Antidumping Policy and Product R&D

Kuo-Feng Kao[*] and Cheng-Hau Peng [†]

Abstract

We analyze firms' incentive to invest in product R&D and how this product R&D affects firms' incentive to petition for an antidumping protection. It is found that, when one of the governments implements antidumping policy, the protected firm decreases its product R&D investment while the constrained firm invests more. The total product R&D investment is even lower than that under free trade, which in turn may deteriorate the profit of protected firm. Accordingly, the protected firm may withdraw its anti-dumping petition. Moreover, we show that the constrained firm has the incentive to petition for a fight-back anti-dumping policy only if the level of product R&D can be endogenously determined. Finally, such an anti-dumping retaliation increases the incentive of the protected firm to petition for an anti-dumping protection if the level of product R&D is large enough.

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Anti-dumping Policy and Product R&D

1. Introduction

In the real world, anti-dumping (AD, hereafter) policy is felt to be a mechanism fostering the interests of domestic producers. Although AD policies are commonly considered as a kind of trade policy, they have potential impacts on behaviors or strategies of domestic and foreign industries. Konings and Vandenbussche (2005) use panel data of about 4000 EU producers that were involved in AD cases to estimate markups before and after the filing of a case, and find that AD protection has positive and significant effects on domestic markups. AD policies may encourage foreign firms to engage in FDI (Belderbos, 1997; Blonigen, 2002; Belderbos et al., 2004), or improve their product quality (Vandenbussche and Wauthy, 2001).

Some empirical papers have already devoted into explaining why AD retaliation happens or why there are so many firms withdraw their AD petitions; however, to the best of our knowledge, there are no papers explain these phenomenon theoretically. Moreover, we would also like to know whether AD retaliation increases or decreases firms' incentive to petition theirs government for an AD protection. We tackle these issues by taken firms' R&D behaviors into account.

Empirical evidence has shown that AD protections often target on R&D intensive industries such as electronics, primary metals, chemical and mechanical engineering industries (Neils, 2000). Thus, it is an important objective to investigate the R&D behavior under AD policies. Gao and Miyagiwa (2005) is the first paper to investigate the impacts of AD policies on the cost-reducing R&D incentives of the protected firm and the dumping firm. Given an ad valorem transport cost, they find that a unilateral AD policy decreases (increases) the cost-reducing R&D of the protected (dumping) firm. However, approximately three-fourths R&D by firms in the US are devoted to product R&D (Scherer and Rose, 1990). That is to say, Gao and Miyagiwa (2005) can explain only part of the reality. The main aim of this paper is to explore the product R&D strategies of the firms when they are protected or constrained by antidumping policy. We shall also consider the impacts of antidumping on consumer surplus and welfare when firms can determine their product R&D levels.

Understanding a firm's behavior in R&D has been an important objective of industrial organization. A substantial literature has highlighted the welfare consequences of marginal-cost-reducing (process) R&D investment (see for example, Arrow, 1962; Brander and Spencer, 1983; D'Aspremont and Jacquemin, 1988, among others). More recently, literature on R&D has started to center on product R&D and its linkage between process R&D (for example, Cohen and Klepper, 1996; Bonanno and Haworth, 1998; Lin and Saggi, 2002, Symeonidis, 2003) In addition, Haaland and Kind (2008) examine the industrial R&D investments and policy competition between countries in an international setting. They show that trade liberalization generates more R&D and the policy competition between countries depending critically on the competitiveness of the market. The product R&D setup of this paper is basically borrowed from Lin and Saggi (2002). They compare the impact of competition mode on firms' product incentive whereas we investigate the effect of antidumping policies on the product R&D incentive of firms.

