, the domestic market sales volume in scenario III is lower than that in scenario I, i.e., $q_D(GIII) \leq q_D(GI)$.

(iii) The gray market sales volume in scenario III is higher than that in scenario I, i.e.,$q_G(GIII) > q_G(GI)$.

(iv) The wholesale price w_F in scenario III is higher than that in scenario I, i.e., $w_F(GIII) > w_F(GI)$.

In scenario I of the gray market, there is no need to set domestic wholesale price. The standard view such as Hirshleifer (1956) and Antia *et. al.*,(2008) is that the transfer price is above marginal cost under decentralization. In our model, if the market satisfies conditions given by Proposition 1, the domestic wholesale price is above marginal cost. But if foreign market size is large enough compared to domestic market size and the product differentiation is very low, the transfer price which is lower than marginal cost will be set for deterring gray market. Because of double marginalization, the higher transfer price is, the lower the efficiency is. In this paper, if the optimal transfer price, $w_D(GIII)$, is above marginal cost, manufacturer may loss a partial profit in home market. Simultaneously, the wholesale price above marginal cost ($w_D(GIII)>0$) will reduce the competitiveness in domestic market. So the sales volume of gray market products is increasing (illustrated by Proposition 2-ii and iii). The effects of the Proposition 2-ii will be compounded by boosting quantity in gray market because of lower market competition. In scenario III, the manufacturer's losses in domestic retail market can be compensated by the wholesale benefits. The manufacturer's net benefit depends on the net effect between foreign and domestic markets.

Specifically, we denote the manufacturer's profit as $\Pi_U = \Pi_{U1} + \Pi_{U2}$, the first part Π_{U1} represents the profit from home market and the second term represents the profit from foreign distributor. We draw the corresponding domestic profit expressions by substituting q_D into $\Pi_{U1}(Gi) = q_D(\alpha_D - q_D - \gamma q_G)$ and compare the two profit expressions yield $\Pi_{U1}(GIII) - \Pi_{U1}(GI) < 0$. It is consistent with previous literatures that there will be a strict loss when transfer price (w_D) is above marginal cost. Meanwhile, the wholesale profit from foreign market is $\Pi_{U2}(Gi) = \tau w_F(q_F + q_G)$. The gray market quantity q_G in scenario III is strictly larger than that in scenario I. The manufacturer's profit difference from foreign market between scenario III and scenario I is above zero, $\Pi_{U2}(GIII) - \Pi_{U2}(GI) > 0$. And the positive value reflects that the external sales channel with two-part tariffs contract can increase company U's profits from the foreign distributor. However, the issue with which we are concerned is the overall profit difference. In a gray market setting, the scenario III will dominate the scenario I if $\Pi_{U2}(GIII) - \Pi_{U2}(GI) > \Pi_{U1}(GIII) - \Pi_{U1}(GI)$. Otherwise, the manufacturer will choose self-built distribution channel. The gap of manufacturer's overall profits between the two scenarios is

$$\Pi_u(G\,III) - \Pi_u(G\ I) = (\Pi_{u1}(G\,III) + \Pi_{u2}(G\,III)) - (\Pi_{u1}(G\ I) + \Pi_{u2}(G\ I)) \quad (11)$$

Proposition 3. *For the manufacturer, in a gray market setting, the overall profit in scenario III is higher than that in scenario I for all* γ.

Actually, the manufacturer is not able to effectively deter the gray market or the preventing cost is too high (Raff *et. al.*,, 2007). So Proposition 3 shows that if the manufacturer provides goods to firm F, he will obtain more profit when selecting an external channel with two-part tariffs contract. As $\frac{\partial \Pi_u}{\partial \gamma} < 0$ indicates that the smaller the product differentiation γ is, the higher profit the manufacturer can obtain. The lower product differentiation γ needs the foreign firm F investing more, and we don't consider investment cost here. The export rebate rate is exogenous variable. For a given ξ, there must exist $\gamma^*(\xi)$, with which satisfies $\Pi_u(G\,III) = \Pi_u(G\ I)$. For tractability, we assume $\xi = 0$ and provide the following numerical example to develop intuition of the results. The trend of the profit gap between scenario *III* and scenario *I* is shown as Figure 2.

