

Multichannel Distribution under International Oligopoly*

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Abstract

We revisit how a tariff reduction affects consume surplus by an international oligopoly model. We consider a market wherein a home manufacturer sells products through a home retailer and a foreign manufacturer who carries out FDI sells products through another home retailer. Meanwhile, the foreign manufacturer can also export products directly through an EC site, while incurring a tariff per each unit. A tariff reduction is easily thought as enhancing the foreign manufacturer's export efficiency and thus promoting home competition. However, contradicting to this conventional wisdom, we show that due to the foreign manufacturer's multichannel distribution, the tariff reduction always increases home consumer surplus, and may reduce the foreign firm's profit and increase home producer surplus. We further consider a symmetric case wherein both the foreign and home manufacturers can use EC sites for direct selling. Moreover, we confirm our results regarding home consumer surplus by generalizing the number of foreign and home manufacturers.

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1 Introduction

We revisit tariff effects on market outcomes in an international oligopoly with a foreign firm’s multichannel distribution. Conventionally, a foreign firm involved in international business always produces products both in its own country (hereafter “foreign country”) and countries whom it wants to do business with (hereafter “home country”).¹ Both the “foreign-made” and “home-made” products once had to be sold via local retailers. However, with the development of online trading system in the past decade, foreign firms have started to use EC (electronic commerce) sites to export the “foreign-made” products directly to local consumers.² On the other hand, the traditional “brick-and-mortar” retailing business still plays an important role.³ In fact, more and more major foreign firms have started to use EC site to export foreign made products while keeping their “brick-and-mortar” retailing business.⁴ Foreign firms’ such multichannel distribution triggers a competition between the multinational and home channels.

In this study, we raise the following question: when a foreign manufacturer carries out multichannel distribution, how trade liberalization affects trading outcomes? To this end, we consider the following bilateral duopoly case: A home manufacturer sells

¹For example, Canon’ digital cameras sold in China are produced in both factories in Nagasaki, Miyazaki (Japan) and Zhuhai (China); Sony’ liquid crystal televisions sold in China are produced in both factories in Inazawa (Japan) and Shanghai (China); etc.

²In China, “selling through EC sites” has become an extremely important exporting strategy for foreign firms. The trading volume through EC sites occupied 34.3% of the total in 2010 and has been at a growing rate of 33.3% every year. Among the total EC trading volume, import of foreign products is expected to increase from 3.1% in 2015 to 7% in 2018 (JETRO, 2016).

³Despite of the booming online retailing in China, the offline retailing business still achieves an annul growth rate of around 5% (Daxue Consulting, June, 2016). <http://daxueconsulting.com/retail-industry-china/>

⁴In electronics industry, Japanese brands such as Cannon, SONY, etc., sell “Japan made” products through EC sites like Taobao and JD.com, while keeping physical retailing business via local shopping malls.

products through a home retailer. Meanwhile, a foreign manufacturer who carries out FDI sells “home-made” products through another home retailer and exports “foreign-made” products directly to home consumer through EC sites. We assume that the export incurs a specific tariff. The manufacturers negotiate with their respective retailers over a two-part tariff contract in a Nash bargaining process. A tariff reduction is easily thought as enhancing the foreign manufacturer’s export efficiency and thus promoting home competition. However, contradicting to this conventional wisdom, we show that due to the foreign manufacturer’s multichannel distribution, the tariff reduction always increases home consumer surplus, and may reduce the foreign firm’s profit and increase home producer surplus.

Our main result is that a tariff reduction may reduce consumer surplus. The intuition follows from the fact that the foreign manufacturer tends to substantially raise the wholesale price for the home retailer when facing a lower tariff. Specifically, the wholesale price will be raised twice by the foreign manufacturer. Firstly, a lower tariff shrinks the price margin for selling “home-made” products. Knowing this, the foreign manufacturer raise the wholesale price to depress the home retailer’s sale. Secondly, a lower tariff enlarges the price margin for selling “foreign-made” products, which motivates the foreign to further raise the wholesale price to shift the share from its indirect channel to the EC channel. Such an efficiency loss in distribution caused by the tariff reduction will consequently result in a reduction in the foreign supply chain’s total sale, which is referred to as the *crowding out effect*. Thus, despite of the efficiency enhancement in the exporting channel, the tariff reduction makes a smaller total sale and higher price, thus harms domestic consumers.

The mechanism that a tariff reduction motivates the foreign manufacturer to substantially raise the wholesale price plays the main role in our study. Specifically, due to a higher wholesale price charged by the foreign manufacturer, the retailer who sells “home-made” products have to reduce its quantity. Such a quantity reduction of “home-made” products may even outweigh the increase in the export of “foreign-made”

products. In other words, the total market share of the foreign manufacture, including both “home-made” and “foreign-made” ones, would be less due to the tariff reduction. Using this feature, we obtain other counterintuitive results as follows.

Firstly, the tariff reduction may even make the foreign manufacturer worse off. How the tariff reduction affects the foreign manufacturer’s profit is decided by the following trade-offs: On one hand, it creates the foreign manufacturer a better outside option and enhances the efficiency of exporting, which is positive; On the other hand, it reduces the foreign manufacturer’s market share, which is negative. This result holds when the value of tariff and the manufacturer’s bargaining power is high enough.

Secondly, the tariff reduction may increase the home producer surplus. The following trade-offs motivate this result. On one hand, due to strategic substitutability, the decrease of the foreign manufacturer’s total quantity leaves more demand for the home manufacturer, which generates a positive effect. On the other hand, the home retailer who is supplied by the foreign manufacturer has to pay a higher wholesale price, which is negative for the home producer surplus. The positive effect dominates when the manufacturer’s bargaining power is large enough.