Our paper is mostly relevant to Gao and Miyagiwa (2005). In their cost-reducing R&D model, the ad valorem trade cost is crucial to the results. The firms has an incentive to alter their cost-reducing R&D under antidumping policy mainly because the cost saving effect becomes larger (lower) for the dumping (protected) firm. In other words, AD policy has no effect under specific trade cost as the cost saving effect not affected by AD policy. However, in our model, product differentiation can affect the dumping margin which gives the two firms some strategic effect to change their product R&D level even without considering the cost saving effect. Moreover, Gao and Miyagiwa (2005) only compares the R&D levels whereas we compare the welfare implications under AD policy which sheds some light and deserves some policy implications for the developing and developed countries.

In this paper, we mainly focus on price undertaking as it is more amiable to the dumping firm. The dumping firm usually chooses to accept the price set by the authority rather than paying duties (Gao and Miyagiwa, 2005). Furthermore, although countries such as the US and Canada usually adopt antidumping duties as their instrument against the dumping country, most of EU antidumping filings finalize with the acceptance by the EU of a price undertaking.[1] The study by Zanardi (2004) also shows that countries like Japan, Finland, Sweden and South Korea make frequent use of price undertakings.[2]

The remainder of this paper is organized as follows. Section 2 introduces our basic model. Section 3 investigates the equilibrium under unilateral anti-dumping policy. Section 4 examines the bilateral anti-dumping policy case. Section 5 concludes the paper.

2. The Benchmark Model

Assume there are two countries, Country Home and Country Foreign, host one firm each. Firm H and Firm F produce differentiated products and ship the product from one country to another while incurring a per-unit trade cost, *t*. We further assume that the utility function of a representative consumer in both countries is as follows:

$$U = a(q+Q) - \frac{1}{2}\left(bq^2 + 2rqQ + bQ^2\right) + m \ ,$$

[1] As agreed on the Essen Summit in 1994, these Agreements grant a preferential role for price undertakings (see e.g. Annex IV to the Conclusions of the Essen European Council 1994; Chapter IV, Article 34 of the European Agreement with Bulgaria).

[2] Zanardi (2004) shows that, for the period of 1881-2001, Japan accepted more undertakings, i.e. in about 60% of the cases, as well as Finland and Sweden before their EU membership (82% and 100% respectively).

$$U^* = a(q^* + Q^*) - \frac{1}{2}\left(bq^{*2} + 2rq^*Q^* + bQ^{*2}\right) + m,$$

where the variables in lower (upper) case are the action taken by the Home (Foreign) firm and those with asterisk are happened in country F. Moreover, r is the level of product differentiation and *m* is the consumption of numerarie goods. Accordingly, the demand functions of the two products in the two different countries are as follows:

$$q = \frac{a(b-r) - bp + rP}{b^2 - r^2}, \quad Q = \frac{a(b-r) - bP + rp}{b^2 - r^2}; \tag{1}$$

$$q^* = \frac{a(b-r) - bp^* + rP^*}{b^2 - r^2}, \quad Q^* = \frac{a(b-r) - bP^* + rp^*}{b^2 - r^2}. \tag{2}$$

Now, we assume both Home firm and Foreign firm can invest on product R&D to enlarge the product differentiation. More specifically, $r \equiv b - k - K$, where *k* (*K*) is the improvement on product differentiation made by Home (Foreign) firm. If both firms do not invest on product R&D, then consumers may consider the final goods are homogeneous. For simplicity, we assume $k, K \in [0, b/2]$.

The profit function of Home firm and Foreign firm are as follows:

$$\pi = (p-c)q + (p^* - c - t)q^* - f(k), \tag{3}$$

$$\Pi = (P-c-t)Q + (P^* - c)Q^* - f(K), \tag{4}$$

where *c* is the marginal production cost, *t* is the per-unit transport cost, and *f*(*k*) (*f*(*K*)) is the R&D investment of Home (Foreign) firm, and $\partial f(k)/\partial k > 0$ ($\partial f(K)/\partial K > 0$) and $\partial^2 f(k)/\partial k^2 > 0$ ($\partial^2 f(K)/\partial K^2 > 0$).

In the following, we would like to investigate the effect of anti-dumping policy.

