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Welfare Effects of Tariffication on Parallel Trade

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WTO has long called for converting non-tariff barriers into tariffs. This is called tariffication. Utilizing a two-country model, this paper examines the welfare effect of tariffication on parallel trade. We also compare the R&D levels of the manufacturer before and after tariffication. It is found that tariffication is socially undesirable for the domestic country no matter whether the manufacturer adopts one-part or two-part tariff pricing. But the effects of pricing on the manufacturer's R&D are very different. If the domestic manufacturer adopts two-part (one-part) tariff pricing, tariffication discourages (has no effect on) the R&D investment of the domestic manufacturer. This implies that domestic welfare worsens in the long run under two-part tariff pricing.

Keywords: tariffication, parallel imports, R&D, social welfare
JEL classification: F12, F13, L11, L13

1 Introduction

Non-tariff barriers (NTBs) were prevalent before 1990s until WTO called for its member countries to convert NTBs into tariffs, which is called tariffication. The main reason is that tariffs are usually less restrictive than NTBs.

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The existing literature has demonstrated that tariffication ameliorates both domestic and world welfare levels (Yang, 1997; Lee and Lee, 2009; Hwang, Peng, and Wu, 2013).

On the other hand, parallel importation (PI) has been popular and observed in many products since 1980s. Ganslandt and Maskus (2004) show that EU loses approximate $3 billion sales per year owing to the occurrence of PI. 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 resold online and in discount stores without violating U.S. copyright law.[1] 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.[2] The issue of PI has been debated extensively in the literature.

It seems that the effect of PI is a force to be reckoned with and should not be overlooked when considering the welfare effect of tariffication. For example, the US government imposes tariffs on the products resold from aboard via internet. Besides, there are numerous American-made cars sold back from Canada and Mexico every year. Cars imported to the US were subject to quota constraints but they are now replaced by tariffs.[3] Nevertheless, all the existing studies focus only on PI policies, ignoring the importance of tariffication.

Given the prevalence of PI and the importance of tariffication, this paper investigates the short-run and long-run welfare effects of tariffication on PI. We will construct a duopoly model in which a domestic manufacturer sells its product directly to the domestic market and meanwhile sells the same product to a foreign retailer. The manufacturer adopts either two-part tariff pricing or one-part tariff pricing when selling its product to the foreign retailer. The retailer which is a monopolist in the foreign market can also sell the product back to the domestic market (i.e., PI occurs) and compete *a la*

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

[2] PI is also legal in Japan, Austria and New Zealand. EU permits PI within only its member countries according to the doctrine of regional exhaustion.

[3] See the details from the following link: http://www.examiner.com/article/considering-importing-a-car-into-the-u-s-you-may-want-to-read-this-first.

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Cournot fashion with the manufacturer in the domestic market.[4] We first examine the equilibrium under the quota regime and then convert it into an import-volume-equivalent tariff to explore the welfare effect of tariffication. In addition, we also make an extension by allowing the domestic manufacturer to conduct cost-reducing R&D to investigate the welfare effect of tariffication in the long run.

This paper is closely related to two strands of studies in international trade: tariffication and parallel imports. The welfare effect of tariffication has been debated extensively after URAA held in 1995 (see, for example, Yang (1997), Jørgensen and Schröder (2007), Lee and Lee (2009), Hwang, Peng, and Wu (2013)). However, these papers all ignore the existence of PI which is a popular economic activity in international trade, and also overlook the R&D incentive of firms. The issue of PI and its effect on R&D has drawn considerable attention and been debated extensively in the literature (see, for example, Maskus and Chen (2004), Chen and Maskus (2005), Li and Maskus (2006), Li (2006), Kao and Peng (2009), Mueller-Langer (2012), Matteucci and Reverberi (2014), among others). However, this strand of literature mainly focuses on optimal PI policies. By contrast, our paper evaluates the welfare level under a given amount of PI and then compares this welfare level with that under an import-volume-equivalent tariff. Moreover, most of the PI papers mentioned above assume that the manufacturer adopts two-part tariff pricing when selling its product to the foreign retailer.[5] We consider both two-part tariff pricing and one-part tariff pricing.

Similar to settings in the above mentioned literature, our model deals with products with a single manufacturer. Our paper contributes to the literature in several ways. First, it is the first paper to consider the welfare effect of tariffication on PI. Second, the literature on PI has mainly focused on optimal quantitative restrictions and failed to compare it with tariff restrictions. In this paper, we shall investigate the welfare effect when the domestic government imposes an import-volume-equivalent tariff. Third, the literature on tariffication has mainly taken the technology of the firms as given. In this paper, we allow the domestic manufacturer to conduct cost-reducing R&D so that we can explore the long-run welfare effect of tariffication on

[4]This kind of setup is very common in the PI literature; see for examples, Maskus and Chen (2004), Chen and Maskus (2005), Li and Maskus (2006), Mueller-Langer (2012), and Matteucci and Reverberi (2014), among others.

