Parallel Imports, Product Innovation and Market Structures

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(This version: June 20, 2014)

Abstract

This paper sets up a two-country model in which there is one domestic manufacturer authorizing its product to a distributor in foreign country to investigate the effect of parallel imports (PI) on product innovation of the former. The distributor can sell the product not only to its own market (i.e., the foreign market) but also back to the domestic market if parallel imports are allowed by the domestic government. We find that if the manufacturer adopts a two-part tariff pricing scheme when selling its output to the foreign distributor, permitting PI necessarily decreases the manufacturer's product innovation. This result however is very sensitive to market structures. If the domestic market becomes duopolistic or oligopolistic, the above result is definitely reversed—PI has a positive effect on the manufacturer's product innovation. Finally, if there are more than one distributor in the foreign market, parallel imports may increase or decrease product innovation depending on the consumers' quality valuations in the two countries.

JEL classification: F12, F13, L11, L13

Keywords: Parallel imports, Product innovation, Two-part tariff pricing, Market structure

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1. Introduction

Parallel import (PI) occurs when a genuine product is sold back by licensed foreign distributers without the permission of the domestic intellectual property owner who, we call it the manufacturer hereafter, also serves the domestic market.

PI has been popular and observed in many products since 1980s. For example, the value of PI in the US rose from 7–10 billion USD in the mid-1980s to 20 billion USD in the 1990s (Cespedes *et al*. (1988); Computer Reseller News (2001)). The US is not the only country encountering PI. According to the House of Commons report (1999), the volume of PI in the UK's motorcycle market was around 25% of the sales in 1999.[1] EU also suffers approximate $3 billion sales per year owing to the occurrence of PI (Ganslandt and Maskus (2004)). Furthermore, according to the First Sale Doctrine of U.S. copyright law, it was illegal to import or resell the American copyright items. However, not until recently, the Supreme Court of the United States voted for the rule that textbooks and other goods made and sold abroad can be re-sold online and in discount stores without violating U.S. copyright law.[2] It means that the First Sale Doctrine is not applicable to PI and U.S.-made items such as textbooks, CDs, computer software purchased from foreign markets can be brought back to U.S. for resale. Besides, there are numerous American-made cars sold back from Canada and Mexico every year. PI is also legal in other countries such as Australia, China, Japan, New Zealand, Singapore, and Taiwan.

PI has attracted substantial attention and been investigated extensively in the literature. The main focus along this strand of research is on optimal PI policies (see,

[1] Please refer to the following website for details:
http://www.parliament.the-stationery-office.co.uk/pa/cm199899/cmselect/cmtrdind/380/38007.htm

[2] Please refer to the following website for details:
http://seattletimes.com/html/politics/2020593063_apussupremecourtcopyrights.html

for example, Maskus and Chen (2004); Chen and Maskus (2005); Kao and Peng (2009); Mueller-Langer (2012); Mukherjee and Zhao (2012), among others). Maskus and Chen (2004) utilize a two-country and two-firm Cournot model with a linear demand to investigate the optimal quantitative control of PI for an import country. They show that restricting parallel trade has an ambiguous welfare effect, depending on the trade cost of PI. Chen and Maskus (2005) reach a similar result with a general demand function. Mueller-Langer (2012) extends Maskus and Chen (2004) by assuming that products are heterogeneous and the manufacturer adopts one-part tariff pricing. He shows that permitting PI has a positive effect on the global welfare if the difference of the market sizes between the two countries is large and trade costs are low. Furthermore, Mukherjee and Zhao (2012) find that PI is profitable for the manufacturer if there is a labor union in the domestic country. Kao and Peng (2009) construct a three-country model to discuss the optimal quantitative regulation for PI. They show that if the manufacturer engages in price discrimination, the optimal PI policy is that of partial regulation and PI may decrease the global welfare if the manufacturer adopts two-part tariff pricing.

Another strand of the literature on PI shows that its effect on the manufacturer's process innovation depends on the trade cost (Li and Maskus (2006); Li and Robles (2007)) or the degree of the horizontal product differentiation (Li and Robles (2007)). Nevertheless, empirical evidences have shown that process R&D can only represent a minor part of the reality.[3] The effect of PI on product innovation remains an important issue to be further addressed in the literature. Matteucci and Reverberi (2014) find that PI may stimulate the manufacturer's product innovation, depending

[3] For example, Cohen *et al*. (1997) show that 51.5% of the innovations in the American manufacturing sector between 1991 and 1993 are those of product innovations and only 33% are of process innovations. Arundel and Kabla (1998) also find that the percentage of innovations is made for product innovations is 35.9%, and it is 24.8% for process innovations in Europe's industrial firms.

on consumers' preferences for innovation between the two countries.

Our paper complements the literature in several ways. First, we consider the effect of PI on the manufacturer's product innovation by assuming the domestic manufacturer sells its product to the foreign distributor via two-part tariff pricing. Second, we explore the effect of local rivals in the domestic market, which is commonly observed in the real world but has been overlooked in this line of research. Third, we consider the case in which the manufacturer has multiple distributors in the foreign market.

