The Tariff Link between Enforcement Rate and Foreign Market Size

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Abstract

Because of intense international trade, infringement of intellectual property has caught the persistent attentions. This paper analyzes how domestic government decides the optimal enforcement rate through tariff link when the intellectual property is held by a foreign company. We find the domestic government would set the enforcement rate to zero when the foreign market size is small. On the contrary, when the foreign market size is large, the domestic government would raise the enforcement rate to the upper limit. Besides, when the foreign market size is moderate, the enforcement rate would be zero or at the upper limit.

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1. Introduction

K-economy is confirmed by United Nations in 1998 symbolizes the time of intellectual property is coming. Intellectual property is the enterprises' core competency, so how to protect it becoming an important issue nowadays. Besides, the increasing number of international trade and there is no legislation or institute can prohibit piracy from other countries make piracy become the question between countries. The remaining way to protect intellectual property is only governments can do something.[1] For example, U.S.A. government usually put economic pressure on China government, because there are so many counterfeiters in China. Many scholars discuss the impacts of piracy from different aspects. Krugman (1979) makes the north-south trade model to discuss piracy's impact on world distribution of income and many scholars use this model to discuss international piracy, such as Helpman (1993) bases on the North-South trade model, he analyzes the impacts on piracy made from terms of trade, production composition, available product and intertemporal allocation of counterfeiting. Glass and Saggi (2002) discuss how the South protects intellectual property influences endogenous invention, piracy and foreign direct investment cycle.

Grossman and Shapiro (1988a, 1988b) discuss domestic owner of intellectual property competes with foreign counterfeiters in domestic market, and the existence of piracy is good for domestic social welfare. Grossman and Shapiro (1988a) base on the north-south trade model and add the impact of consumers to discuss. For consumers piracy can be divided into two types: one is deceptive counterfeiting which means consumers can't determine the good is the original or pirate edition; the other is nondeceptive counterfeiting which means consumers can recognize product as the original or pirate edition. Many scholars also discuss about piracy's impact on knowledge innovation.[2]

[1] For example, according to the data of BSA 2009 shows, global piracy rate from 41% (2008) to 43% (2009), up to 514 billion US dollars which reveals the seriousness of piracy.
[2] Such as Conner and Rumelt (1991), Gallini (1992), Shy and Tisse (1999), and Takalo and Kanniainen (2000).

From the perspective of owner of intellectual property, of course, the less piracy is better and from the view of social welfare, Novos and Waldman (1984) use general model to show a better intellectual property protection can reduce social welfare losses from insufficient production. Besen and Kirby (1989) show that photocopy may not do the bad to the owner of intellectual property and also analyze the impact to social welfare. Freedman (1999) use a case to point out the impact of piracy- not only damage the image of owner of intellectual property but the more direct impact is income decreasing. The invention of the Internet makes piracy severer; however, some studies have found that if piracy through network which has network externalities, it can bring profit to the owner of intellectual property.[3]

Scholars Higgins and Rubin (1986) and Banerjee (2003) both discuss the relation between cost of enforcement and social welfare to know how to investigate piracy. Higgins and Rubin (1986) find that when there is no enforcement cost, government or owner of intellectual property investigates piracy both can have maximum of social welfare; when enforcement having cost, only government investigates piracy can have maximum of social welfare. Banerjee (2003) find that the maximum of social welfare is still possibly exists when government investigates piracy, but if the monopoly has profit when setting safety mechanism to prevent piracy not to investigate piracy is optimal.

In international trade, Grossman and Lai (2004) show that government's optimal behavior is to adopt the harmonized intellectual property protection and finance the company's research and development. However, when domestic government adopts some certain policies other governments also have their strategies or responses. Kang (2006) found that different sizes of markets and abilities of research and development led government adopts different patent policies. Not always government's policy works. Noble et al (2005) use China's automobile industry as case shows that foreign governments' pressures on it don't work. In some cases, negotiation between governments is also a common trade policy on piracy issue.[4]

In this paper, we discuss foreign government influence domestic government's enforcement rate by tariff and how domestic government reacts. We find the domestic government would set the enforcement rate to zero when the foreign market size is small. On the contrary, when the foreign market size is large, the domestic government would raise the enforcement rate to the upper limit. Besides, when the foreign market size is moderate, the enforcement rate would be zero or at the upper limit. The remainder of this paper is organized as follows. Section II briefly discusses market competence. Section III determines domestic government's optimal enforcement rate. Section IV decides foreign government's optimal tariff. Concluding remarks are presented in Section V.