[5]Kao and Peng (2009) and Matteucci and Reverberi (2014) are exceptions.

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PI.

The reminder of this paper is organized as follows. Section 2 examines the welfare effect of tariffication under two-part tariff pricing. Section 3 studies the impact of tariffication on the manufacturer's R&D investment and its resulting welfare. Section 4 investigates the welfare effect of tariffication when the manufacturer adopts one-part tariff pricing. Section 5 concludes the paper.

2 Two-Part Tariff Pricing

Assume there are two countries, a home country, H, and a foreign country, F. In the home country, there is a manufacturer who sells x units of its product to its own (i.e., the domestic) market and $y + y^*$ to a distributor in country F who then sells y^* units to its own (i.e., the foreign) market and also sells y units back to the home country through PI if it is profitable to do so.[6] It implies that PI occurs if the trade cost to sell back to the home market is not high. For simplicity, we shall assume that the trade cost is nil. The variables with asterisks indicate that they are associated with the foreign country.

We assume that the inverse demand functions in countries H and F are respectively $p = p(x + y)$ and $p^* = p^*(y^*)$ with $p_x = p_y = p^*_{y^*} < 0$ and $p_{xx} = p_{xy} = p_{yy} = p^*_{y^*y^*} = 0$. Subscripts are used to denote derivatives.[7] We further assume that the manufacturer adopts two-part tariff pricing (a per-unit wholesale price plus a fixed fee) when selling the product to the distributor.[8] The host country imposes either a quota or an import-volume-equivalent tariff on the parallel imports from the foreign distributor.

The game in question comprises two stages. In the first stage, given the quota on PI, the manufacturer determines its optimal two-part tariffs. In the second stage, the manufacturer and the distributor choose their sale(s) in the two markets. The sub-game perfect Nash equilibrium will be solved via backward induction. In what follows, we shall first investigate the case in

[6] We assume that the manufacturer cannot distinguish PI from the output sold in the foreign market and charge discriminatory prices. Thus, it is not possible for the manufacturer to stop PI.

[7] While evaluating the effects of tariffication, we need to compare profits of the manufacturer and social welfare of the domestic and the foreign country between the quota and the tariff regimes. The linearity assumption is made for the rest of the paper to get unambiguous results. This is a limitation of the study.

[8] The one-part tariff case will be discussed in Section 4.

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which the government of the domestic country implements a quota on the PI followed by a tariff on the PI.

2.1 The Quota Regime

Under the quota regime, the profit functions of the manufacturer and the distributor can be expressed respectively as follows:

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

$$\pi^{*}\left(y^{*};w\right)=(p-w)\bar{y}+\left(p^{*}-w\right)y^{*}-T. \tag{2}$$

where w is the per-unit wholesale price and T is the fixed fee charged by the manufacturer when selling its product to the distributor, and $\bar{y}$ represents the quota on the PI set by the domestic government.[9] Note that the distributor is subject to a quota, not being able to freely choose the volume of PI (i.e., $\bar{y}$). By differentiating (1) with respect to x and (2) respect to y^{*}, we can derive the following two first-order conditions for the second stage of the game as follows:

$$\frac{d\pi}{dx}=p-c+p_{x}x=0, \tag{3}$$

$$\frac{d\pi^{*}}{dy^{*}}=p^{*}-w+p_{y^{*}}^{*}y^{*}=0. \tag{4}$$

The second-order conditions are satisfied, given the linear demands and the constant marginal costs. By solving (3) and (4) respectively, we can derive the equilibrium outputs of the manufacturer selling to the domestic market and the sales of the foreign distributor to the foreign market as follows: $x=x(\bar{y})$ and $y^{*}=y^{*}(w)$. In addition, by (3) and (4), we can derive the comparative static effects as follows: $x_{\bar{y}}=-1/2<0$, $x_{c}=1/(2p_{x})<0$ and, $y_{w}^{*}=1/(2p_{y^{*}}^{*})<0$. That is, the output sold by the manufacturer to the market in country H decreases with $\bar{y}$ and c, whereas the output sold by the distributor in country F deceases in w.

By substituting the equilibrium outputs into (1) and (2), we can rewrite the profit function of the manufacturer for the first-stage game as follows:

$$\max_{w}\ \pi=(p-c)x+(w-c)\left(\bar{y}+y^{*}(w)\right)+T\left(y^{*}(w),w\right).$$

[9] A quota is effective if the marginal revenue of PI is higher than the marginal cost of the exporting firm. We shall assume this to be the case throughout the analysis.