It is found that permitting PI necessarily decreases the manufacturer's product R&D incentive if the domestic market is monopolized by the manufacturer. However, PI necessarily stimulates product innovation of the manufacturer if it faces local rivals. In addition, If the manufacturer can authorize its product to multiple foreign distributors, it is found that the incentive of product innovation can be either positively or negatively affected by PI, depending on consumers' preferences for innovation in the domestic and the foreign markets.

The reminder of this paper is organized as follows. Section 2 introduces the basic model and examines the optimal product innovation with no PI. Section 3 investigates the effect of PI on the manufacturer's product innovation. Section 4 explores the product innovation of the manufacturer when it faces domestic rivals or authorizes its product to multiple distributors. Section 5 concludes the paper.

2. Product Innovation with no Parallel Imports

Assume that there are two countries, a home country and a foreign country, hosting one firm each. A manufacturer, located in the home country, sells x units of its product to its own (i.e., the home) market. The manufacturer also sells its product to the foreign market via an authorized foreign distributor. The distributor may engage in parallel trade, selling y^* to the foreign market and x^* back to the home market, if the home government adopts the international exhaustion rule (*i.e.*, allowing parallel trade). Contrarily, PI does not occur and $x^* = 0$ if the home government endorses the national exhaustion rule.

When producing the product, the manufacturer incurs a constant marginal cost, *c*. Trade costs and retailing costs are assumed to be zero for simplification.[4] The manufacturer charges two-part tariff pricing (i.e., a fixed fee, *T* plus a wholesale price, *w*), when selling the product to the foreign distributor. Furthermore, the manufacturer engages in product innovation θ and its R&D cost function is specified as $V(\theta)$ with $V_\theta > 0$ and $V_{\theta\theta} > 0$. The inverse demand functions of the home and the foreign markets are assumed to be $p = p\left(x + x^*, \theta\right)$ and $p^* = p^*\left(y^*, \theta\right)$ with $p_x = p_{x^*} < 0$, $p_y^* < 0$, $p_\theta > 0$, $p_\theta^* > 0$ and the second derivatives of the demands are assumed to be zero. Subscripts are used to denote derivatives.

The game in question consists of three stages. In the first stage, the manufacturer determines its optimal product innovation level. In the second stage, taking the product quality as given, the manufacturer chooses its optimal pricing contract (w plus T) and offers it to the foreign distributor. In the third stage, the manufacturer and the foreign distributor determine their optimal sales in the two markets with or with no PI. The sub-game perfect Nash equilibrium will be solved via backward induction. In this section, we shall investigate the case under national exhaustion (i.e., the no PI regime) and then, in Section 3, examine the international exhaustion case (i.e., the PI regime).

Under the national exhaustion regime, the foreign distributor is not allowed to resell the product back to the home market. Under such a circumstance, the home and the foreign markets are monopolized respectively by the manufacturer and the foreign distributor. Accordingly, the profit functions of the manufacturer and the foreign distributer can be respectively expressed as follows:

$$\pi(x; w, T, \theta) = \left[p\left(x, \theta\right) - c \right] x + (w - c) y^* + T - V(\theta), \tag{1}$$

$$\pi^*(y^*; w, T, \theta) = (p^* - w) y^* - T. \tag{2}$$

By differentiating (1) with respect to x and (2) respect to y^*, we can derive the

[4] This is for mathematical simplicity and does not change the qualitative results of the paper.

first-order conditions for the third stage of the game as follows:

$$\pi_x = p - c + p_x x = 0, \tag{3}$$

$$\pi^*_{y^*} = p^* - w + p^*_{y^*} y^* = 0. \tag{4}$$

The second-order and the stability conditions are all satisfied given the assumption of linear demands and constant marginal cost. Thus, we can derive the equilibrium outputs of the two firms as follows: $x(c)$ and $y^*(w)$. By (3) and (4), we can further derive the comparative static effects as follows:

$$x_\theta = -p_\theta / 2p_x > 0, \quad y^*_\theta = -p^*_\theta / 2p^*_{y^*} > 0, \text{ and } y^*_w = 1/2p^*_{y^*} < 0. \tag{5}$$

The above results show that an increase in product innovation raises the sales of the home and the foreign markets whereas increasing the wholesale price w lowers the sales of the foreign distributor to the foreign market. By substituting the equilibrium outputs from the third stage into (1), we can rewrite the profit function of the manufacturer for the second-stage game as follows:

$$\underset{w}{\text{Max}} \ \pi(x, y^*(w), w, T; \theta) = (p - c)x + (w - c)y^*(w) + T - V(\theta), \tag{6}$$

Following the literature, we assume that the manufacturer can extract the entire profit from the foreign distributor under two-part tariff pricing. Thus, the optimal fixed fee charged by the manufacturer is defined as $T = (p^*(y^*(w)) - w)y^*(w)$.