Literature has been paying an intensive attention to firms’ strategic behaviors in international oligopoly since 1980s.⁵ From the late 1990s, researchers have started to focus on how supply chain management affects international trade outcomes and draw conclusions from some new insights. For example, Ishikawa and Spencer (1999) considers how the location of intermediate-good industry (whether in the foreign or home country) affects a government’s incentive of subsidizing export. Raff and Schmitt (2005) studies how tariff reduction affects foreign and domestic manufacturers’ incentives to specify exclusive territories for domestic retailers and finds a negative impact of tariff reduction on domestic social welfare. Ara and Ghosh (2016) considers how

⁵For example, in a simple two-country model, how national government’s tariff or subsidy policies affect social welfare is widely studied (e.g., Brander and Spencer, 1984; Brander and Spencer, 1985; Anis and Ross, 1992). Other studies model different competition factors into the existing framework such as R&D (Spencer and Brander, 1983), multinational firms’ FDI (Brander and Spencer, 1987) and product quality choice (Herguera et al., 2002).

bargaining power affects international supply chain members' profits.⁶ To the best of our knowledge, the present study is the first attempt considering how the foreign firm's multichannel marketing affects trade outcomes and thus adds several new incomes into the existing literature.

Ishikawa et al. (2010) may be the most related one to ours. In that research, a foreign firm competes with the domestic firm in the domestic product market. Meanwhile, the foreign firm can decide whether to carry out post-production service by itself (via FDI) or by outsourcing to the domestic rival. The domestic firm, thus, may potentially profit from multichannels—its own sale and the payments from carrying out the foreign firm's post production service. Ishikawa et al. (2010) insightfully shows that a reduction in *ad valorem* tariff may increase the service price (or royalty) offered by the domestic firm and reduce consumer surplus, which seems to be similar with our main result. However, the mechanism behind is quite different. The mechanism in Ishikawa et al. (2010) comes from the difference in sensitivity between the foreign firm's profit of FDI case and outsourcing case. Precisely, if the tariff reduction increases the foreign firm's equilibrium profit more in the outsourcing case than in the FDI case, the foreign firm would rather pay a higher service price but still chooses outsourcing. One important logic in that study is that the foreign firm can sell its products at a higher price and obtain a larger revenue (gross of the service cost) in the outsourcing case than in the FDI case, which relies on the assumption of *ad valorem* tariff.⁷ In our study, the crowding out effect plays the main role so that our result can hold under both a specific tariff and a *ad valorem* tariff.⁸

The rest of the paper proceeds as follows. In Section 2, we introduce the main

⁶For other parallel studies, see Raff et al. (2007), Raff and Schmitt (2006, 2012, 2016), Ara and Ghosh (2017).

⁷In Ishikawa et al. (2010), one necessary condition for the above logic is that the price of foreign products is higher in the outsourcing case than in the FDI case. However, in a price competition with a specific tariff, the "direct effect" from the price will not exist, which violates the necessary condition.

⁸Ishikawa et al., (2016) studies an international duopoly wherein a foreign firm chooses whether to carry out repair service for products made by itself and a domestic firm chooses whether to carry out repair service for the foreign firm's products. The authors also show that a tariff reduction may reduce consumer welfare.

model setting and use a general demand function to derive our main result regarding consumer surplus. In Section 3, we use a linear demand system to derive our further results. In Section 4, we carry out two extensions including the case with n foreign firms and m home firms and the case wherein foreign products are horizontally differentiated with home products. Section 5 concludes the paper.

2 A basic model

Let us first consider an international bilateral duopoly model with a home manufacturer, foreign manufacturer, and two home retailers. We call products made in the home country “home-made,” and those made in the foreign country “foreign-made.” A home manufacturer (H) sells products to consumers through a home retailer (R_1), and a foreign manufacturer (F) who carries out FDI in production and sells its “home-made products” through another home retailer (R_2). The trading terms within each supply chain is determined via a negotiation over a two-part tariff contract comprising a wholesale price w_i and a fixed fee f_i , where $i = 1$ or 2 . The negotiation process is carried out by generalized Nash bargaining, wherein each manufacturer’s bargaining power is denoted by $\beta \in (0, 1)$ and each retailer’s is denoted by $1 - \beta$. The manufacturers can also choose to export its “foreign-made products” to consumers through an EC site, while incurring a specific tariff ($t \geq 0$).⁹ Besides, we assume the marginal selling cost is $c \geq 0$ when the manufacturer sells through its EC site but zero when it sells through the home retailer. The market structure is shown in Figure 1.

Now, we explain the above settings. First, the two-part tariff contract is quite common in the real world wherein a manufacturer uses EC sites and physical retailers for multichannel distribution.¹⁰ Second, different with stocking “home-made” products, stocking “foreign-made” products needs to be done long before the market forms be-

⁹We can obtain qualitatively same result when a foreign firm incurs an *ad valorem* tariff.