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By employing two-part tariff pricing, the manufacturer can extract the entire rent of the distributor.[10] Hence, for any given unit price w, the optimal fixed fee, T, is set equal to the entire rent of the distributor, i.e., $T = (p - w)\bar{y} + (p^* - w)y^*$. By substituting T into the above profit function, we can rewrite the manufacturer's profit function as follows:

$$\max_{w} \ \pi\left(y^*(w)\right) = (p - c)\,(x + \bar{y}) + \left(p^* - c\right) y^*. \tag{5}$$

By differentiating (5) with respect to w and using (4), we can derive the first-order condition for profit maximization of the manufacturer as follows:

$$\frac{d\pi}{dw} = \frac{\partial \pi}{\partial y^*}\frac{\partial y^*}{\partial w} = \left(p^* - c + p^*_{y^*} y\right) y^*_w = (w - c) y^*_w = 0. \tag{6}$$

From (6), we can derive the optimal wholesale price under the quota regime, w^q, as follows:

$$w^q = c.$$

As expected, since there is only one manufacturer, it will set the wholesale price equal to its marginal cost and uses the fixed fee to extract all the rent of the distributor from both the domestic and the foreign market.[11] Therefore, we can establish the following lemma.

Lemma 1. Under the quota regime, the manufacturer, if adopting two-part tariff pricing, sets the wholesale price equal to its marginal cost and uses fixed fee to extract the entire rent from the distributor.

2.2 The Tariff Regime

In the previous subsection, we discussed the equilibrium under the quota regime. Now let us assume that country H converts its quota restriction to a tariff. Under the tariff regime, the government of the domestic country sets a tariff at which the import-volume is equivalent to that under the quota

[10] It is assumed implicitly that there are many potential distributors in the foreign country and the manufacturer chooses one of them to become the authorized distributor. This is why the manufacturer can act as a monopolist when selling its product to the distributor. That one manufacturer deals with one distributor is a common assumption in the literature on parallel imports. See, for example, Maskus and Chen (2004) and Chen and Maskus (2005).

[11] Hwang, Peng, and Shih (2014) consider the multiple manufacturer case and find that the wholesale price is lower than the marginal cost of the manufacturer.

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regime. We shall call this tariff the import-volume-equivalent tariff.[12] The profit functions of the two firms under the equivalent tariff regime can be written respectively as follows:

$$\pi(x) = (p - c)x + (w - c)\left(y + y^*\right) + T, \tag{7}$$

$$\pi^*\left(y, y^*\right) = (p - w - t)y + \left(p^* - w\right)y^* - T. \tag{8}$$

where t is the import-volume-equivalent tariff set by the domestic government.

In the second stage, the manufacturer and the distributor determine their sales in the final goods markets. By differentiation (7) with respect to x, and (8) with respect to y and y^*, we can derive the first-order conditions as follows:

$$\frac{d\pi}{dx} = p - c + p_x x = 0, \tag{9}$$

$$\frac{d\pi^*}{dy} = p - w - t + p_y y = 0, \tag{10}$$

$$\frac{d\pi^*}{dy^*} = p^* - w + p^*_{y^*} y^* = 0. \tag{11}$$

The second-order conditions and the stability condition for profit maximization are all satisfied, given the linear demands and constant marginal costs. By solving (9) and (10) simultaneously, and (11) alone, we can obtain the equilibrium sales as follows: $x(w, c)$, $y(w, c)$ and $y^*(w)$. The comparative static effects are also derivable as follows: $x_w = y_c = -1/(3p_x) > 0$, $x_c = y_w = 2/(3p_x) < 0$, and $y^*_w = 1/(2p^*_{y^*}) < 0$. By comparing the comparative static effects between the two regimes, we find that the signs

[12]As stated in the guideline of the WTO, the initially proposed method for setting tariff equivalents relies on calculating the gap between the internal (domestic) price and the external (international) price. Although it has the advantage of simplicity, this method of calculating a tariff equivalent may not always accurately reflect the level of protection under the equivalent tariff equal to that under the non-tariff barrier they replace. As a result, the agreements for tariffication give importing governments considerable latitude in their interpretation; consequently, the governments tend to interpret them in ways that benefit their domestic interests. That is, they often set their initial tariffs at very high levels while minimizing the amount by which these tariffs are to be reduced. These high tariffs are also referred to as dirty tariffication in the literature (Ingco, 1996; Ghimire and Adhikari, 2001; Swinbank, 2004).

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of the effects are the same. But for the effect of the manufacturer's marginal cost on its sales in its own market, it is more negative under the tariff regime. This is because an increase in the marginal cost causes more damages to the manufacturer if the market is duopoly (i.e., under the tariff regime) than monopoly (i.e., under the quota regime).