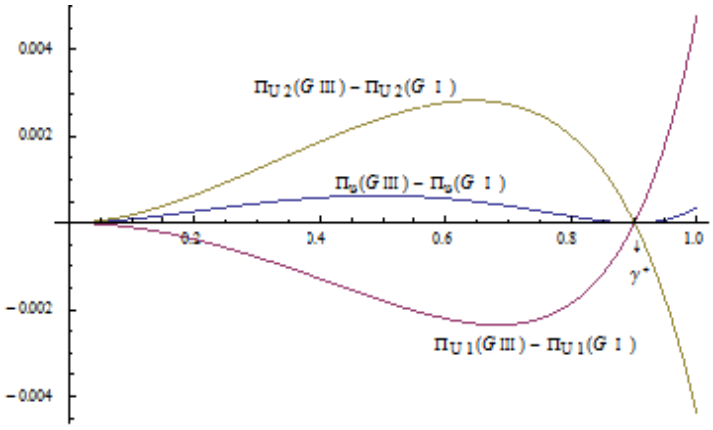

Figure 2. The Profit Gap as a Function of γ in Case of $\xi = 0$

As is shown in Figure 2, from scenario *III* to scenario *I*, the increased profit from foreign distributor is higher than the manufacturer's losses in domestic market when $0 < \gamma \leq \gamma^*$. With the increase of product differentiation ($\gamma > \gamma^*$), the wholesale profit from foreign market will decrease, but his domestic profit will increase in scenario *III* when $\gamma^* \leq \gamma \leq 1$. Because of high substitution, the manufacturer will increase wholesale price to foreign distributor in order to deter gray market. So the increased domestic profit will dominate the decreased wholesale profit.

In reality, the reason is that company U can convey the signal of competitiveness in domestic market through channel structure. In scenario *III*, the level of competition can be adjusted by regulating domestic wholesale price w_D and foreign wholesale price w_F at the same time. Given market size ratio $\frac{\alpha_F}{\alpha_D}$, the domestic wholesale price is above marginal cost for all $\gamma \in (0, \gamma^*)$. It shows that the competitiveness in domestic market isn't very fierce. The loss in domestic market is less than the increased wholesale profit from foreign market. If product differentiation satisfies $\gamma \in [\gamma^*, 1]$, we can find that the domestic wholesale price w_D is below marginal cost. Two kinds of products are so similar that profit erosion caused by gray market is prominent. Transfer price which is below marginal cost can convey the signal of aggressive competiveness, $\gamma^* = \frac{2-\sqrt{2}\sqrt{1+(\alpha_F/\alpha_D)^2}}{1-\alpha_F/\alpha_D}$.

In a sealed market setting, retail prices in both two markets are not influenced by product differentiation coefficient γ because of lacking competition. With gray market dealer selling products back, competition in domestic market is intensified. There has a

significant impact on retail prices gap. In a gray market setting, the retail prices in domestic and foreign market are denoted as $p_D(Gi)$ and $p_F(Gi)$, respectively. In a gray market setting, the price gaps in the scenario I and scenario III are denoted as $f(\gamma,\xi)$ and $\varphi(\gamma,\xi)$.

$$f(\gamma,\xi) = p_D(G\ I) - \ p_F(G\ I) \tag{12}$$

$$\varphi(\gamma,\xi) = p_D(GIII) - \ p_F(GIII) \tag{13}$$

Firstly, the first partial derivations, $\frac{f(\gamma,\xi)}{\partial\xi}$ and $\frac{\varphi(\gamma,\xi)}{\partial\xi}$ are all above 0. The outcome reflects that the price gap is increasing with the export tax rebate under both scenarios. Secondly, the expression $\varphi(\gamma,\xi) - \ f(\gamma,\xi)$ reflects the gap difference between scenario III and scenario I. For the given export rebate rate ξ, there exists γ^* which entails $f(\gamma,\xi) = \varphi(\gamma,\xi)$. The export rebate rate is a exogenous variable. For simplicity, we assume that $\xi = 0$.