¹⁰Lafontaine (1992) shows that manufacturers’ multichannel marketing exists in most industries (e.g., auto services, business aids, education services, and hotels and motels) and that in over 90% (504 out of 548) cases two-part tariff contracts are used. Similar finding is also shown by Kalnins (2004).

cause of the long-distance delivery. For this sake, the physical retailer who faces space constraints always prefers selling “home-made” products to avoid stocking risks. On the other hand, selling “foreign-made” products through the EC site makes stocking more flexible in the sense that stocking is contingent on consumers’ orders.¹¹ For above reasons, we assume that only the foreign firm uses the EC site for analytical simplicity. Notice that this assumption can be relaxed. Third, the assumption that selling through the EC site is less efficient than selling through the retailer follows from the fact that manufacturers employing online business need to bear transportation expenses for delivering to consumers.¹² To show that our main results do not essentially depend on the assumption regarding selling cost, we first consider $c = 0$ in our basic model.

Denote each retailer’s quantity by q_i , and the foreign manufacturer’s export by q_F . In our basic model, we consider homogeneous quantity competition.¹³ We assume that the inverse demand function $P(Q)$ for final products is nonnegative, strictly decreasing, and twice differentiable, where P is the price and Q is the total quantity.

Firm’s profits are denoted as follows:

$$\pi_F = w_2 q_2 + f_2 + [P(Q) - t] q_F, \quad (1)$$

$$\pi_H = w_1 q_1 + f_1, \quad (2)$$

$$\pi_i = [P(Q) - w_i] q_i - f_i. \quad (3)$$

We consider a two-stage game as follows: In Stage 1, the foreign and home manufacturers negotiate with their respective retailer over the trading terms. In Stage 2, each retailer decides the quantity of wholesale products and pays for the manufacturer

¹¹Selling “foreign-made” products via EC sites is quite common in the real world. It is true that “foreign-made” products are also sold through physical retailers as well, though, for simplicity and feasibility in modeling, in this study we assume the “foreign-made” and “home-made” products are distributed exclusively via different channels.

¹²Moreover, the assumption that direct distribution channel is less efficient than the indirect channel is standard in the literature of multichannel distribution in industrial organization, marketing and management science. Other explanations include higher risks of return and refund in online trade, manufacturers’ less experience in retail activities, comparing with physical retailers (e.g., Arya et al., 2007; Li et al., 2015; Pan, 2016).

¹³Even when firms compete in price, the effect we emphasize in our basic model exists. We can confirm the main result can hold when firms compete in price with incurring an *ad valorem* tariff.

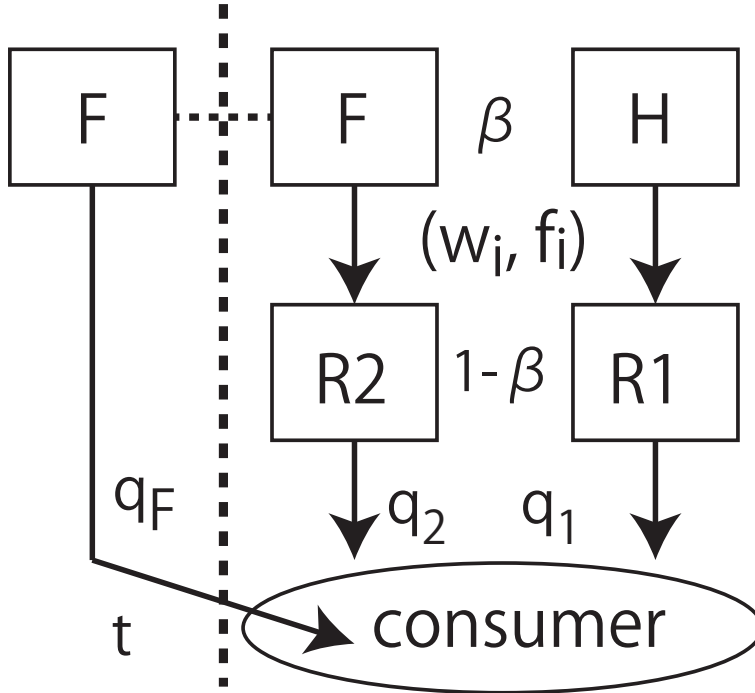


Figure 1: Market structure: Duopoly case

based on the contract determined in Stage 1. For simplicity, we first assume the foreign firm always exports foreign-made products.

3 Analysis

To simplify analysis, we first assume $c = 0$. Solving by backward induction, we derive subgame perfect equilibria. In Stage 2, each firm decides its output. The first-order conditions are as follows:

$$\frac{\partial \pi_F}{\partial q_F} = [P(Q) - t] + P'q_F = 0, \quad (4)$$

$$\frac{\partial \pi_i}{\partial q_i} = [P(Q) - w_i] + P'q_i = 0. \quad (5)$$

Note that this implies that the equilibrium outcome is Cournot triopoly outcome with marginal costs w_i and t , respectively. Hence, by the theorem of Bergstrom and Varian (1985), the equilibrium total quantity, Q , depends only on the sum of the marginal costs, $t + w_1 + w_2$.

Next, we consider the outcome when the negotiation in each supply chain breaks down (i.e., outcomes off the equilibrium path). Because we are discussing a symmetric case wherein only the foreign manufacturer has an outside option, we need to consider the following two cases: (1) the negotiation between the home manufacturer and Retailer 1 breaks down; (2) the negotiation between the foreign manufacturer and Retailer 2 breaks down. We use the hat symbol ($\hat{\cdot}$) to denote the case of “breaking down.” For the first case, when the negotiation between the home manufacturer and Retailer 1 breaks down, both the home manufacturer and Retailer 1 gain zero profit:

$$\hat{\pi}_H \equiv 0, \hat{\pi}_1 \equiv 0. \quad (6)$$

On the other hand, when the negotiation between the foreign manufacturer and Retailer 2 breaks down, the foreign manufacturer has an outside option to export “foreign made” products to consumers, although incurring a specific tariff. In this case, Retailer 2 is forced to exit the market, and the foreign manufacturer competes with Retailer 1. The equilibrium outcomes are characterized by the following equations:

$$\frac{\partial \pi_F}{\partial q_F} = [P(Q) - t] + P'q_F = 0, \quad (7)$$

$$\frac{\partial \pi_1}{\partial q_1} = [P(Q) - w_1] + P'q_1 = 0. \quad (8)$$

Note that this implies that the equilibrium outcome is Cournot duopoly outcome with marginal costs w_1 and t , respectively.