2. Basic Model

We assume that there are domestic market and foreign market. In domestic market, the selling product is designed by foreign owner of intellectual property, and there are many counterfeiters of perfect competition. Domestic customers can distinguish the original from pirate edition, so they can choose to buy the original, pirate edition or neither. In other words, domestic consumers can add their welfare even they buy pirate edition. In foreign market, one domestic monopoly sells another kind of product which is different from the product selling at domestic market. However, foreign government can tax tariff on it, and use higher or lower tariff to make domestic government raise or lower the enforcement rate.[5] We use three-stage game and reverse solution method to discuss the optimal enforcement rate under no political contribution. In first-stage, foreign government makes import tariff depending on domestic government's enforcement rate. In second-stage, domestic government decides the optimal enforcement rate concerning the maximizing sum of domestic consumer surplus and domestic seller's profit. In third-stage, foreign owner of intellectual property and domestic counterfeiters go market competition under the optimal enforcement rate. Now we set domestic government's optimal enforcement rate to get perfect competition solution. We assume that p_h is the original's price, a is pirate edition's price, c_f is marginal cost of the original, b is marginal cost of pirate edition, ϕ is enforcement rate $\phi \in \left[0, \overline{\phi}\right]$, $\overline{\phi}$ is the upper bar of enforcement rate.[6]

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[3] Such as Nascimento and Vanhonacker (1988), Conner and Rumelt (1991), Takeyama (1994), and Shy and Tisse (1999).

[4] Such as An and Maskus (2009), Copeland (1990), Krakowski (2008), and Rutstrom (1995).

[5] We simplify that two products sell only at the other country.

[6] About $\overline{\phi}$ see Note 9.

Besides, we assume that there are no fixed costs of the original and pirate edition. q is the ratio of pirate edition to the original $q \in (0,1)$ which means there is only $(1-\phi)$ sellout opportunity. Under equilibrium condition for perfect competition, and pirate edition still has the quality of $q > b/c_f$. We know that counterfeiters' expect revenue equals its marginal cost $(1-\phi)a = b$.[7]

$$a = \frac{b}{1-\phi} \qquad (1)$$

In product demand, we assume every consumer only can buy one kind of product, and they have heterogeneous preference of θ, and it's uniform distribution between $[\overline{\theta}, \underline{\theta}]$, $\overline{\theta} > \overline{\theta}_0 \equiv [b(2-q)-c_f q]/[q(1-q)]$.[8] Consumers' net utility of buying different kinds of product.

$$U(\theta) = \begin{cases} \theta - p_h, & \text{Buy the original} \\ q\theta - a, & \text{Buy pirate edition} \\ 0, & \text{No consuming} \end{cases} \qquad (2)$$
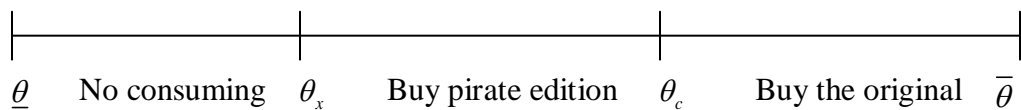
When a consumer thinks buying the original or pirate edition can get the same utility, we assume the preference as θ_c. The preference satisfies $U(\theta_c) = \theta_c - p_h = q\theta_c - a$.

$$\theta_c = \frac{p_h - a}{1-q} \qquad (3)$$

When consumers thinks buying pirate edition or nothing can get the same utility, we assume the preference as θ_x. The preference satisfies $U(\theta_x) = q\theta_x - a = 0$.

$$\theta_x = \frac{a}{q} \qquad (4)$$

From equation (3), (4) and $q \in (0,1)$, we know that consumers buy the original in the condition $\theta > \theta_c$. Under $\theta_c > \theta > \theta_x$, consumers will buy pirate edition, and when $\theta < \theta_x$ they buy nothing.

$$\underline{\theta} \quad \text{No consuming} \quad \theta_x \quad \text{Buy pirate edition} \quad \theta_c \quad \text{Buy the original} \quad \overline{\theta}$$

Therefore, demand curve of the original D_h and pirate edition D_c shows below.

$$D_h = \overline{\theta} - \theta_c = \frac{(1-q)\overline{\theta} - p_h + a}{1-q} \qquad (5)$$

$$D_c = \theta_c - \theta_x = \frac{qp_h - a}{q(1-q)} \qquad (6)$$

From equation (6), we know that the demand curve of pirate edition ($D_c > 0$) must suit

$$qp_h > a \qquad (7)$$

Because in perfect competition, counterfeiters have zero profit, however, for foreign owner of intellectual property its profit function is

$$\pi_f = (p_h - c_f)D_h \qquad (8)$$

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[7] Pirate edition has opportunity ϕ to be caught. In order to simplify, we assume that when being caught there is no penalty.