Proposition 4. *In a gray market setting, if product differentiation is high* $(0 < \gamma \leq \gamma^*)$*, the scenario* III *can amplify the retail price gap; if product differentiation is low* $(\gamma^* < \gamma \leq 1)$*, the scenario* III *can narrow the retail price gap.*

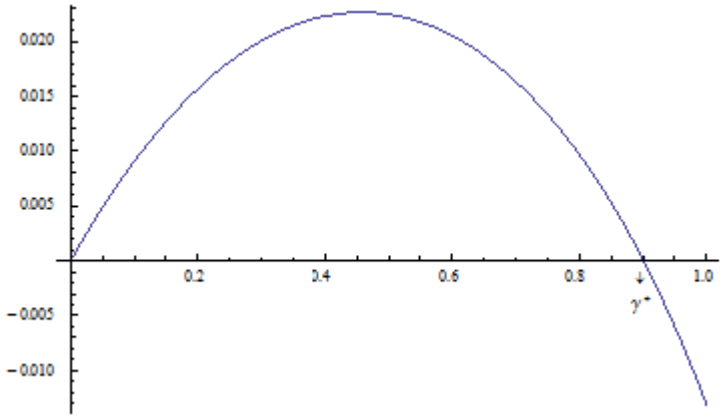

Figure 3. Is The Price Gap Difference $\varphi(\gamma,\xi) - \ f(\gamma,\xi)$

We can see that channel structure in scenario III increase the retail price gap if the level of product differentiation is high $(0 < \gamma \leq \gamma^*)$. The big price gap entail company U to get more benefit from foreign market and gray market. If the level of product differentiation is low $(\gamma^* < \gamma \leq 1)$ in scenario I, the manufacturer overly fixate on domestic retail market. So the wholesale price will be too low. In this case, the price gap in scenario III is narrower than that in scenario I. The price gap difference $\varphi(\gamma,\xi) - f(\gamma,\xi)$ is shown as Figure 3.

4.3. Impacts of the Export Tax Rebate Rate

The intention of the export tax rebate policy is to enhance the product competitiveness when entering international market. If gray market dealer sells goods back, there will exist additional tradeoffs. With the export tax rebate policy, the manufacturer rationally reduces the wholesale price. The foreign distributor will purchase more inputs with a lower wholesale price, and more profit and export tax rebates can be obtained. More products may "leak" into gray market under this circumstance and the manufacturer's profits from domestic market will decrease.

We summarize the following features of export tax rebate by analyzing the equilibrium outcomes in gray market setting.

Corollary 1. (i) *In scenario III, the domestic wholesale price* $w_D(GIII)$ *is increasing with the export tax rebate rate, i.e.,* $\frac{\partial w_D(GIII)}{\partial \xi} > 0$;

(ii) *In both scenario III and scenario I, the wholesale prices* w_F *are decreasing in the export tax rebate rate, i.e.,* $\frac{\partial w_F(GIII)}{\partial \xi} < 0 \& (\frac{\partial w_F(G\ I)}{\partial \xi} < 0)$;

(iii) *In scenario III, the domestic sales volume* $q_D(GIII)$ *is decreasing in the export tax rebate,* $\frac{\partial q_D(GIII)}{\partial \xi} < 0$ *; but in scenario I , it is increasing in the export tax rebate,* $\frac{\partial q_D(G\ I)}{\partial \xi} > 0$;

(iv) *In both scenario I and III, the gray market sales volumes are increasing in the export tax rebate, i.e.,* $\frac{\partial q_D(GIII)}{\partial \xi} > 0$ & $\frac{\partial q_D(G\ I)}{\partial \xi} > 0$;

(v) *In both scenario I and III, the sales volumes in foreign market are increasing in the export tax rebate, i.e.,* $\frac{\partial q_D(GIII)}{\partial \xi} > 0$ & $\frac{\partial q_D(G\ I)}{\partial \xi} > 0$;

(vi) *In both scenario I and III, the company U's profit is increasing in the export tax rebate, i.e.,* $\frac{\partial \Pi_u(GIII)}{\partial \xi} > 0$& $\frac{\partial \Pi_u(G\ I)}{\partial \xi} > 0$.