For the second case, the foreign manufacturer gain positive profit while Retailer 2 gain zero profit:

$$\hat{\pi}_F \equiv \hat{\pi}_F(w_1, t), \hat{\pi}_2 \equiv 0. \quad (9)$$

Thus, the bargaining process is as follows:

$$\max_{(w_1, f_1)} \Omega_1 = (\pi_H)^\beta (\pi_1)^{1-\beta}, \quad (10)$$

$$\max_{(w_2, f_2)} \Omega_2 = (\pi_F - \hat{\pi}_F)^\beta (\pi_2)^{1-\beta}, \quad (11)$$

where $\hat{\pi}_F$ is the foreign manufacturer's profit when the negotiation breaks down, depending only on w_1 and t .

Under the assumption of two-part tariff contract, the maximization problem is rewritten by

$$\max_{w_1} \quad \pi_H + \pi_1 = P(t, w_1, w_2)q_1, \quad (12)$$

$$\max_{w_2} \quad \pi_F - \hat{\pi}_F + \pi_2 = [P(t, w_1, w_2) - t]q_F + P(t, w_1, w_2)q_2. \quad (13)$$

The first-order conditions are as follows:

$$\frac{\partial P}{\partial w_1}q_1 + P \frac{\partial q_1}{\partial w_1} = 0, \quad (14)$$

$$\frac{\partial P}{\partial w_2}q_F + [P(\cdot) - t] \frac{\partial q_F}{\partial w_2} + \frac{\partial P}{\partial w_2}q_2 + P \frac{\partial q_2}{\partial w_2} = 0. \quad (15)$$

Denote the left-hand sides of the equations as Ω_1^1 and Ω_2^2 , respectively. Differentiating the simultaneous equations by t , we have

$$\begin{bmatrix} \frac{\partial \Omega_1^1}{\partial w_1} & \frac{\partial \Omega_1^1}{\partial w_2} \\ \frac{\partial \Omega_2^2}{\partial w_1} & \frac{\partial \Omega_2^2}{\partial w_2} \end{bmatrix} \begin{bmatrix} \frac{dw_1}{dt} \\ \frac{dw_2}{dt} \end{bmatrix} = \begin{bmatrix} -\frac{\partial \Omega_1^1}{\partial t} \\ -\frac{\partial \Omega_2^2}{\partial t} \end{bmatrix}. \quad (16)$$

Also, define $\partial \Omega_i^i / \partial w_j \equiv \Omega_i^{ij}$ and $\partial \Omega_i^i / \partial t \equiv \Omega_i^{it}$. Note that the second-order conditions imply $\Omega_i^{ii} < 0$.

Assumption 1 *The reaction function of the home manufacturer's bargaining pair is downward sloping, and the absolute value of each bargaining pair's reaction function is less than one. Formally,*

$$0 < -\frac{\Omega_1^{12}}{\Omega_1^{11}} < 1, \text{ and } \left| -\frac{\Omega_2^{21}}{\Omega_2^{22}} \right| < 1. \quad (17)$$

These are natural assumptions which assure that the equilibrium is stable. Note that we do not assume that the reaction function of the foreign manufacturer's bargaining pair is downward sloping.¹⁴

¹⁴In fact, the slope of reaction function of the foreign manufacturer's bargaining pair is zero under the linear demand function.

Arranging Eq. (16), we have

$$\frac{dw_1}{dt} = \frac{-\Omega_1^{1t}\Omega_2^{22} + \Omega_1^{12}\Omega_2^{2t}}{\Omega_1^{11}\Omega_2^{22} - \Omega_1^{12}\Omega_2^{21}}, \quad (18)$$

$$\frac{dw_2}{dt} = \frac{-\Omega_1^{11}\Omega_2^{2t} + \Omega_1^{1t}\Omega_2^{21}}{\Omega_1^{11}\Omega_2^{22} - \Omega_1^{12}\Omega_2^{21}}. \quad (19)$$

Proposition 1 *Under Assumption 1, if tariff reduction reduces the wholesale price of home manufacturer, then it increases the price and decreases consumer surplus. Formally, we have*

$$\mathbf{sign}\left(\frac{dw_1}{dt}\right) = -\mathbf{sign}\left(\frac{d(t + w_1 + w_2)}{dt}\right). \quad (20)$$

This proposition implies that when a tariff reduction makes the home supply chain (i.e., firms H and R_1) aggressive (i.e., lower wholesale price), it must increase the total marginal cost and consequently hurt consumer surplus.

To see the intuition, we discuss the mechanism in each supply chain one by one.