By substituting T and the equilibrium sales from the second stage into (7), we can derive the objective function of the manufacturer in the first stage as follows:

$$\max_{w} \ \pi\left(x(w), y(w), y^*(w)\right) = (p-c)x + (p-c-t)y + \left(p^* - c\right)y^*. \tag{12}$$

By differentiating (12) with respect to w, we can derive the first-order condition as follows:

$$\begin{aligned}\frac{d\pi}{dw} &= \frac{\partial \pi}{\partial x}\frac{dx}{dw} + \frac{\partial \pi}{\partial y}\frac{dy}{dw} + \frac{\partial \pi}{\partial y^*}\frac{dy^*}{dw} \\ &= p_x y x_w + \left(p - c - t + p_y(x+y)\right)y_w \\ &\quad + \left(p^* - c + p^*_{y^*}y^*\right)y^*_w = 0.\end{aligned} \tag{13}$$

The second-order condition is satisfied as $\pi_{ww} = 13/(18p_x) < 0$. Thus, the optimal wholesale price, w^t, can be derived from (13). By evaluating (13) at $w^q = c$, and utilizing (9), (11) and $p_x = p_y$, we can show that $d\pi/dw|_{w=w^q=c} = p_y(x_w + y_w)y - ty_w > 0$. Namely, the manufacturer charges a higher wholesale price ($w^t > w^q$) under the tariff than the quota regime.[13] Thus, we can establish the following proposition.

Proposition 1. The manufacturer, if adopting two-part tariff pricing, raises the wholesale price after tariffication.

The intuition of the above proposition is as follows. The volume of parallel imports, y, is not affected by the wholesale price under the quota regime but it is affected by the wholesale price after tariffication. This offers

[13]Note that we have assume that the manufacturer is not capable of charging discriminatory prices on y and y^*. If the manufacturer could charge an additional fee based on the re-imported quantity (y), the manufacturer would set a prohibitive fee on y to eliminate parallel trade. By doing so, the manufacturer can reach its first-best solution by making monopoly profits from both the domestic and the foreign markets under both regimes.

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the manufacturer an incentive to raise the wholesale price so as to increase the marginal cost of the distributor when engaging in parallel imports.[14]

In addition, we can derive from (13) that $w_c = 11/13 > 0$ which implies that the optimal wholesale price increases with the marginal cost of the manufacturer.

2.3 Welfare Comparison

We now move to compare the welfare levels under the two regimes. The welfare functions of the domestic country before (after) tariffication is defined as the summation of the manufacturer's profit, domestic consumer surplus and quota rent (tariff revenue).[15] The welfare of the foreign country is the summation of its consumer surplus and producer surplus. By assumption, the import volumes under the two regimes are the same, i.e., $y^t = \bar{y}$. Comparing (3) and (9), we find that the equilibrium of the domestic market remains unchanged after tariffication as the outputs supplied by the manufacture to the domestic market are the same. Therefore, consumer surplus and the profit of the manufacturer from the domestic market are not affected by tariffication. Nevertheless, the profit of the manufacturer from the foreign market necessarily decreases after tariffication as tariffication increases the wholesale price, hurting the profit of the distributor which in turn the profit of the manufacturer.[16] It implies that the welfare of the domestic country

[14]This paper assumes that parallel trade is carried out by the distributor. Nevertheless, it may also be carried out by consumers. If this is the case, the manufacturer would charge a very high wholesale price to eliminate the trade. The proof is available from the authors upon request.

[15]Quota rent is the rent a country can get when allocating a quota. The size of the rent depends on how the quota is administered; it could be done by means of auction or first-come-first-serve. For the former, the quota rent can go as high as $(p - c^*)q$ where p is the price, c^* is the marginal cost of the foreign firm and q is the quota level. For the latter, it is zero. As the quota rent is indeterminate whereas the tariff revenue is unambiguously equal to tq, the welfare ranking between the two regimes becomes ambiguous. It is common in the literature on tariff-quota equivalence to assume either tariff revenue being equal to the quota rent or exclude them from the welfare function. See for example Fung (1989), Matschke (2003), Chiou, Hwang, and Lin (2005), Hwang, Kao, and Peng (2011) and Hwang, Peng, and Wu (2013). In our model, it is assumed that they are the same.

[16]Under two-part tariff pricing, the manufacturer's profit from the foreign market is maximized if setting the wholesale price equal to the marginal cost and then using a fixed fee to

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decreases after tariffication. This result is based on the assumption of one manufacturer dealing with one distributor.

Now let us examine the welfare of the foreign country. Consumer surplus in the foreign country declines after tariffication due to a higher wholesale price.[17] Moreover, given the manufacturer adopts two-part tariff pricing, the distributor earns zero profit under both regimes. It implies that tariffication also reduces the welfare of the foreign country. From the above discussions, we can construct the proposition as follows:

Proposition 2. In the presence of PI, tariffication decreases not only the profits of the manufacturer but also the welfare of both the domestic and foreign countries.

In the absence of PI, Hwang, Peng, and Wu (2013) show that tariffication is necessarily welfare-enhancing. This proposition shows that their result is not robust if PI is considered. The reason is that in the presence of PI, tariffication encourages the domestic manufacturer to increase its wholes price which causes a distortion in the wholesale market. This proposition also bears a policy implication: Countries should be cautious when engaging in tariffication if the product in question involves PI.