As a first step, we shall derive the equilibrium under free trade. The game structure is as follows: In the first stage, Home firm and Foreign firm simultaneously determines the level of R&D investment on product differentiation. In the second stage, given the level of product differentiation, both firms compete in price in both countries. We use backward induction to derive the sub-game perfect equilibrium.

In the second stage, both firms determine the prices in Home country and Foreign country simultaneously. By solving $\partial\pi/\partial p = 0$, $\partial\Pi/\partial P = 0$, $\partial\pi/\partial p^* = 0$ and $\partial\Pi/\partial P^* = 0$ simultaneously, we can derive the optimal prices under free trade as follows:

$$p^{FT} = \frac{a(b-r)+bc}{2b-r} + \frac{brt}{4b^2-r^2}, \quad P^{FT} = \frac{a(b-r)+bc}{2b-r} + \frac{2b^2 t}{4b^2-r^2}; \qquad (5)$$

$$p^{*FT} = \frac{a(b-r)+bc}{2b-r} + \frac{2b^2 t}{4b^2-r^2}, \quad P^{*FT} = \frac{a(b-r)+bc}{2b-r} + \frac{brt}{4b^2-r^2}, \qquad (6)$$

where the superscript FT denotes the equilibrium under free trade regime. Accordingly, the dumping margins are as follows:

$$p^{FT} - (p^{*FT} - t) = \frac{(b+r)t}{2b+r},$$

$$P^{*FT} - (P^{FT} - t) = \frac{(b+r)t}{2b+r}.$$

It should be noted that the dumping margin increases as the product differentiation increases. The final outputs can be derived by substituting (5) and (6) into (1) and (2), and are as follows:

$$q^{FT} = Q^{*FT} = \frac{b(a-c)}{(2b-r)(b+r)} + \frac{b^2 rt}{(b^2-r^2)(4b^2-r^2)},$$

$$Q^{FT} = q*^{FT} = \frac{b(a-c)}{(2b-r)(b+r)} - \frac{b(2b^2 - r^2)t}{(b^2 - r^2)(4b^2 - r^2)}.$$

By substituting p^{FT}, P^{FT}, $p*^{FT}$, and $P*^{FT}$ (i.e., (5) and (6)) into π and Π (i.e., (3) and (4)), the equilibrium profit can be derived as follows:

$$\pi^{FT} = \frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2} + \frac{b(b+r)t^2}{2(b-r)(2b+r)^2} - f(k), \tag{7}$$

$$\Pi^{FT} = \frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2} + \frac{b(b+r)t^2}{2(b-r)(2b+r)^2} - f(K). \tag{8}$$

In the first stage, both the firms determine the level of R&D investment on product differentiation. By differentiating (7) with respect to *k* and (8) with respect to *K*, the first-order derivatives are as follows:

$$\begin{aligned}\frac{d\pi^{FT}}{dk} &= \frac{\partial r}{\partial k}\frac{\partial}{\partial r}\left[\frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2}\right] + \frac{\partial r}{\partial k}\frac{\partial}{\partial r}\left[\frac{b(b+r)t^2}{2(b-r)(2b+r)^2}\right] - \frac{\partial f(k)}{\partial k} \\ &= \underbrace{(-1)\frac{-b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}}_{+} + \underbrace{(-1)\frac{b(b^2+br+r^2)t^2}{(b-r)^2(2b+r)^3}}_{-} - \underbrace{\frac{\partial f(k)}{\partial k}}_{+},\end{aligned}$$

$$\begin{aligned}\frac{d\Pi^{FT}}{dK} &= \frac{\partial r}{\partial K}\frac{\partial}{\partial r}\left[\frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2}\right] + \frac{\partial r}{\partial K}\frac{\partial}{\partial r}\left[\frac{b(b+r)t^2}{2(b-r)(2b+r)^2}\right] - \frac{\partial f(K)}{\partial K} \\ &= \underbrace{(-1)\frac{-b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}}_{+} + \underbrace{(-1)\frac{b(b^2+br+r^2)t^2}{(b-r)^2(2b+r)^3}}_{-} - \underbrace{\frac{\partial f(K)}{\partial K}}_{+}.\end{aligned}$$

By solving $d\pi^{FT}/dk = 0$ and $d\pi*^{FT}/dK = 0$ simultaneously, we can have the optimal level of R&D investment on product differentiation, that is, k^{FT} and K^{FT}.