First, let us consider the foreign manufacturer's supply chain. Eq. (15) implies two effects, which are given as follow:

$$0 = \underbrace{\frac{\partial P}{\partial w_2}q_2 + P\frac{\partial q_2}{\partial w_2}}_{\text{marginal revenue from Retailer 2}} + \underbrace{\left[\frac{\partial P}{\partial w_2}q_F + (P - t)\frac{\partial q_F}{\partial w_2}\right]}_{\text{intra-brand competition}}. \quad (21)$$

On one hand, because a lower tariff drives down price and shrinks the price margin of supplying Retailer 2, the foreign manufacturer tends to raise w_2 to depress Retailer 2's sale. On the other hand, the tariff reduction enlarges the price margin of exporting via the EC site, the foreign manufacturer therefore tends to further raise w_2 to depress Retailer 2's sale so as to shift more demand to its export. The logic that a tariff reduction will cause w_2 to be raised twice by the foreign manufacturer plays the key role in our study. Consequently, a lower t may increase $w_2 + t$ and hence reduce $q_2 + q_F$, which we referred to as a *crowding out effect*.

Second, let us consider the home manufacturer's supply chain. As the tariff reduction shrinks Retailer 1's profit margin, the home manufacturer should have raised w_1

to depress Retailer 1's sale, but in fact w_1 becomes lower. This is because the crowding out effect in the foreign supply chain creates Retailer 1 more demand via strategic substitution. Conversely, the crowding out effect must be strong enough to trigger the home manufacturer's incentive to reduce w_1 . Thus, $\partial w_1 / \partial t > 0$ serves as a prerequisite to imply that the total quantity and the consumer surplus must be decreasing in t .

Note that the condition for Proposition 1 is fairly reasonable. We first provide here some parametric examples when demand function is non-linear: $P(Q) = a - Q^\alpha$. In the next section, we will provide a formal analysis of linear demand function, Figure 2 shows that a tariff reduction can increase the price and decrease consumer surplus when demand function is either convex or concave.

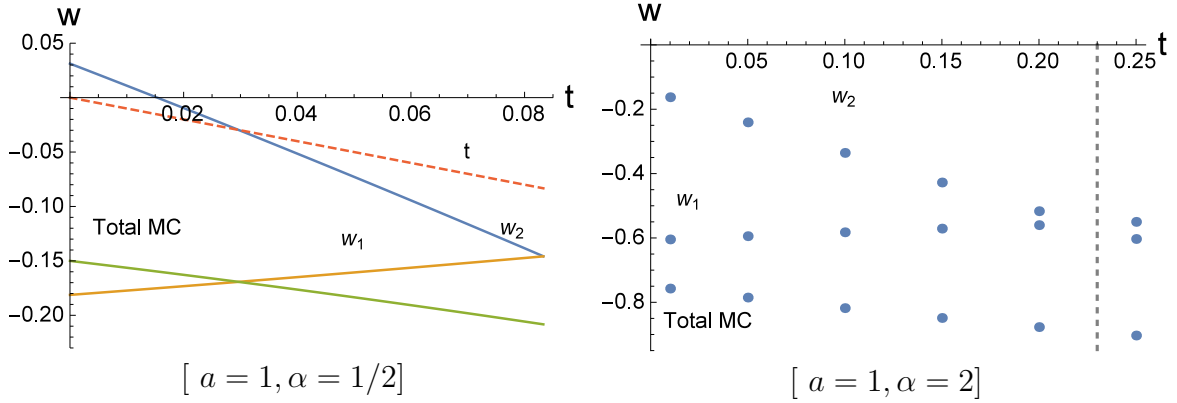


Figure 2: Relationship between wholesale prices and tariff.

4 Linear demand function

To explicitly derive our further results, hereafter we use a simple linear demand system, $P = a - Q$, where $a > 0$. To guarantee that the foreign manufacturer always exports foreign products, we need the following assumption:

Assumption 2

$$(i) t < \frac{a}{7} \text{ and } (ii) \beta < \frac{50(2a - 5t)^2}{324a^2 - 25(a + 11t)^2}.$$

The condition on t guarantees that the foreign manufacturer's exporting quantity is always positive. The condition on β guarantees the foreign manufacturer's incentive compatibility of exporting.

If the negotiation between the foreign manufacturer and Retailer 2 succeeds, there are three firms compete in Stage 2. The equilibrium outcomes are given as follows:

$$q_F(w_1, w_2) = \frac{a - 3t + w_1 + w_2}{4}, \quad q_i(w_i, w_j) = \frac{a + t - 3w_i + w_j}{4}, \quad i \neq j. \quad (22)$$

The resulting profits are

$$\pi_H \equiv w_1 q_1(w_1, w_2) + f_1, \quad (23)$$

$$\pi_F \equiv [q_F(w_1, w_2)]^2 + w_2 q_2(w_1, w_2) + f_2, \quad (24)$$

$$\pi_i \equiv [q_i(w_i, w_j)]^2 - f_i. \quad (25)$$

Next, we consider the outcome when the negotiation in each supply chain breaks down. For the first case, when the negotiation between the home manufacturer and Retailer 1 breaks down, both the home manufacturer and Retailer 1 gain zero profit:

$$\hat{\pi}_H \equiv 0, \quad \hat{\pi}_1 \equiv 0. \quad (26)$$

On the other hand, when the negotiation between the foreign manufacturer and Retailer 2 breaks down, the equilibrium outcomes are given as follows:

$$\hat{q}_F(w_1) = \frac{a - 2t + w_1}{3}, \quad \hat{q}_1(w_1) = \frac{a + t - 2w_1}{3}. \quad (27)$$

The resultant equilibrium profits are

$$\hat{\pi}_F \equiv [\hat{q}_F(w_1)]^2, \quad \hat{\pi}_2 \equiv 0. \quad (28)$$