3 Tariffication and the Manufacturer's R&D

In this section, we assume that the manufacturer can undertake a cost-reducing R&D to lower its marginal cost by ε and its R&D cost function is specified by $V(\varepsilon)$ with $V_\varepsilon > 0$ and $V_{\varepsilon\varepsilon} > 0$, where V_ε reflects the R&D efficiency and a higher V_ε indicates lower R&D efficiency. Therefore, the marginal production cost of the manufacturer declines from c to $c - \varepsilon$ after R&D. Given this assumption, we have $x_\varepsilon = -x_c > 0$, $y_\varepsilon = -y_c < 0$, and $w_\varepsilon = -w_c < 0$.

The game in question now encompasses three stages. The last two stages are the same as those in the previous section. We need to work out only the first-stage game: The manufacturer determines its optimal R&D level. As usual, we examine the optimal R&D under the quota regime followed by the

extract the rent from the distributor. Hence, any wholesale price higher than the marginal cost lowers its profit from the foreign market.

[17] It is straightforward to show that $dp^*/dw = p_x(x_w + y_w) > 0$.

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import-volume-equivalent tariff regime. We will also compare the resulting welfare levels.

In the first stage, the profit function of the manufacturer under the quota regime can be specified as follows:

$$\max_{\varepsilon} \ \pi\left(x(\varepsilon), y^*(w(\varepsilon)), \varepsilon, V(\varepsilon); \bar{y}\right) = (p - c + \varepsilon)(x + \bar{y}) + \left(p^* - c + \varepsilon\right) y^* - V(\varepsilon).$$

By differentiating the profit function with respect to ε, we can derive the first-order condition for profit maximization of the manufacturer as follows:

$$\begin{aligned}\frac{d\pi}{d\varepsilon} &= \frac{\partial \pi}{\partial x}\frac{\partial x}{\partial \varepsilon} + \frac{\partial \pi}{\partial y^*}\frac{\partial y^*}{\partial \varepsilon} + \frac{\partial \pi}{\partial \varepsilon} \\ &= p_x \bar{y} x_\varepsilon + \left(p^* - c + \varepsilon + p^*_{y^*} y\right) y^*_w w_\varepsilon + \left(x + \bar{y} + y^*\right) - V_\varepsilon = 0.\end{aligned} \tag{14}$$

By the first-order conditions of the third-stage game and the second-stage game, it can be found that $(p^* - c + \varepsilon + p^*_{y^*} y) = (w - c + \varepsilon) = 0$ as $w^q = c - \varepsilon$ under the quota regimes. Assuming that the second-order condition is satisfied, we can derive from (14) the optimal R&D investment, ε^q.[18]

We now move to the tariff regime. The profit function of the manufacturer can be specified as follows:

$$\begin{aligned}\max_{\varepsilon} \ & \pi(x(w(\varepsilon), \varepsilon), y(w(\varepsilon), \varepsilon), y^*(w(\varepsilon)), \varepsilon, V(\varepsilon)) \\ & = (p - c + \varepsilon)x + (p - c + \varepsilon - t)y + \left(p^* - c + \varepsilon\right) y^* - V(\varepsilon).\end{aligned}$$

By differentiating the profit function with respect to ε and using (10) and (11), we can derive the first-order condition for profit maximization of the manufacturer as follows:

$$\begin{aligned}\frac{d\pi}{d\varepsilon} &= \frac{\partial \pi}{\partial x}\frac{dx}{d\varepsilon} + \frac{\partial \pi}{\partial y}\frac{dy}{d\varepsilon} + \frac{\partial \pi}{\partial y^*}\frac{\partial y^*}{\partial \varepsilon} + \frac{\partial \pi}{\partial \varepsilon} \\ &= (w - c + \varepsilon)(-17/26 p_x) + \left(10x/13 + 8y/13 + y^*\right) - V_\varepsilon = 0.\end{aligned} \tag{15}$$

[18]The second-order condition is satisfied if $V_{\varepsilon\varepsilon}$ is sufficiently large.

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where $dx/d\varepsilon = (x_w w_\varepsilon + x_\varepsilon) = -5/(13p_x)$, $dy/d\varepsilon = (y_w w_\varepsilon + y_\varepsilon) = -3/(13p_x)$. Assume the second-order condition is satisfied; the optimal R&D, ε^t, is derivable from (15).

By subtracting (14) from (15) and assuming that the domestic government imposes an import-volume-equivalent tariff, we can find that:

$$\frac{d\pi^t}{d\varepsilon} - \left.\frac{d\pi^q}{d\varepsilon}\right|_{y^t=y^q} = \left[(w-c+\varepsilon)\left(\frac{-17}{26p_x}\right)\right] + \left[\frac{-3x^q}{13} + \frac{3y^q}{26} + y^{*q}\left(w^t\right) - y^{*q}(c-\varepsilon)\right]. \tag{16}$$

Note that if $w = c - \varepsilon$ (i.e., the quota case), (16) is necessarily negative as the quota is assumed to be effective, $x^q \geq y^q$. It implies that tariffication necessarily decreases the R&D investment of the manufacturer. But the sign becomes ambiguous, given $w^t > c-\varepsilon$ under the tariff case. In what follows, we shall provide an example to show our result. Assume that the demands in the two countries are respectively $p = 1-x-y$ and $p^* = a - y^*$ where $a > (=<)1$. We can therefore derive the corresponding R&D investments under the quota regime and the tariff regime as follows:

$$\varepsilon^q = \frac{(1+a)-2c}{2k-2}, \quad \text{and} \quad \varepsilon^t = \frac{(12+13a)-25c-4t}{26k-25}.$$

By subtracting ε^q from ε^t, we can derive the difference of the R&D levels under the two regimes as follows:[19]

$$\varepsilon^t - \varepsilon^q = \frac{[(1-a)-2k(1-c)]-(2k-1)8t}{52k^2-102k+50} < 0.$$

From the finding, we can establish the following proposition.