3. Unilateral Anti-dumping Policy

In this section, we would like to investigate how unilateral anti-dumping affects the firm's incentive on product differentiation. Without loss of generality, we assume

Home country imposes price-undertaking on Foreign firm, that is, $P^* = P - t$. The profit function of Home firm and Foreign firm are (3) and (4); however, the Foreign firm is subject to the price-undertaking constraint when determining the prices. Let the objective function of Foreign firm be as follows:

$$L^* \equiv \Pi + \lambda\left[P^* - \left(P - t\right)\right],$$

where λ is the Largrange multiplier. By solving $\partial\pi/\partial p = 0$, $\partial L^*/\partial P = 0$, $\partial\pi/\partial p^* = 0$, $\partial L^*/\partial P^* = 0$, and $\partial L^*/\partial\lambda = 0$ simultaneously, we can derive the optimal prices under free trade as follows:

$$p^U = \frac{a(b-r)+bc}{2b-r} + \frac{(3b-r)rt}{4b(2b-r)}, \quad P^U = \frac{a(b-r)+bc}{2b-r} + \frac{(3b-r)t}{2(2b-r)}; \qquad (9)$$

$$p^{*U} = \frac{a(b-r)+bc}{2b-r} + \frac{(4b^2-3br+r^2)t}{4b(2b-r)}, \quad P^{*U} = \frac{a(b-r)+bc}{2b-r} - \frac{(b-r)t}{2(2b-r)}, \quad (10)$$

where the superscript "*U*" denotes the equilibrium under unilateral anti-dumping policy. It should be noted that the dumping margins now are as follows:

$$p^U - (p^{*U} - t) = \frac{(b+r)t}{2b} > \frac{(b+r)t}{2b+r} = p^{FT} - (p^{*FT} - t),$$

$$P^{*U} - (P^U - t) = 0.$$

If Home country implements anti-dumping policy on Foreign firm, then the dumping margin of Home firm in Foreign country is higher than that under free trade regime. Moreover, given the effort on product differentiation, that is, k and K, we have $p^{FT} < p^U$, $P^{FT} < P^U$, $p^{*FT} > p^{*U}$, $P^{*FT} > P^{*U}$. Since the Foreign firm is subject to the price-undertaking, it should raise the Home price (i.e., P^U) and lower the

Foreign price (i.e., P^{*U}). The price competition in Home (Foreign) country is less (more) intensive. Substituting p^U, P^U, p^{*U}, and P^{*U} (i.e., (9) and (10)) into (1) and (2), the outputs of Home firm and Foreign firm are as follows:

$$q^U = \frac{b(a-c)}{(2b-r)(b+r)} + \frac{(3b-r)rt}{4(b^2-r^2)(2b-r)},$$

$$Q^U = \frac{b(a-c)}{(2b-r)(b+r)} - \frac{(3b-r)(2b^2-r^2)t}{4b(b^2-r^2)(2b-r)},$$

$$q^{*U} = \frac{b(a-c)}{(2b-r)(b+r)} - \frac{(4b^2-br-r^2)t}{4(b^2-r^2)(2b-r)},$$

$$Q^{*U} = \frac{b(a-c)}{(2b-r)(b+r)} + \frac{(2b^3+2b^2r-3br^2+r^3)t}{4b(b^2-r^2)(2b-r)}.$$