Using Eqs. (26) and (28), the bargaining process is as follows:

$$\max_{(w_1, f_1)} (\pi_H)^\beta (\pi_1)^{1-\beta}, \quad (29)$$

$$\max_{(w_2, f_2)} (\pi_F - \hat{\pi}_F)^\beta (\pi_2)^{1-\beta}. \quad (30)$$

Solving simultaneous equations derived from Eqs. (29) and (30), we summarize the equilibrium outcomes in the following proposition:

Proposition 2 (i) *The equilibrium contracts are*

$$w_1^* = -\frac{a-t}{3}, w_2^* = -2t; \quad (31)$$

$$f_1^* = [\beta P(w_1^*, w_2^*) - w_1^* + (1-\beta)t]q_1(w_1^*, w_2^*), \quad (32)$$

$$f_2^* = [\beta P(w_1^*, w_2^*) - w_2^*]q_2(w_1^*, w_2^*) \\ -(1-\beta)[P(w_1^*, w_2^*) - t]q_F(w_1^*, w_2^*) + (1-\beta)\hat{\pi}_F; \quad (33)$$

(ii) *Firms' equilibrium quantities and profits are*

$$q_F^* = \frac{a-7t}{6}, q_1^* = \frac{a-t}{2}, q_2^* = \frac{a+11t}{6}, \quad (34)$$

$$\pi_H^* = \frac{\beta(a-t)^2}{12}, \pi_F^* = \frac{\beta(a+11t)^2 + 2(2a-5t)^2}{162}, \quad (35)$$

$$\pi_1^* = \frac{(1-\beta)(a-t)^2}{12}, \pi_2^* = \frac{(1-\beta)(a+11t)^2}{162}. \quad (36)$$

To guarantee $q_F^* > 0$, we need the first condition in Assumption 2. The result that both the foreign and home manufacturer offers a subsidy (or a below-cost wholesale price) is in line with most literature about oligopoly supply chain competition (Milliou and Petrakis, 2007). Each manufacturer does so to promote its exclusive retailer's competitive power. Notice that as long as $t > 0$, π_F^* is always larger than $\hat{\pi}_F$. In other words, despite of the bargaining power, the foreign manufacturer never chooses to completely rely on exporting because of the tariff incurred.

We first carry out comparative statics about the tariff on consumer surplus (CS).¹⁵ Remember that because in a quantity competition with homogeneous products, consumer surplus is always positive correlated to total quantity and thus negatively correlated to total costs, we only need to examine how the tariff reduction affects the total costs. Summing up w_1^* , w_2^* and t , we obtain

$$w_1^* + w_2^* + t = -\frac{a+2t}{3} < 0, \quad (37)$$

From Eq. (37), the tariff reduction always increases the total marginal costs, which confirms that the condition in Proposition 1 can be satisfied under the linear demand function. This is summarized as follows:

¹⁵In this setting, $CS = \frac{Q^2}{2}$.

Proposition 3 *A tariff reduction always increases price and reduces consumer surplus. Formally,*

$$\frac{dP}{dt} < 0 \text{ and } \frac{dCS}{dt} > 0.$$

In conventional wisdom, one might think a tariff reduction to make the foreign firm more competitive and thus reduces home producer surplus. However, this seemingly intuitive thinking may fail to hold with the presence of manufacturer's multichannel distribution as in the current study.

Next, we examine how the tariff reduction affects the foreign manufacturer's profit. The result is summarized in the following proposition:

Proposition 4 *A tariff reduction may reduce the foreign manufacturer's profit. Formally, $d\pi_F/dt > 0$ if and only if*

$$(i) \ t > \frac{7a}{55} \text{ and } (ii) \ \beta > \frac{20a - 50t}{11a + 121t}.$$

To see the intuition, substituting f_1^* back to π_F in Eq. (24), we rewrite the foreign manufacturer's profit function as

$$\pi_F = \beta[P \times (q_F + q_2) - tq_F] + (1 - \beta)\hat{\pi}_F. \quad (38)$$

The foreign manufacturer's profit has three components: the supply chain's aggregate profit gross of tariff as denoted by the first term, the total costs on tariff as denoted by the second term, and the outside option as denoted by the third term. Because the tariff reduction not only saves the total costs, but also creates the foreign manufacturer a better outside option, it clearly generates a positive effect on both the second and third terms. However, a lower tariff causes the crowding out effect, which always creates a negative effect on the first term. Whether the foreign manufacturer benefits or loses

from the tariff reduction is decided by the above trade-offs. When t is large, q_F^* is small so that the positive effect from the second term in Eq. (38) is small. Moreover, when β is large, the weight on $\hat{\pi}_F$ is small. Therefore, the positive effects cannot compensate the loss from the first term Eq. (38). Notice that the inequalities in Proposition 4 can hold under Assumption 2. Figure 3 presents a numerical example of Proposition 4.

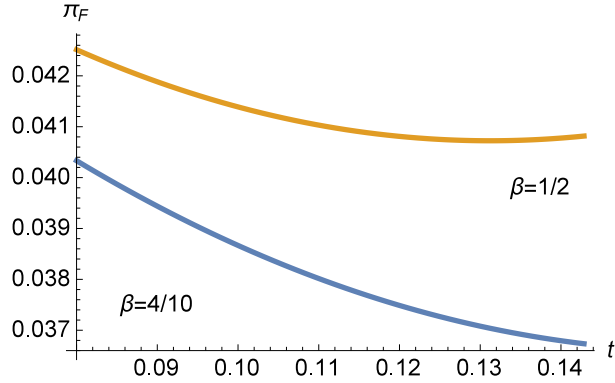


Figure 3: Tariff and the profit of foreign manufacturer [$a = 1$.]