Proposition 3. Tariffication on parallel trade necessarily discourages the manufacturer's R&D investment if the manufacturer adopts two-part tariff pricing.

The intuition is as follows. The wholesale price charged by the manufacturer increases after tariffication. This higher wholesale price reduces its profit from the foreign market. It also lowers the marginal benefit of the R&D investment, resulting in less R&D investment by the manufacturer.

[19]Note that the second-order condition holds if $k > 1$.

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Proposition 2 indicates that for any given marginal cost, tariffication lowers social welfare of the domestic country and the foreign country as well. Following Proposition 3, we can conclude that the welfare effect stated in Proposition 2 is robust even if the R&D level of the manufacturer is endogenously determined.

4 One-part tariff pricing

Most PI literature assumes that the manufacturer engages in a two-part tariff pricing strategy. This assumption however reflects only part of the reality. One-part tariff pricing is also popular in practice. The purpose of this section is to examine whether the results we derived under two-part tariff pricing still hold if the manufacturer adopts one-part tariff pricing instead.

We follow the model setting of Section 3 except that the manufacturer now charges only a wholesale price to the distributor. Assume that the market size of the foreign country is smaller than the home country to ensure the occurrence of PI. For simplicity of calculation, we assume that the demands in the two countries are respectively $p = 1 - x - y$ and $p^* = a - y^*$ where $a < 1 - 10t/3$.[20] As the equilibrium outputs and prices in the third stage are the same as those under two-part tariff pricing, we need to work out only the first and the second stages of the game.

In the second-stage, the wholesale prices under the quota and the import-volume-equivalent tariff regimes are derivable as follows:[21]

$$w^q = \frac{a + 2\bar{y} + c - \varepsilon}{2}, \quad w^t = \frac{(10 + 9a) + 19(c - \varepsilon) - 8t}{38}. \tag{17}$$

They are quite different from those in the two-part tariff case. In the two-part tariff case, the manufacturer sets the wholesale price equal to (higher than) the marginal cost under the quota (tariff) regime. But in the one-part tariff case, the wholesale price is definitely higher than the marginal cost under either the quota or the tariff regime. This is because the manufacturer, if adopting one-part tariff pricing, cannot use a fixed fee to extract the rent from the distributor. Instead, it charges a higher wholesale price.

[20] Under one-part tariff, we find that PI takes place only if $a < 1 - 10t/3$. It implies that the market of the foreign country must be sufficiently smaller than that of the domestic country. Otherwise, the wholesale price charged by the manufacturer would be too high to make PI profitable.

[21] Please see the appendix for the detailed proof.

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Moreover, if we utilize the assumption that the quota is set equal to the import under the tariff (i.e., $\bar{y} = y^t = 3-3a-10t/19$), it is straightforward to show that: $w^t - w^q = 2(1-a-3t)/19 > 0$. It implies that the result of Proposition 1 is robust even if the pricing strategy of the manufacturer switches from two-part to one-part tariff. But the effects of R&D investment on the wholesale price are quite different. From (17), we obtain $w^q_\varepsilon = w^t_\varepsilon = -1/2$ in the one-part tariff case, which are less significant than their counterparts in the two-part tariff case, $w^q_\varepsilon = -1$ and $w^t_\varepsilon = -11/13$.

We now move to compare the domestic social welfare under the two regimes. With no R&D, the social welfare function under the quota regime can be written as follows:

$$\begin{aligned} \mathrm{SW}^q(t) = \mathrm{CS}^q + \pi^q = \frac{1}{2}\left[\frac{(22-3a)-19(c-\varepsilon)-10t}{38}\right]^2 \\ + \left[\frac{(16+3a)-19(c-\varepsilon)+10t}{38}\right]^2 \\ + \frac{1}{2}\left[\frac{(6+13a)-19(c-\varepsilon)-20t}{38}\right]^2. \end{aligned}$$

On the other hand, the domestic social welfare under the tariff regime can be expressed as follows.

$$\begin{aligned} \mathrm{SW}^t = \mathrm{CS}^t + \pi^t = \frac{1}{2}\left[\frac{(22-3a)-19(c-\varepsilon)-10t}{38}\right]^2 \\ + \left[\frac{(16+3a)-19(c-\varepsilon)+10t}{38}\right]^2 \\ + \left[\frac{(10+9a)-19(c-\varepsilon)-8t}{38}\right] \\ \left[\frac{(2+17a)-19(c-\varepsilon)-32t}{76}\right]. \end{aligned}$$