From a direct comparison, we can find that $q^U > q^{FT}$, $Q^U < Q^{FT}$, $q^{*U} < q^{*FT}$ and $Q^{*U} > Q^{*FT}$. The equilibrium profit in the second stage can be derived by substituting p^U, P^U, p^{*U}, and P^{*U} (i.e., (9) and (10)) into (3) and (4), and are as follows:

$$\pi^U = \frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2} + \frac{(b+r)t^2}{8b(b-r)} - f(k), \tag{11}$$

$$\Pi^U = \frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2} - f(K). \tag{12}$$

Given *k* and *K*, from comparing (7) and (11), and (8) and (12), it is easy to show that $\pi^U > \pi^{FT}$ and $\Pi^U \leq \Pi^{FT}$. The protected firm (i.e., Home firm) earns a higher profit under unilateral anti-dumping protection while the constrained firm (i.e., Foreign firm) losses.

In the first stage, both firms determines an R&D level on product differentiation to maximize profits, the first-order derivative of Home firm and Foreign firm can be derived by differentiating (11) with respect to *k* and (12) with respect to *K*, and are as follows:

$$\begin{aligned}\frac{d\pi^U}{dk} &= \frac{\partial r}{\partial k}\frac{\partial}{\partial r}\left[\frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2}\right]+\frac{\partial r}{\partial k}\frac{\partial}{\partial r}\left[\frac{(b+r)t^2}{8b(b-r)}\right]-\frac{\partial f(k)}{\partial k}\\ &= \underbrace{(-1)\frac{-b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}}_{+}+\underbrace{(-1)\frac{t^2}{4(b-r)^2}}_{-}-\underbrace{\frac{\partial f(k)}{\partial k}}_{+},\end{aligned} \quad (13)$$

$$\begin{aligned}\frac{d\Pi^U}{dK} &= \frac{\partial r}{\partial K}\frac{\partial}{\partial r}\left[\frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2}\right]-\frac{\partial f(K)}{\partial K}\\ &= \underbrace{(-1)\frac{-b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}}_{+}-\underbrace{\frac{\partial f(K)}{\partial K}}_{+}.\end{aligned} \quad (14)$$

By solving $d\pi^U/dk=0$ and $d\Pi^U/dK=0$, we can have the optimal level of R&D investment on product differentiation, that is, k^U and K^U. Moreover, given *k* and *K*, by comparing $d\pi^U/dk$ and $d\Pi^U/dK$ with respect to $d\pi^{FT}/dk$ and $d\Pi^{FT}/dK$, we find that $d\Pi^U/dK > d\Pi^{FT}/dK = d\pi^{FT}/dk > d\pi^U/dk$. The protected firm acts passive on product R&D; however, the constrained firm acts more aggressive on product R&D. Accordingly, we can infer that $k^U<k^{FT}$ while $K^U>K^{FT}$.

Moreover, by summing up (13) and (14) yields:

$$\frac{d\pi^U}{dk}+\frac{d\Pi^U}{dK}=\frac{2b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}+\frac{-t^2}{4(b-r)^2}-\frac{\partial f(k)}{\partial k}-\frac{\partial f(K)}{\partial K}. \quad (15)$$

Evaluate (15) at k^U and K^U, we would have $\left(d\pi^U/dk\right)+\left(d\Pi^U/dK\right)=0$. Similarly, by substituting $k=k^{FT}$ and $K=K^{FT}$ into (15), we can derive that:

$$\left.\frac{d\pi^U}{dk}+\frac{d\Pi^U}{dK}\right|_{k=k^{FT},K=K^{FT}}=\underbrace{\frac{d\pi^{FT}}{dk}+\frac{d\Pi^{FT}}{dK}}_{0}+\underbrace{\frac{2b(b^2+br^{FT}+r^{FT\,2})t^2}{(b-r^{FT})^2(2b-r^{FT})^3}+\frac{-t^2}{4(b-r^{FT})^2}}_{-}<0, \quad (16)$$

which implies $K^{FT}+k^{FT}>K^U+k^U$. We make this result as the following proposition.