Finally, we examine how home producer surplus is affected by the tariff reduction. We denote the home producer surplus by

$$PS \equiv \pi_H^* + \pi_1^* + \pi_2^*. \quad (39)$$

Here, we also find a counterintuitive result: A tariff reduction may even benefit the home producers. This finding is summarized in the next proposition.

Proposition 5 *When t is sufficiently small, a tariff reduction may increase home producer surplus. Formally, $dPS/dt < 0$ if and only if*

$$\beta > \frac{269t - 5a}{22(a + 11t)}.$$

The crowding effect caused by the tariff reduction shifts more market share to the home supply chain, which generates a positive effect on home producer surplus. On the other hand, the tariff reduction drives up w_2^* , and thus reduces the profit of Retailer

2, which generates a negative effect. The first and second terms in Eq. (39) denote the total profit of the home manufacturer's supply chain, which does not depend on β . However, when β is large enough, the impact from the third term is small so that the positive effect outweighs the negative effect. Figure 4 presents a numerical example of Proposition 5.

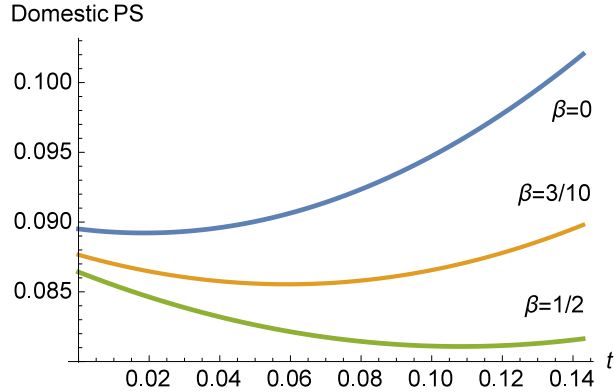


Figure 4: Tariff and domestic producer surplus

5 Extensions

5.1 Extension 1: m foreign firms and n home firms

We consider an extension case with m foreign chains and n home chains. That is, there are m foreign manufacturers and n home manufacturers which trade with their respective retailers. The inverse demand function is:

$$P = a - \left(\sum_{i \in \{1, \dots, n+m\}} q_i + \sum_{i \in \{1, \dots, m\}} q_{Fi} \right), \quad (40)$$

where q_i with $i \in \{1, \dots, n\}$ denote outputs of the retailers who trade with the home manufacturers, q_i with $i \in \{n+1, \dots, n+m\}$ denote those of the retailers which trade with foreign manufacturers, and q_{Fi} with $i \in \{1, \dots, m\}$ denote those of the foreign manufacturers.

Since the analysis is essentially the same, we only provide equilibrium outcomes. We get the equilibrium wholesale prices for the retailers which trade with the home

manufacturers and those which trade with the foreign manufacturers, respectively, as follows:

$$\begin{aligned} w_H &= -\frac{(2m+n-1)(a-mt)}{2m^2+(3n-1)m+n^2+1}, \\ w_F &= -\frac{(2m+n-3)a+t(2m^2+5mn+m+2n^2+2)}{2m^2+(3n-1)m+n^2+1}. \end{aligned} \quad (41)$$

We have qualitatively the same result with the duopoly case.

Proposition 6 *A tariff reduction always increases price and reduces consumer surplus.*

Formally,

$$\frac{dP}{dt} < 0, \text{ and } \frac{dCS}{dt} > 0.$$

This result implies that the proportion of the number of foreign manufacturers and home manufacturers does not change our result.

5.2 Extension 2: Horizontal product differentiation

We finally consider an extension case where the products from the EC site and from the physical retailers are horizontally differentiated. The inverse demand functions are given by

$$p_H = a - (q_1 + q_2) - \gamma q_F, \quad (42)$$

$$p_F = a - \gamma(q_1 + q_2) - q_F, \quad (43)$$

where p_H (p_F) is the price of product from the physical retailers (exported by the foreign manufacturer), and $\gamma \in (0, 1)$ reflects the substitutability of the products.

We present the numerical example of this extended model in Figure 5. Note that when the substitutability of the products is relatively high, a tariff reduction reduces consumer surplus even when products are differentiated.

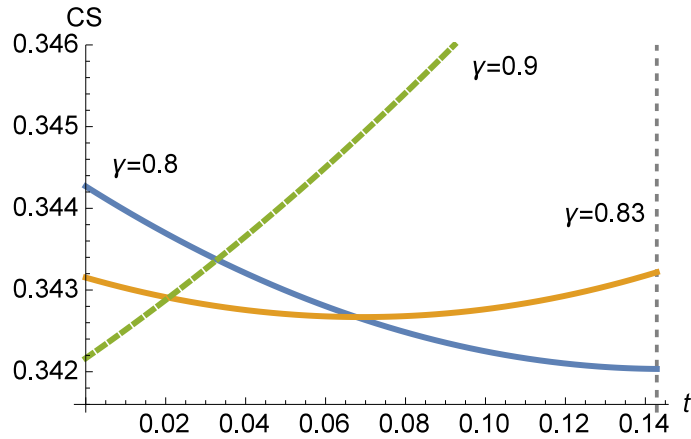


Figure 5: Tariff and consumer surplus [$a = 1$]

6 Conclusion

In this study, we use an international oligopoly model with a vertical structure to demonstrate how a tariff reduction affects price and consume surplus. Due to the foreign firm's adaption of both FDI in production and direct export through EC sites, the tariff reduction can increase price and harm consumers. We clarify a notable effect—crowding out effect—which is caused by the foreign firm's incentive for reallocating its output from indirect channel to exporting via EC site.