By substituting T into (6) and then differentiating it with respect to w, we can derive the first-order condition for profit maximization of the manufacturer in the second stage as follows:

$$\frac{d\pi}{dw} = \frac{\partial \pi}{\partial y^*}\frac{\partial y^*}{\partial w} + \frac{\partial \pi}{\partial w} + \frac{\partial \pi}{\partial T}\frac{\partial T}{\partial w} \quad = (w - c)y^*_w = 0. \tag{7}$$

By solving (7), we derive the optimal wholesale price with no PI as $w = c$. By substituting w into T, we can further derive the optimal fixed fee as $T^* = (p^*(y^*(c)) - c)y^*(c)$. This result implies that if the manufacturer adopts two-part tariff pricing, it will set the wholesale price at its marginal cost and extract the monopoly rent from the foreign distributor via the fixed fee. Furthermore, product innovation has no effect on the wholesale price as $w_\theta = 0$ by (7). Given the above results, we can establish the first proposition as follows.

Proposition 1. If the manufacturer adopts two-part tariff pricing and parallel trade

is prohibited, product innovation has no effect on the wholesale price.

The above result differs from those in Li and Maskus (2006) and Matteucci and Reverberi (2014). The former assumes that the manufacturer adopts two-part tariff pricing, and shows that process innovation decreases the wholesale price while the latter assumes that the manufacturer employs one-part tariff pricing and finds that product innovation increases the wholesale price.

Making use of the results in the previous two stages, the profit function of the manufacturer in the first-stage game can be expressed as follows:

$$\underset{\theta}{\text{Max}}\ \pi(x(\theta), y^*(\theta), T(\theta), \theta) = (p(x(\theta),\theta) - c)x(\theta) + T(y^*(\theta),\theta) - V(\theta). \quad (8)$$

By differentiating (8) with respect to θ and using the envelope theorem, we can derive the first-order condition for profit maximization as follows:

$$\frac{d\pi}{d\theta} = \frac{\partial\pi}{\partial T}\frac{dT}{d\theta} + \frac{\partial\pi}{\partial\theta} = p_\theta^* y^* + p_\theta x - V_\theta = 0\,. \quad (9)$$

where $dT/d\theta = (\partial T/\partial y^*)(\partial y^*/\partial\theta) + (\partial T/\partial\theta) = p_\theta^* y^*$.

From (9), we can derive the optimal product innovation level θ^N under the no PI regime. We shall compare θ^N with that under the PI regime to be examined in the following section.

3. Product Innovation with Parallel Imports

Under the PI regime, the foreign distributor can engage in PI if it is profitable. All the assumptions and model settings are the same as those in the previous section, except that the foreign distributor now sells part of the goods acquired from the manufacturer back to the home market and competes with the manufacturer in Cournot fashion. Thus, the profit functions for the manufacturer and the foreign distributor can be respectively written as follows:

$$\pi(x, x^*, y^*; w, T, \theta) = \left[p\left(x + x^*, \theta\right) - c\right]x + (w - c)\left[x^* + y^*\right] + T - V(\theta), \quad (10)$$

$$\pi^*(x, x^*, y^*; w, T, \theta) = \left[p\left(Q, \theta\right) - w\right]x^* + \left[p^*\left(y^*, \theta\right) - w\right]y^* - T\,, \quad (11)$$

where $x*$ as defined before is the goods sold back to the home market by the foreign distributor. By differentiating (10) with respect to x and (11) with respect to

$x*$ and $y*$, we can derive the first-order conditions for profit maximization as follows:

$$\pi_x = p - c + p_x x = 0, \tag{12}$$

$$\pi^*_{x^*} = p - w + p_{x*} x^* = 0. \tag{13}$$

$$\pi^*_{y^*} = p^* - w + p^*_{y*} y^* = 0. \tag{14}$$

The three equations can be divided into two segments. By solving (12) and (13), we can derive the equilibrium outputs and price of the home market while by solving (13) alone, we can derive the counterparts of the foreign market. The second-order and the stability conditions are all satisfied as $\pi^*_{x^*x^*} = 2p_{x^*} < 0$, $\pi_{xx} = 2p_x < 0$, and $\pi_{xx}\pi^*_{x^*x^*} - \pi_{xx^*}\pi^*_{x^*x} > 0$, given the linear demand and constant marginal cost assumptions. From the above first-order conditions, we can derive the comparative static effects as follows:

$$x_\theta = -p_\theta/3p_x > 0,\ x^*_\theta = -p_\theta/3p_x > 0, \text{ and } y^*_\theta = -p^*_\theta/2p^*_{y*} > 0\,. \tag{15}$$

$$x_w = -1/3p_x > 0,\ x^*_w = 2/3p_x < 0, \text{ and } y^*_w = 1/2p^*_{y*} < 0\,. \tag{16}$$

The intuition for the above results is quite straightforward. Each firm's equilibrium output increases with product innovation and its rival's marginal cost (*i.e.*, the wholesale price) but decreases with its own marginal cost.