Proposition 1. A unilateral anti-dumping policy stifles product R&D of the protected firm whereas it stimulates that of the constrained firm increases. Furthermore, the aggregate investment on product R&D is necessarily suppressed by the unilateral anti-dumping policy.

We are now in the position to investigate whether the protected firm, Home firm, has the incentive to petition for an AD protection. To this aim, we shall derive the profit change of Home firm after the product R&D is taken into account. From (11) and evaluated the product R&D level of both firms at free trade level (i.e., k^{FT} and K^{FT}), it is easy to derive that $\pi^U(k^{FT}, K^{FT}) > \pi^{FT}(k^{FT}, K^{FT})$. Moreover, the profit change of the Home firm with respect to product R&D under unilateral AD policy is as follows:

$$d\pi^U = \underbrace{\frac{\partial r}{\partial(k+K)}}_{-} \underset{-}{\frac{d\pi^U}{dr}} d(k+K) - \underset{+}{\frac{\partial f(k)}{\partial k}} dk \ .$$

From Proposition 1, since $k^U < k^{FT}$, $K^U > K^{FT}$ and $K^{FT} + k^{FT} > K^U + k^U$, we have $d(k+K) < 0$ and $dk < 0$. The latter (i.e., $dk < 0$) increases the profit of Home firm under unilateral AD policy as the home firm decreases the investment on product R&D. However, the former (i.e., $d(k+K) < 0$) decreases the profit of Home firm as the products become less differentiated. If this effect is large enough, then the profit of Home firm may even lower than that under free trade. We make this result as the following proposition.

Proposition 2. When the product R&D is taken into account, the protected firm may withdraw its anti-dumping petition as the level of aggregate product R&D drops too much.

This result in some extent explains why the protected firm withdraws its AD petition. As the aggregate investment in product R&D decreases too much, the products become less differentiated, which intensifies the competition and dampens the profit of protected firm.

4. Bilateral Anti-dumping Policy

In this section, we consider the trade retaliation case in which each government institutes antidumping action on its foreign firm. In this context, we examine how the bilateral anti-dumping policy affects the product R&D incentives of the two firms. All the model setups and game structure are the same as those in the previous section, except that now the foreign also imposes antidumping policy on the domestic firm.

In the second stage, both firms determine the optimal prices subject to the price-undertaking policies. That is to say, Home (Foreign) firm should satisfy the constraint such that $p = p^* - t$ ($P^* = P - t$) when determining its prices. The objective functions of the two firms under antidumping policies can be specified as follows:

$$L \equiv \pi + \lambda^* \left[p - \left(p^* - t \right) \right],$$

$$L^* \equiv \Pi + \lambda \left[P^* - \left(P - t \right) \right],$$

where λ and λ^* are the Largrangian multipliers. By solving $\partial L / \partial p = 0$, $\partial L^* / \partial P = 0$, $\partial L / \partial p^* = 0$, $\partial L^* / \partial P^* = 0$, $\partial L / \partial \lambda^* = 0$, and $\partial L^* / \partial \lambda = 0$ simultaneously, we can derive the optimal prices under bilateral anti-dumping as follows:

$$p^B = P^{*B} = \frac{a(b-r)+bc}{2b-r} - \frac{(b-r)t}{2(2b-r)},$$

$$p^{*B} = P^B = \frac{a(b-r)+bc}{2b-r} + \frac{(3b-r)t}{2(2b-r)},$$

where the superscript "*B*" denotes the equilibrium under bilateral anti-dumping regime. Given *k* and *K*, by comparing the prices under bilateral anti-dumping regime with respect to that under free trade regime and unilateral anti-dumping regime, we can have that $p^B < p^{FT} < p^U$, $P^{FT} < P^U = P^B$, $p^{*B} > p^{*FT} > p^{*U}$, $P^{*FT} > P^{*U} = P^{*B}$. It should be noted that the constrained firm's (i.e., Foreign firm) pricing strategy is independent of whether other firms are subject to anti-dumping policy.