4.4. Extension

In fact, with the self-built distribution channel, the sales department often has some decision-making power to determine its retail quantity. And manufacturers often set a transfer price for sales department. So we will consider the situation that sales department can make decisions combining the whole company's profit objective. So the coefficient $\lambda \in (0,1]$ is considered as the priority overweight department's profit objective and the coefficient $1-\lambda$ as the priority overweight whole company's profit. Then, the sales department's decision function is

$$\max_{q_D} \lambda \Pi_R(q_D, q_G, q_F, w_D, w_F) + (1-\lambda)\Pi_u(q_D, q_G, q_F, w_F) \quad (14)$$

The joint decision function care profit both from the view of company U and its sales department. The authorization level of determining domestic retail quantity is given to the sales department through the choice of λ. Jointly solving the first conditions from (6) and (14) yields the equilibrium retail quantities $q_D(w_D, w_F, \lambda)$ and $q_G(w_D, w_F, \lambda)$. From the analyses of expressions $q_i(w_D, w_F, \lambda)$

$$q_D(w_D, w_F, \lambda) = \lambda q_D(w_D, w_F)[GIII] + (1-\lambda) q_D(w_F)[G\ I]$$

$$q_G(w_D, w_F, \lambda) = \lambda q_G(w_D, w_F)[GIII] + (1-\lambda) q_G(w_F)[G\ I]$$

We can see that the quantity is a weighted average of the corresponding quantity in both scenario *III* and *I*. Substituting $q_i^d(w_D, w_F, \lambda)$ into the company U's objective function of pricing problem

$$\max_{w_D, w_F} \Pi_u\left(q_D(w_D, w_F, \lambda), q_G(w_D, w_F, \lambda), q_F(w_F), w_D, w_F, \lambda\right) \quad (15)$$

We draw the domestic transfer price and foreign wholesale price by solving the first-order condition of (14).

$$w_D(\lambda) = w_D(GIII)/\lambda; \quad w_{FG}^d(\lambda) = w_{FG}^d$$

Substituting the two wholesale prices into the corresponding expressions, we draw the same outcomes in scenario*III*.

Corollary 2. *With self-built sales channel, if the sales department has a certain*

decision-making power to determine its retail quantity, then the manufacturer's profit in scenario I is equal to that in scenario III.

The outcomes reflect that company U can adjust the domestic transfer price according to sales department's priorities. The adjusted transfer price is equal to the domestic wholesale price in scenario *III*. No matter what level of priorities is, the manufacturer can get optimal profits. We can explain that the domestic transfer price also can convey signals of market competition. In this case, the manufacturer can keep optimal level of competitiveness in domestic market equal to that in the scenario *III*.

5. Conclusion

Gray market has attracted considerable interest in the press and the international practice. The previous literature mainly examines the gray market from the perspective of price elasticity, demand uncertainty, and product information service, *etc*., This paper is from the view of operating and marketing. In the paper, we analyze the manufacturer's optimal operation strategy. The basic assumption is that products provided for foreign market can be different. And the manufacturer can control the extent of product differentiation.

We find that under some conditions the company U will have incentive to encourage gray market. In a gray market setting, the manufacturer has a tradeoff between loses in domestic retail market and gains from wholesale market. His optimal strategy is to select external distribution channel with two-part tariffs contract (scenario *III*). We also draw that, with self-built sales channel, if sales department is given a certain decision-making power to select retail quantity, then manufacturer's profit equals to that scenario *III*. The reason is that manufacturer can achieve the desired level of competitiveness in domestic market by adjusting the transfer price w_D. If product differentiation satisfies $0 < \gamma \leq \gamma^*$, manufacturer will set a higher transfer price to reduce the competitiveness. Observing this, the distributor F will purchase more products and company U will expand its wholesale profitability. If it satisfies $0 < \gamma \leq \gamma^*$, the manufacturer will set a lower transfer price to deter the erosion from gray market. In this case, the loss in domestic market plays a prominent role.

In the paper, we does not consider several interesting issues. For example, the basic assumption for our model is under symmetric information. In fact, retailers can better observe the market information. Furthermore, providing differentiate products needs more manufacturer's investment. So the directions for our further research are to consider factors such as asymmetric information, investment and so on.

Conflict of Interests

The author declare that there is no conflict of interests regarding the publication of this paper.

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