By substituting the equilibrium into (10), the profit function of the manufacturer for the second-stage game can be expressed as follows:

$$\underset{w}{\text{Max}}\ \pi(x(w), x^*(w), y^*(w), w, T; \theta)$$

$$= (p(Q(w)) - c)x(w) + (w - c)\left[x^*(w) + y^*(w)\right] + T - V(\theta)\,. \tag{17}$$

By differentiating (17) with respect to w and applying the envelope theorem, we can derive the first-order condition for profit maximization of the manufacturer as follows:

$$\frac{d\pi}{dw} = \frac{\partial\pi}{\partial x^*}\frac{\partial x^*}{\partial w} + \frac{\partial\pi}{\partial y^*}\frac{\partial y^*}{\partial w} + \frac{\partial\pi}{\partial w} + \frac{\partial\pi}{\partial T}\frac{dT}{dw}$$

$$= p_x x^*_w x + (w - c)\left[y^*_w + x^*_w\right] + p_x x_w x^* = 0\,. \tag{18}$$

The second-order condition is satisfied as $\pi_{ww} = x^*_w + y^*_w + 2p' x_w x^*_w < 0$.

By utilizing (16), we can derive from (18) that $w(\theta) = -2p_x(2x - x^*)/5 + c$, which is necessarily greater than the marginal cost of the manufacturer as $x > x^*$. By substituting $w(\theta)$ into T, we can derive that the optimal fee as $T = T(\theta)$.

By totally differentiating (18), we can derive the comparative static effect as follows: $w_\theta = -\pi_{w\theta}/\pi_{ww} > 0$, where $\pi_{w\theta} = -p_\theta/9p_x > 0$. This result stands in line with the finding in Matteucci and Reverberi (2014) but runs against that in Li and Maskus (2006). It implies that the wholesale price definitely increases with product innovation under the PI regime. This result is also in sharp contrast to the one derived under the no PI regime. If there is no PI, the wholesale price as we concluded in Proposition 1 is always set at the marginal cost of the manufacturer and is not affected by product innovation. Contrarily, the wholesale price necessarily increases with product innovation if PI is allowed. This is because product innovation shifts the demands outwards, increasing the volume of PI. This hurts the profits of the manufacturer from the home market, giving the manufacturer an incentive to raise the wholesale price to mitigate PI from the foreign distributor. Given the above discussions, we can construct the proposition as follows.

Proposition 2. If the manufacturer adopts two-part tariff pricing and parallel imports are permitted, the wholesale price is necessarily higher than its marginal cost and is positively related to the product innovation level.

We can now move to the first-stage of the game to solve the optimal innovation level of the manufacturer. The profit function of the manufacture firm is defined as follows:

$$\underset{\theta}{\text{Max}} \;\; \pi(x(w(\theta),\theta), x^*(w(\theta),\theta), y^*(w(\theta),\theta), w(\theta), T(w(\theta),\theta), \theta; t)$$

$$=\left[p(x+x^*)-c\right]x+\left[w(\theta)-c\right]\left[x^*+y^*\right]+T(\theta)-V(\theta)\,. \tag{19}$$

By differentiating the above equation with respect to θ, applying the envelope theorem and utilizing (15), (16) and $w_\theta=-\pi_{w\theta}/\pi_{ww}$, we can derive the first-order condition for profit maximization as follows:

$$\frac{d\pi}{d\theta}=\frac{\partial\pi}{\partial w}\frac{\partial w}{\partial\theta}+\frac{\partial\pi}{\partial y^*}\frac{\partial y^*}{\partial\theta}+\frac{\partial\pi}{\partial x^*}\frac{\partial x^*}{\partial\theta}+\frac{\partial\pi}{\partial T}\frac{\partial T}{\partial x}\frac{\partial x}{\partial\theta}+\frac{\partial\pi}{\partial T}\frac{\partial T}{\partial\theta}+\frac{\partial\pi}{\partial\theta}$$

$$=(w-c)\left[x_\theta^*+y_\theta^*\right]+p_{x^*}x_\theta^*x+p_xx_\theta x^*+p_\theta^*y^*+p_\theta\left[x+x^*\right]-V_\theta$$

$$=p_\theta\left[\frac{-(w-c)}{3p_x}+\frac{2(x+x^*)}{3}\right]+p_\theta^*\left[\frac{-(w-c)}{2p_{y*}^*}+y^*\right]-V_\theta=0\,. \tag{20}$$

The second-order condition for the profit maximization requires that $\pi_{\theta\theta}=p_\theta\left[2p_\theta-w_\theta\right]/9p_x-p_\theta^{*2}/2p_{y*}^*-V_{\theta\theta}<0$ which is assumed to be satisfied. From (20), we can derive the optimal innovation under the PI regime.

We now compare the product innovation levels under the two regimes. By evaluating (20) at the product innovation level derived under the no-PI regime (i.e., (9)), we obtain:

$$\left.\frac{d\pi}{d\theta}\right|_{\theta=\theta^N}=p_\theta\left[\frac{-(w-c)}{3p_x}+\frac{2(x+x^*)}{3}-x^N\right]+p_\theta^*\left[\frac{-(w-c)}{2p_{y*}^*}+y^*-y^{*N}\right] \tag{21}$$

If we further assume that the inverse demand functions of the home and the foreign markets take respectively the following linear forms as $p=a(\theta)-b(x+x^*)$ and $p^*=a^*(\theta)-b^*y^*$, we can derive that

$$\left.\frac{d\pi}{d\theta}\right|_{\theta=\theta^N}=\frac{-p_\theta}{2(4b^*+9b)}\left[a(\theta)-c\right]<0.$$

It shows that PI definitely decreases the product innovation of the manufacturer. The intuition of this result is as follows. The manufacturer is capable of making monopoly rent from both markets if there is no PI. This is the first-best solution from the viewpoint of the manufacturer. With PI, two effects take place. First, the domestic market becomes duopolistic. Second, in order to lower the competition from the distributor, the manufacturer tends to raise its wholesale price which deviates from its first-best solution. Both of the effects reduce the profits of the manufacturer, causing a lower incentive to engage in product innovation. Therefore, we can arrive at the proposition as follows.