Since the CS and the profit of the manufacturer from the domestic market (the first and the second terms on the RHS of the equations) are the same under the two regimes, the welfare difference between the two regimes is derivable as follows:

$$\Delta\mathrm{SW} = \mathrm{SW}^t - \mathrm{SW}^q = -2(1-a+3t)^2/361 < 0. \qquad (18)$$

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It shows that tariffication is definitely welfare-reducing as it decreases the profit of the manufacturer from the foreign market.[22] This result is the same as that from the two-part tariff case.

We now examine the long-run equilibrium. If the manufacturer is able to engage in R&D investment, by proceeding as before, we can derive the optimal R&D investments under the two regimes as follows:

$$\varepsilon^t = \frac{(2+a)-3c}{4k-3}, \quad \text{and} \quad \varepsilon^q = \frac{(2+a)-3c}{4k-3}. \tag{19}$$

That is to say, if the manufacturer adopts one-part tariff pricing, its R&D investments under the two regimes are identical. It leads to the following proposition:

Proposition 4. Tariffication on parallel trade has no effect on the manufacturer's R&D investment if the manufacturer adopts one-part tariff pricing.

The intuition of the proposition is as follows. The volumes of parallel imports are the same and independent of the manufacturer's R&D efforts under the quota and the tariff regimes. As a result, the marginal revenue functions of the R&D are the same under the two regimes. For the given marginal cost function of R&D, the optimal R&D investments should also be the same under the two regimes.

By (19), we conclude that the domestic social welfare is lower under the tariff than the quota regime ($\mathrm{SW}^t(\varepsilon) < \mathrm{SW}^q(\varepsilon)$). Moreover, the R&D investment undertaken by the manufacturer is not affected by tariffication. It implies that if the manufacturer adopts one-part tariff pricing, tariffication is welfare-deteriorating not only in the short run but also in the long run as well.

5 Conclusions

There has been more and more countries tend to convert non-tariff barriers into tariff barriers since the WTO advocated tariffication. In this paper, we have utilized a two-country-and-two-firm model to investigate the welfare effect of tariffication on PI which is prevalent in international trade.

[22] PI occurs if $a < 1 - 10t/3$. By utilizing this inequality, we can derive that (19) is necessarily negative.

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We have derived some interesting results. Regardless of the manufacturer's pricing strategy, tariffication necessarily raises the wholesale price which reduces the profits of the domestic manufacturer. Moreover, since we choose an import-volume equivalent tariff as the tool of tariffication, the total sales in the home country are necessarily the same under the quota or the tariff regime, leaving domestic consumer surplus unchanged. Therefore, if we assume that the tariff revenue is equal to the quota rent, tariffication is socially undesirable for the domestic country as it decreases the profit of the domestic manufacturer. Moreover, tariffication also decreases the foreign welfare as it raises the wholesale price which in turn increases the final good price in the foreign country. These results are robust even if the manufacturer adopts one-part tariff pricing.

Finally, if the domestic manufacturer adopts two-part (one-part) tariff pricing, tariffication discourages (has no effect on) R&D investment of the domestic manufacturer. It implies that the domestic and the foreign welfare levels both become lower after tariffication irrespective of one-part or two-part tariff pricing taken by the manufacturer.

In this paper, we have assumed that there is only one manufacturer and one distributor in the model. It is of some interest to study how a change in market structure affects the manufacturer's R&D and social welfare under the two regimes. This extension is reserved for our future research.

Mathematical Appendix:

This appendix is prepared to facilitate the reviewing process, not intended for publication. It derives the equilibria under the quota and the equivalent tariff regimes when the manufacturer adopts one-part tariff pricing.

A.1 The quota regime

When the domestic government sets a restrictive quota $\bar{y}$, the profit functions of the manufacturer and the distributor can be written as follows, respectively.

$$\pi(x) = (p - c + \varepsilon)x + (w - c + \varepsilon)\left(\bar{y} + y^*\right),$$
$$\pi^*\left(y^*\right) = (p - w)\bar{y} + \left(p^* - w\right)y^*.$$

As the equilibrium outputs and prices in the second stage are the same as those under two-part tariff, we need to work out only the first-stage game.

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In the first stage, the manufacturer determines its optimal wholesale price to maximize $\pi(x, y^*(w), w)$. By differentiating π with respect to w and setting it equal to zero, we can derive the equilibrium wholesale price under the quota regime as follows:

$$w^q = \frac{a + 2\bar{y} + (c - \varepsilon)}{2}. \tag{A1}$$

This is equation (17) in the text.