We also show that the tariff reduction may increase or decrease the foreign firm's profit and the domestic producer surplus because the crowding out effect reduces the foreign supply chain's market share. This result contradicts most existing literature in international oligopoly demonstrating that a tariff reduction must make foreign firms more competitive and thus reduces home producer surplus.

For these results, the crowding out effect plays an important role in our model. Because this effect alleviates domestic market competition, this can provide an important policy implication under multichannel distribution in an international oligopoly. We believe that this paper has provided a new insight to trade policy.

Appendix: Proofs

Proof of Proposition 1. First, we have

$$\frac{\partial \Omega_1^1}{\partial t} = \frac{\partial^2 P}{\partial w_1 \partial t} q_1 + \frac{\partial P}{\partial w_1} \frac{\partial q_1}{\partial t} + \frac{\partial P}{\partial t} \frac{\partial q_1}{\partial w_1} + P \frac{\partial^2 q_1}{\partial w_1 \partial t}, \quad (44)$$

$$\frac{\partial \Omega_1^1}{\partial w_2} = \frac{\partial^2 P}{\partial w_1 \partial w_2} q_1 + \frac{\partial P}{\partial w_1} \frac{\partial q_1}{\partial w_2} + \frac{\partial P}{\partial w_2} \frac{\partial q_1}{\partial w_1} + P \frac{\partial^2 q_1}{\partial w_1 \partial w_2}. \quad (45)$$

Since $\partial P / \partial w_i = \partial P / \partial t$, we have

$$\frac{\partial^2 P}{\partial t \partial w_1} = \frac{\partial^2 P}{\partial w_2 \partial w_1} \quad (46)$$

$$\Rightarrow \frac{\partial^2 P}{\partial w_1 \partial t} = \frac{\partial^2 P}{\partial w_1 \partial w_2}. \quad (\text{by continuity}) \quad (47)$$

Similarly, since $\partial q_1 / \partial t = \partial q_1 / \partial w_2$, we get

$$\frac{\partial^2 q_1}{\partial w_1 \partial t} = \frac{\partial^2 q_1}{\partial w_1 \partial w_2}. \quad (48)$$

Hence, by Eqs. (44), (45), (47) and (48), we obtain $\Omega_1^{1t} = \Omega_1^{12}$. Using this equation, we can rewrite Eq. (18) as follows:

$$\frac{dw_1}{dt} = \frac{-\Omega_1^{12}(\Omega_2^{22} - \Omega_2^{2t})}{\Omega_1^{11}\Omega_2^{22} - \Omega_1^{12}\Omega_2^{21}}. \quad (49)$$

We next derive the effect of tariff on the total marginal cost.

$$1 + \frac{dw_1}{dt} + \frac{dw_2}{dt} = \frac{\Omega_1^{11}\Omega_2^{22} - \Omega_1^{12}\Omega_2^{21} - \Omega_1^{12}(\Omega_2^{22} - \Omega_2^{2t}) - \Omega_1^{11}\Omega_2^{2t} + \Omega_1^{1t}\Omega_2^{21}}{\Omega_1^{11}\Omega_2^{22} - \Omega_1^{12}\Omega_2^{21}}, \quad (50)$$

$$= \frac{(\Omega_1^{11} - \Omega_1^{12})(\Omega_2^{22} - \Omega_2^{2t})}{\Omega_1^{11}\Omega_2^{22} - \Omega_1^{12}\Omega_2^{21}}. \quad (51)$$

This leads to

$$\frac{\frac{dw_1}{dt}}{1 + \frac{dw_1}{dt} + \frac{dw_2}{dt}} = \frac{-\Omega_1^{12}}{\Omega_1^{11} - \Omega_1^{12}} < 0. \quad (52)$$

■

Proof of Proposition 4. Differentiating the foreign firm's profit with respect to t , we have

$$\frac{d\pi_F}{dt} = \frac{a(11\beta - 20) + (121\beta + 50)t}{81} > 0, \quad (53)$$

$$\Leftrightarrow \beta > \frac{10(2a - 5t)}{11(a + 11t)}. \quad (54)$$

When $t > \frac{7a}{55}$, the range satisfying both Assumption 2 and the Eq. (54) becomes non-empty. ■

Proof of Proposition 5. Differentiating the home producer surplus with respect to t , we have

$$\frac{dPS}{dt} = \frac{(269 - 242\beta)t - a(22\beta + 5)}{162} < 0, \quad (55)$$

$$\Leftrightarrow \beta > \frac{269t - 5a}{22(a + 11t)}. \quad (56)$$

Although we can not derive the exact value due to the mathematical difficulty, when t is sufficiently small, the range satisfying both Assumption 2 and the Eq. (56) becomes non-empty. ■

Proof of Proposition 6. We only have to examine the tariff effect on the total marginal cost. In this case, the total marginal cost is

$$mt + mw_F + nw_H = -\frac{2m^2(t + 1) + m(n(t + 3) + t - 3) + (n - 1)n}{2m^2 + m(3n - 1) + n^2 + 1}. \quad (57)$$

Differentiating this with respect to t , we have

$$\frac{d(mt + mw_F + nw_H)}{dt} = -\frac{m(2m + n + 1)}{2m^2 + m(3n - 1) + n^2 + 1} < 0. \quad (58)$$

This implies that a tariff reduction increases the total marginal cost and thus also hurts consumer surplus. ■

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