Proposition 3. If the manufacturer adopts two-part tariff pricing, parallel import definitely reduces product innovation of the manufacturer.

This result is in sharp contrast to the finding by Matteucci and Reverberi (2014). They assume the manufacturer adopts one-part tariff pricing and conclude that PI likely raises its product innovation. It is also worth mentioning that this result is similar to the finding of Li and Maskus (2006). They assume the manufacturer adopts, like that in our model, two-part tariff pricing and conclude that the openness of parallel trade inhibits the manufacturer's *process* innovation.

4. Product Innovation and Market Structures

In the existing literature on PI, it is commonly assumed that there are only two firms-one manufacturer and one distributor- in the models. This assumption simplifies the analysis, but makes the model less general and realistic. In this section, we shall relax this assumption to investigate the effect of PI on the manufacturer's product innovation if the domestic or the foreign market becomes oligopolistic. We will first explore the case in which there are many rivals in the domestic market followed by the case with multiple distributors in the foreign market.

4.1 The existence of domestic rivals

All the model settings are the same as those in the previous sections except that now there are n homogeneous rivals in the domestic market whose product innovation is predetermined and whose outputs are sold to the home market only. The inverse demand functions for the home and the foreign markets under the PI regime are $p = a(\theta) - x - \sum_{i=1}^{n} x^i - x^*$ and $p^* = p^*\left(y^*, \theta\right) = a^*(\theta) - y^*$, and $x^* = 0$ if there is no PI. We shall first investigate the equilibrium under the no PI regime followed by that under the PI regime. Given this specification, the profit functions of the manufacturer, the domestic rival firms and the foreign distributor under the no PI regime can be respectively expressed as follows:

$$\pi(x, x^i; w, T, \theta) = \left[p\left(Q, \theta\right) - c \right] x + (w - c) y^* + T - V(\theta),$$

$$\pi^i(x, x^i; \theta) = \left[p\left(Q, \theta\right) - c \right] x^i, \quad \text{for } i = 1, \ldots, n.$$

$$\pi^*(y^*; w, T, \theta) = \left[p^*\left(y^*, \theta\right) - w \right] y^* - T.$$

where x^i denotes the output of the *i*th domestic rival.

The first-order conditions for profit maximization for the third-stage game are derivable as follows:

$$\pi_x = p - c + p_x x = 0,$$

$$\pi^i_{x^i} = p - c + p_{x^i} x^i = 0, \quad i = 1, \ldots, n,$$

$$\pi^*_{y^*} = p^* - w + p^*_{y*} y^* = 0.$$

The profit function of the manufacturer in the second-stage game can be expressed as follows:

$$\underset{w}{\text{Max}} \;\; \pi(x, x^i, y^*(w), w, T; \theta) = (p(Q)) - c)x + (w - c) y^*(w) + T - V(\theta),$$

subject to $T = (p^*(y^*(w)) - w) y^*(w).$

Proceeding as before, we can derive the optimal wholesale price as $w = c$. The economic explanation is as follows. In the absence of PI, the markets in the two countries are independent. As a result, the equilibrium in the foreign market is that of monopoly, not affected by the existence of the domestic rivals. It is optimal for the manufacturer to set the wholesale price equal to the marginal cost and to extract the monopoly rent from the foreign distributor via the fixed fee.

Making use of these results, we can rewrite the profit function of the manufacturer for the first-stage game as follows:

$$\underset{\theta}{\text{Max}} \;\; \pi(x(\theta), x^i(\theta), y^*(\theta), w, T(w,\theta), \theta)$$

$$= (p(Q(\theta),\theta) - c)x(\theta) + (p^*(y^*(\theta),\theta) - c)y^*(\theta) - V(\theta).$$

By differentiating the above profit function with respect to θ and applying the envelope theorem, we can derive the first-order condition for profit maximization as follows:

$$\frac{d\pi}{d\theta} = n\frac{\partial\pi}{\partial x^i}\frac{\partial x^i}{\partial\theta} + \frac{\partial\pi}{\partial y^*}\frac{\partial y^*}{\partial\theta} + \frac{\partial\pi}{\partial\theta} = np_x x^i_\theta x + p^*_\theta y^* + p_\theta x - V_\theta = 0. \tag{22}$$