By substituting (A1) into the equilibriums solved in previous stage, we can derive the following equilibrium outputs:

$$x = \frac{1 - \bar{y} - (c - \varepsilon)}{2}, \quad y^* = \frac{a - 2\bar{y} - (c - \varepsilon)}{4}.$$

A.2 The tariff regime

If the domestic country imposes an import-volume-equivalent tariff t, the profit functions of the manufacturer and the distributor can be expressed respectively as follows:

$$\pi(x) = (p - c + \varepsilon)x + (w - c + \varepsilon)\left(y + y^*\right),$$
$$\pi^*\left(y, y^*\right) = (p - w - t)y + \left(p^* - w\right)y^*.$$

Again, the equilibrium in the second stage is the same as that in Subsection 2.2. We only need to solve the maximizing problem in the first-stage game. By differentiating $\pi(x(w), y(w), w)$ with respect to w, the optimal wholesale price of the manufacturer is derivable as follows.

$$w^t = \frac{(10 + 9a) + 19(c - \varepsilon) - 8t}{38}. \tag{A2}$$

This is equation (17) in the text. By substituting (A.2) into the equilibriums solved in second stage, we then derive the following equilibrium outputs:

$$x = \frac{(16 + 3a) - 19(c - \varepsilon) + 10t}{38}, \quad y = \frac{(3 - 3a) - 10t}{19}, \quad \text{and}$$
$$y^* = \frac{(-10 + 29a) - 19(c - \varepsilon) + 8t}{76},$$

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Utilizing import-volume equivalent tariffication, the quota of PI is set at the volume of PI under the tariff regime ($\bar{y} = y^t = (3 - 3a) - 10t/19$). The domestic social welfare of the quota regime can be written as follows.

$$\begin{aligned} SW^q = & \frac{1}{2}\left[\frac{(22 - 3a) - 19(c - \varepsilon) - 10t}{38}\right]^2 \\ & + \left[\frac{(16 + 3a) - 19(c - \varepsilon) + 10t}{38}\right]^2 \\ & + \frac{1}{2}\left[\frac{(6 + 13a) - 19(c - \varepsilon) - 20t}{38}\right]^2 \end{aligned}$$

On the other hand, the domestic social welfare under the tariff regime can be expressed as follows.

$$\begin{aligned} SW^t = & \frac{1}{2}\left[\frac{(22 - 3a) - 19(c - \varepsilon) - 10t}{38}\right]^2 \\ & + \left[\frac{(16 + 3a) - 19(c - \varepsilon) + 10t}{38}\right]^2 \\ & + \left[\frac{(10 + 9a) - 19(c - \varepsilon) - 8t}{38}\right] \\ & \left[\frac{(2 + 17a) - 19(c - \varepsilon) - 32t}{76}\right] \end{aligned}$$

By subtracting SW^t from SW^q, we can derive the difference of the social welfare levels under two regimes as follows:

$$\Delta SW = SW^t - SW^q = -2(1 - a + 3t)^2/361 < 0.$$

This is equation (19) in the text.

A.3 The R&D investment

The profit function of the manufacturer at the R&D stage is as follows.

$$\begin{aligned} \pi(\varepsilon) = & [1 - x(\varepsilon) - \bar{y} - (c - \varepsilon)]\, x(\varepsilon) + [w(\varepsilon) - (c - \varepsilon)] \\ & \left(\bar{y} + y^*(\varepsilon)\right) - \frac{1}{2}k\varepsilon^2. \end{aligned}$$

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By solving the maximizing problem, we can derive the R&D investment under the quota regime as follows:

$$\varepsilon^q = \frac{(2+a)-3c}{4k-3}.$$

This is equation (19) in the text.

The objective function of the manufacturer under one-part tariff pricing under the tariff regime can be written as follows:

$$\pi(\varepsilon;t) = [1 - x(\varepsilon) - y - (c-\varepsilon)]x(\varepsilon) + [w(\varepsilon) - (c-\varepsilon)] (y + y^*(\varepsilon)) - \frac{1}{2}k\varepsilon^2.$$

By routine calculation, we can derive the optimal R&D investment as follows:

$$\varepsilon^t = \frac{(2+a)-3c}{4k-3}.$$

This is equation (19) in the text.

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平行輸入商品關稅化之福利效果

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關稅化是世界貿易組織 (WTO) 長期以來所提倡的政策, 其目的在將非關稅貿易障礙轉換爲關稅貿易障礙。本文以一個兩國模型探討進口國政府對平行輸入商品實施關稅化政策所產生之福利效果並進一步討論關稅化政策對於進口國製造商研發投入的影響。本文發現, 無論製造商採取一部訂價或兩部訂價, 關稅化政策都將使進口國福利下降。但關稅化對製造商研發投入的影響卻會因其訂價模式而有所不同。若製造商採兩部 (一部) 訂價法, 關稅化政策將減少 (不影響) 其研發投入。此一結果顯示, 若一國之製造商採兩部訂價法, 且其政府對於平行輸入商品實施關稅化政策, 長期而言將會導致該國福利惡化。

關鍵詞: 關稅化, 平行輸入, 研發創新, 社會福利
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