Substituting p^B, P^B, $p*^B$, and $P*^B$ into (1) and (2), the outputs of Home firm and Foreign firm are as follows:

$$q^B = Q*^B = \frac{b(a-c)}{(2b-r)(b+r)} + \frac{(b^2+2br-r^2)t}{2(b^2-r^2)(2b-r)}, \tag{17}$$

$$Q^B = q*^B = \frac{b(a-c)}{(2b-r)(b+r)} - \frac{(3b^2-r^2)t}{2(b^2-r^2)(2b-r)}. \tag{18}$$

Comparing the outputs under bilateral anti-dumping regime with respect to that under free trade and unilateral anti-dumping regime, we can find that $q^B > q^U > q^{FT}$, $Q^B < Q^U < Q^{FT}$, $q*^B < q*^U < q*^{FT}$ and $Q*^B > Q*^U > Q*^{FT}$. For both firms, bilateral anti-dumping policy enlarges the market share of its protected market and shrinks the market share of its constrained market. The equilibrium profit can be derived by substituting p^B, P^B, $p*^B$, and $P*^B$ (i.e., (17) and (18)) into (3) and (4), and are as follows:

$$\pi^B = \frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2} - f(k), \tag{19}$$

$$\Pi^B = \frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2} - f(K). \tag{20}$$

Given k and K, from (7), (8), (11), (12), (19), and (20), we can show that $\pi^U > \pi^{FT} = \Pi^{FT} > \pi^B = \Pi^B = \Pi^U$. Moreover, both firms have a higher profit under free trade regime than that under bilateral anti-dumping regime. Accordingly, we can have the following two lemmas.

Lemma 1. Given the level of investment on product R&D, the competing firms have a higher profit under the regime of free trade than that under bilateral anti-dumping policies.

The intuition is as follows. When both firms are subject to the regulation of AD policies, they would raise their export price and lower their domestic price to eliminate the dumping margin. This pricing behavior implies that both firms yield some rents to its rival in their dominant market (i.e., domestic market) as receiving some compensation in their weak market (i.e., foreign market). This lowers the profits of competing firms under the regime of bilateral AD.

Lemma 2. Given the level of investment on product R&D, the constrained firm has no incentives to petition for a fight-back anti-dumping policy.

Given the level of investment in product R&D, we have derived that $\Pi^{B} = \Pi^{U}$. If petitioning for a AD protection has cost, then the constrained firm has no incentive to do so.

In the first stage, both firms determines the R&D effort on product differentiation to maximize profits, the first-order derivative of Home firm and Foreign firm can be derived by differentiating (19) with respect to k and (20) with respect to K, and are as follows:

$$\frac{d\pi^B}{dk} = \frac{\partial r}{\partial k}\frac{\partial}{\partial r}\left[\frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2}\right] - \frac{\partial f(k)}{\partial k}$$
$$= \underbrace{(-1)\frac{-b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}}_{+} - \underbrace{\frac{\partial f(k)}{\partial k}}_{+},$$

$$\frac{d\Pi^B}{dK} = \frac{\partial r}{\partial K}\frac{\partial}{\partial r}\left[\frac{b(b-r)(2a-2c-t)^2}{2(b+r)(2b-r)^2}\right] - \frac{\partial f(K)}{\partial K}$$
$$= \underbrace{(-1)\frac{-b(b^2-br+r^2)(2a-2c-t)^2}{(b+r)^2(2b-r)^3}}_{+} - \underbrace{\frac{\partial f(K)}{\partial K}}_{+}.$$