We now turn to the PI regime. In the third stage, the profit functions for the manufacturer, the domestic rival firms and the foreign distributor can be respectively expressed as follows:

$$\pi(x, x^i, x^*, y^*; w, T, \theta) = \left[p(Q,\theta) - c\right]x + (w-c)\left[x^* + y^*\right] + T - V(\theta),$$

$$\pi^i(x, x^i, x^*; w, T, \theta) = \left[p(Q,\theta) - c\right]x^i, \quad i = 1, \dots, n.$$

$$\pi^*(x, x^i, x^*, y^*; w, T, \theta) = \left[p(Q,\theta) - w\right]x^* + \left[p^*(y^*,\theta) - w\right]y^* - T.$$

The first-order conditions for profit maximization are as follows:

$$\pi_x = p - c + p_x x = 0,$$

$$\pi^i_{x^i} = p - c + p_{x^I} x^i = 0, \quad i = 1, \dots, n,$$

$$\pi^*_{x^*} = p - w + p_{x^*} x^* = 0,$$

$$\pi^*_{y^*} = p^* - w + p^*_{y^*} y^* = 0.$$

Proceeding as before, we can derive the optimal wholesale price as follows: $w = 2\left[2x(c) - (n+1)x^*(w)\right]/(3n+7) + c$. It shows that the optimal wholesale price is equal to (lower than) c if $n = (>) 1$.[5] Thus, we can establish the proposition as follows.

Proposition 4. If the manufacturer encounters local rivals in the home market, parallel import reduces the wholesale price of the manufacturer. If there is only one local rival, PI has no effect on the wholesale price.

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[5] This is derived by evaluating the first derivative of the manufacturer's profit function at $w = c$: $d\pi/dw\,|_{w=c} = (1-n)x/(n+3) \le 0$, if n ≥ 1.

The intuition behind this result is quite straightforward. If there are local rivals in the home market, the manufacturer can use PI to increase its effective market share (i.e., its own sale plus the sale via the distributor) and to move the output equilibrium in the home market from Cournot to what would be the Stackelberg leader equilibrium with the manufacturer as the leader. If there is only one local rival, the optimal wholesale price is equal to the marginal cost as at this price, the effective output of the manufacturer is identical to that of the Stackelberg leader.[6] If there are more than one local rival, the Stackelberg leader's output is higher. It implies that the manufacturer should set a lower wholesale price (i.e., lower than the marginal cost).

In the first stage, the manufacturer faces the following maximization problem:

$$\underset{\theta}{\text{Max}}\ \ \pi(x(w(\theta),\theta), x^i(w(\theta),\theta), y^*(w(\theta),\theta), x^*(w(\theta),\theta), w(\theta), T(w(\theta),\theta),\theta)$$

$$=\left[p(Q(w(\theta),\theta)-c\right]x(w(\theta),\theta)+\left[w(\theta)-c\right]\left[y^*(w(\theta),\theta)+x^*(w(\theta),\theta)\right]+T(w(\theta),\theta)-V(\theta)$$

By differentiating the above equation with respect to θ, and utilizing the equilibrium in the last two stages and the envelope theorem, we can derive the first-order condition for profit maximization of the manufacturer as follows:

$$\frac{d\pi}{d\theta}=\frac{\partial\pi}{\partial w}\frac{\partial w}{\partial\theta}+n\frac{\partial\pi}{\partial x^i}\frac{\partial x^i}{\partial\theta}+\frac{\partial\pi}{\partial y^*}\frac{\partial y^*}{\partial\theta}+\frac{\partial\pi}{\partial x^*}\frac{\partial x^*}{\partial\theta}+\frac{\partial\pi}{\partial T}\left(\frac{\partial T}{\partial x}\frac{\partial x}{\partial\theta}+n\frac{\partial T}{\partial x^i}\frac{\partial x^i}{\partial\theta}+\frac{\partial T}{\partial\theta}\right)+\frac{\partial\pi}{\partial\theta}$$

$$=(w-c)\left[y^*_\theta+x^*_\theta\right]+p'\left[x^*_\theta x+x_\theta x^*\right]+np'x^i_\theta\left[x+x^*\right]+p^*_\theta y^*+p_\theta(x+x^*)-V_\theta$$

$$=p_\theta\left[\frac{(w-c)}{(n+3)}+\frac{2(x+x^*)}{(n+3)}\right]+p^*_\theta\left[\frac{(w-c)}{2}+y^*\right]-V_\theta=0\,.$$

By evaluating the above equation at the product quality level derived under the no PI regime (i.e., (22)), we can derive that

$$\left.\frac{d\pi}{d\theta}\right|_{\theta=\theta^N}=\frac{2p_\theta}{(n+1)(n+2)}\left[(n+2)x^*-(n+1)x^N\right]$$

$$=\frac{2p_\theta\left[a(\theta)-c\right](2n^2+2n-1)}{(n+2)^2(n^2+10n+13)}>0\,.$$

The above equation shows that the parallel import necessarily raises the product

[6] If there is only one local rival in the domestic market, the manufacturer will set $w=c$ and its effective output is $x+x^*=-2(p-c)/p_x$ which is exactly the output of the Stackelberg leader under the no PI regime.

innovation of the manufacturer if there are local rivals in the domestic market (i.e., $n \geq 1$). This result is of some interest as it is in sharp contrast to that with no domestic rivals. The intuition is as follows. If there are local rivals in the domestic market, PI increases the market share of the manufacturer, raising its marginal benefit from the innovation investment. Consequently, PI increases the R&D investment of the manufacturer. Given the above result, we can build the proposition as follows.