By solving $d\pi^B/dk = 0$ and $d\Pi^B/dK = 0$, we can have the optimal level of R&D investment on product differentiation, that is, k^B and K^B. Given k and K, by comparing $d\pi^B/dk$ and $d\Pi^B/dK$ with respect to $d\pi^U/dk$, $d\Pi^U/dK$, $d\pi^{FT}/dk$, and $d\Pi^{FT}/dK$, it is derivable that $d\pi^B/dk = d\Pi^B/dK = d\Pi^U/dK > d\Pi^{FT}/dK = d\pi^{FT}/dk > d\pi^U/dk$. Accordingly, compared to the free trade regime, both firms do more products R&D under bilateral anti-dumping regime. Moreover, since $k^B+K^B>k^{FT}+K^{FT}$ and $k^{FT}+K^{FT}>k^U+K^U$, the product differentiation is the largest among the three regimes. Furthermore, it is intuitive to derive that $K^U > k^B = K^B > k^U$ from $k^B+K^B>k^U+K^U$ since $k^B = K^B$ and $K^U > k^U$, we then have $K^U > k^B = K^B > k^{FT} = K^{FT} > k^U$.

Proposition 3. If both governments undertake anti-dumping policy, both firms will investment more in product R&D than they will do under free trade, resulting in a higher aggregate product R&D level.

We are now in the position to investigate whether the constrained firm, Foreign firm, has the incentive to petition for an AD protection once the product R&D is taken into account. Moreover, we would like to know whether such an AD retaliation increases or decreases the incentive of Home firm to petition for an AD protection at first.

As a first step, we shall investigate whether the Foreign firm has an incentive to sue Home firm for dumping. From Lemma 2, we know that if the level of investment on product R&D is fixed, then Foreign firm has no incentives to petition for an AD protection. However, once the level of product R&D is endogenous, we know that $K^B < K^U$ and $k^B+K^B>k^U+K^U$ (from Proposition 3), which raises the profit of Foreign firm since the products becomes more differentiated and Foreign firm invests less in product R&D. This result explains why there are so many antidumping retaliations among different countries. Accordingly, we make this result as the following proposition.

Proposition 4. When the product R&D is taken into account, anti-dumping retaliation occurs.

To investigate whether Home firm has incentive to petition for an AD protection at first, we shall compare whether the profit of Home firm under bilateral AD is larger than that under free trade. Again, from Lemma 1, given the level if product R&D, we have $\pi^{B} < \pi^{FT}$. Moreover, by decomposing the profit of Home firm under bilateral AD yields:

$$d\pi^{B} = \underbrace{\frac{\partial r}{\partial (k+K)}}_{-} \underbrace{\frac{d\pi^{B}}{dr}}_{-} d(k+K) - \underbrace{\frac{\partial f(k)}{\partial k}}_{+} dk .$$

Since $k^{B} > k^{FT}$ and $k^{B}+K^{B}>k^{FT}+K^{FT}$ (Proposition 3), we have $d(k+K) > 0$ and $dk > 0$. The former effect raises the profit of Home firm as the products becomes more differentiated, which soften the competition among firms. However, the latter effect decreases the profit of home firm as the investment in product R&D is higher. If the former effect is large enough, then the profit of Home firm under bilateral AD may larger than that under free trade. This raises the incentive of Home firm to petition for an AD protection at first. We make this result as the following proposition.

Proposition 5. When the product R&D is taken into account, an anti-dumping retaliation may increases the incentive of Home firm to petition for an

anti-dumping protection at first.

5. Conclusion

This paper aims to explain several facts about anti-dumping behaviors, including why firms withdraw their AD petitions and why AD retaliations occur. We find that the level of product R&D plays an important. Under the case of unilateral AD, the protected firm invests less on product R&D while the constrained firm invests more; however, the aggregate investment on product R&D decreases as a whole, which may lead to a too intensive market competition and dampens the profit of protected firm. Therefore, the protected firm may withdraw its AD petition. Moreover, we show that the constrained firm has the incentive to petition for an AD retaliation only if the level of product R&D is taken into account. Finally, such an AD retaliation may increase the constrained firm to petition for an AD protection as first if the aggregate product R&D under bilateral AD is large enough.

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