Proposition 5. If there are local rivals in the domestic market, parallel import stimulates product innovation of the manufacturer.

4.2 Multiple Distributors

We have so far assumed that there is only one distributor in the foreign market. In this sub-section, we shall discuss the case in which the manufacturer can engage in multiple authorizations.[7] All the assumptions and model setups are similar to those in Section 3, except that the manufacturer now can authorize its product to more than one distributor. In addition, for simplicity, we assume that all the distributors are symmetric and can engage in PI if it is permitted by the home country. The inverse demand functions for country H and country F under the PI regime are $p = a(\theta) - x - \sum_{i=1}^{n} x^{*i}$, $p^* = a^*(\theta) - \sum_{i=1}^{n} y^{*i}$, and $\sum_{i=1}^{n} x^{*i} = 0$ if there is no PI. Again, we shall first investigate the equilibrium under the no PI regime followed by that under the PI regime.

At stage three, the profit functions of the manufacturer and the distributors under the no PI regime can be respectively expressed as follows:

$$\pi(x, y^{*i}; w, T, \theta) = \left[p\left(x, \theta\right) - c \right] x + (w - c) \sum_{i=1}^{n} y^* + nT - V(\theta),$$

$$\pi^*(y^{*i}; w, T, \theta) = \left[p^*\left(Q^*, \theta\right) - w \right] y^{*i} - T, \qquad i = 1, \ldots, n$$

The third stage game is similar to that in Section 3. Proceeding as before, we can derive the optimal wholesale price as follows: $w^N = -(n-1) p^*_{y*} y^* + c$ with $w^N_n > 0$.

[7] Multiple authorizations can be found in industries such as books, CDs, video games, cars and ice cream.

It implies that the optimal wholesale price increases with the number of the distributors. By substituting w^N into the distributors' first order conditions in the third stage and by symmetry, we can derive that $\pi^*_{y^*} = p^* - c + p^*_{y*} n y^* = 0$. By comparing this equation with (4), in which $w = c$, it is found that the total output sold to the foreign market is not affected by the number of distributors. Hence, even with multiple distributors in the foreign market, the manufacturer can still earn the monopoly profits from both markets under the no PI regime. Of course, this result hinges on the assumption that the manufacturer can charge two-part tariff pricing when selling its output to the foreign distributors.

Based on these results, we can define the profit function of the manufacturer in the first-stage game, as follows:

$$\underset{\theta}{\mathrm{Max}}\ \pi(x(\theta), y^*(\theta), w(\theta), T(w,\theta), \theta)$$

$$= (p(x(\theta),\theta) - c)x(\theta) + (p^*(y^*(\theta),\theta) - c)y^*(\theta) - V(\theta).$$

The first-order condition for profit maximization is derivable as follows:

$$\frac{d\pi}{d\theta} = p^*_\theta y^* + p_\theta x - V_\theta = \frac{\left[a^*(\theta) - c\right] p^*_\theta + \left[a(\theta) - c\right] p_\theta}{2} - V_\theta = 0 .$$

By solving the above equation, we can derive the optimal R&D of the manufacturer, which is identical to that solved by (9). Thus, we can arrive at the proposition as follows.

Proposition 6. With no PI, the optimal wholesale price increases with the number of authorized distributors in the foreign market. However, the equilibrium outputs of the two markets, the optimal product R&D and the profits of the manufacturer are not affected by the number of the authorized distributors.

We now discuss the equilibrium under the PI regime. In the third stage, the profit functions of the manufacturer and the distributors can be expressed respectively as follows:

$$\pi(x, x^{*i}, y^{*i}; w, T, \theta) = \left[p\left(Q,\theta\right) - c\right]x + (w-c)\left[\sum_{i=1}^{n} y^{*i} + \sum_{i=1}^{n} x^{*i}\right] + nT - V(\theta),$$

$$\pi^*(y^{*i}; w, T, \theta) = \left[p\left(Q,\theta\right) - w\right]x^{*i} + \left[p^*\left(Q^*,\theta\right) - w\right]y^{*i} - T,\ i = 1,\dots,n .$$

The third stage game is similar to that in Section 3. Proceeding as before, we can derive the optimal wholesale price under the PI regime as follows:

$$w = \frac{2(n+1)x-(2-n)(n+1)x^{*}-(n+2)(1-n)y^{*}}{(3n+4)}+c\,.$$

We can further derive that $w_{\theta}>0$. That is to say, the wholesale price increases with product innovation. By utilizing the results from the previous stages of the game, we can define the objective function of the manufacturer for the first stage game as follows:

$$\underset{\theta}{\text{Max}}\;\; \pi(x(w(\theta),\theta), y^{*}(w(\theta),\theta), x^{*}(w(\theta),\theta), w(\theta), T(w(\theta),\theta),\theta)$$

$$=\left[p-c\right]x(w(\theta),\theta)+n\left[w(\theta)-c\right]\left[y^{*}(w(\theta),\theta)+x^{*}(w(\theta),\theta)\right]+nT(w(\theta),\theta)-V(\theta).$$

By differentiating the above equation with respect to θ and using envelop theorem, we can derive the first-order condition for profit maximization as follows.

$$\frac{d\pi}{d\theta}=\frac{\partial\pi}{\partial w}\frac{\partial w}{\partial\theta}+\frac{\partial\pi}{\partial x^{*}}\frac{\partial x^{*}}{\partial\theta}+\frac{\partial\pi}{\partial y^{*}}\frac{\partial y^{*}}{\partial\theta}+n\frac{\partial\pi}{\partial T}\frac{dT}{d\theta}+\frac{\partial\pi}{\partial\theta}$$

$$=np_{x}x_{\theta}^{*}x+n(w-c)\left[y_{\theta}^{*}+x_{\theta}^{*}\right]+n\left[p_{x}x_{\theta}x^{*}+(n-1)(p_{x}x_{\theta}^{*}x^{*}+p_{y^{*}}^{*}y_{\theta}^{*}y^{*})+p_{\theta}x^{*}+p_{\theta}^{*}y^{*}\right]+p_{\theta}x-V_{\theta}$$

$$=p_{\theta}\left[\frac{(w-c)n}{(n+2)}+\frac{2x}{(n+2)}+\frac{2nx^{*}}{(n+2)}\right]+np_{\theta}^{*}\left[\frac{(w-c)}{(n+1)}+\frac{2y^{*}}{(n+1)}\right]-V_{\theta}=0.$$

By evaluating the above first-order condition at the product quality level derived under the no-PI regime (i.e., (22)), we can obtain:

$$\left.\frac{d\pi}{d\theta}\right|_{\theta=\theta^{N}}=p_{\theta}\left[\frac{(w-c)n}{(n+2)}+\frac{2x}{(n+2)}+\frac{2nx^{*}}{(n+2)}-x^{N}\right]+np_{\theta}^{*}\left[\frac{(w-c)}{(n+1)}+\frac{2y^{*}}{(n+1)}-y^{*N}\right]$$

$$=\frac{\left[a(\theta)n+a^{*}(\theta)(1-n)-c\right]\left[(n-1)p_{\theta}^{*}-np_{\theta}\right]}{2(2n^{2}+6n+5)}\;\begin{matrix}>\\=\\<\end{matrix}\;0\quad\text{if}\quad(n-1)p_{\theta}^{*}\begin{matrix}>\\=\\<\end{matrix}np_{\theta}.$$ [8]

This result shows that PI has an ambiguous effect on the manufacturer's product innovation. The intuition is as follows. PI affects the manufacturer's product R&D in two ways. First, there is a negative effect, taking place in the domestic market. With no PI, the manufacturer earns a monopoly profit in the domestic market. When PI is

[8] Note that the first bracket of the numerator is positive if PI is positive (i.e., $x^{*}>0$).

permitted, the domestic market becomes oligopolistic which discourages product innovation of the manufacturer. Furthermore, there is a positive effect taking place in the foreign market. The manufacturer has an incentive to do more product R&D as it can raise the wholesale price, mitigating the amount of PI. The optimal product R&D can increase or decrease with PI, depending on the magnitudes of the two effects. Thus, we can arrive at the proposition as follows.

Proposition 7. If the manufacturer authorizes its product to multiple distributors in the foreign country, parallel imports may increase or decrease its product innovation, depending on the consumers' quality valuations in the two countries.

5. Conclusions

In the past two decades, more and more countries engage in deregulation on PI. Their main concern is that PI is pro-competition and thus beneficial to the domestic welfare. However, many studies have argued that permitting PI could be socially undesirable as it discourages the R&D incentive of the domestic manufacturer.

In this paper, we set out a two-country model to examine how PI affects product innovation of the domestic manufacturer if it adopts two-part tariff pricing when selling its output to foreign distributors. We also investigate the cases in which the manufacturer faces rivals in its domestic market and the manufacturer can authorize its product to multiple distributors in the foreign market. It is found that product innovation of the manufacturer is definitely stifled by PI if the domestic market is monopolized by the manufacturer. Contrarily, if there are rivals in the domestic market, permitting PI necessarily enhances the production innovation. Finally, if the manufacturer authorizes its product to multiple distributors in the foreign country, PI may increase or decrease product innovation depending on the consumers' preferences for product innovation in the two countries.

This paper has assumed that the manufacturer is the only firm which can carry out R&D investment. One possible extension is to allow local rivals or distributors to also engage in R&D. Furthermore, this paper does not consider technology spillover and intellectual property right protection *a la* Mathew and Mukherjee (2014) and Yang (2013). It is of some interest to examine effects of the two factors on parallel imports and the manufacturer's innovation incentive. These extensions are reserved for our future study.

Acknowledgements

This paper was presented at the IREF workshop on "Trade, Resources and Growth" organized by Institute of Economics, Academia Sinica and College of Business, Feng Chia University on May 22, 2014. We would like to thank the participants and in particular Shin-Kun Peng for helpful comments and suggestions.

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