[8] The upper limit of θ, $\overline{\theta}$ can seems to be the sign of market size, and the limitation of $\overline{\theta} > \overline{\theta}_0$ see Note 9.

Partial differentiate of equation (8) with respect to p_h, and satisfy first-order conditions for profit maximization.

$$\frac{\partial \pi_f}{\partial p_h} = \overline{\theta} - \frac{2p_h - a - c_f}{1-q} = 0 \tag{9}$$

Partial differentiate of equation (9) with respect to p_h, and satisfy second-order condition for profit maximization.

$$\frac{\partial^2 \pi_f}{\partial p_h^2} = -\frac{2}{1-q} < 0 \tag{10}$$

From equation (9) we can get the optimal price of the owner of intellectual property p_h.

$$p_h = \frac{(1-q)\overline{\theta} + a + c_f}{2} \tag{11}$$

By putting equation (1) and (11) to equation (7), we can get the upper bar of pirate edition's price $\overline{a}$ and the upper limit of enforcement rate $\overline{\phi}$ when piracy is existing. [9]

$$\overline{a} = \frac{q[(1-q)\overline{\theta} + c_f]}{2-q} \tag{12}$$

$$\overline{\phi} = 1 - \frac{b(2-q)}{q[(1-q)\overline{\theta} + c_f]} \tag{13}$$

By using the result of equation (11) to equations (3)、(5)、(6)、(8), we can get results of relative variables.

$$\theta_c = \frac{(1-q)\overline{\theta} - a + c_f}{2(1-q)} \tag{14}$$

$$D_h = \frac{(1-q)\overline{\theta} + a - c_f}{2(1-q)} \tag{15}$$

$$D_c = \frac{q[(1-q)\overline{\theta} + c_f] + (q-2)a}{2(1-q)q} \tag{16}$$

$$\pi_f = \frac{[(1-q)\overline{\theta} + (a-c_f)]^2}{4(1-q)} \tag{17}$$

3. Domestic Government's Optimal Enforcement Rate

In this chapter, we are talking about domestic government's optimal enforcement rate by analyzing domestic social welfare which can be defined as domestic consumer surplus (CS) plus domestic producer surplus (PS). Besides, domestic consumer surplus (CS) can be divided as consumer surplus which consumers consume the original (CS_m) and consumer consume the pirate edition (CS_c). Domestic producer surplus is domestic producer exports products to foreign market's profit. To sum up, domestic social welfare shows as equation (18).

$$W_h(\phi) = CS_m(\phi) + CS_c(\phi) + \pi_h(\phi) \tag{18}$$

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[9] For upper limit of enforcement rate $\overline{\phi} \in [0,1]$, market size $\overline{\theta}$ must satisfy $\overline{\theta} > \overline{\theta}_0 \equiv [b(2-q) - c_f q]/[q(1-q)]$.

$\pi_h(\phi)$ represents domestic producer exports products to foreign market's profit. We talk about foreign market here because of $\pi_h(\phi)$. Assume y_h as domestic producer exports the product to foreign market's quantities and p_f as the domestic product's price in foreign market. Therefore, the equation of product's demand curve shown below.

$$p_f = \alpha - \beta y_h \qquad (19)$$

α and β are both larger than zero, and to simplify we assume $\beta = 1$. Therefore, domestic producer's profit function π_h shown below.

$$\pi_h = (p_f - t)y_h = [p_f - (1-\phi)\tau]y_h \qquad (20)$$

$t(=(1-\phi)\tau)$ represents the unit tariff taxed by foreign government. In order to emphasize that foreign government can influence domestic government's optimal enforcement rate by taxing unit tariff, we assume the higher enforcement rate the lower unit tariff. Besides, to compare and explain easily, we named τ tariff link.

By putting equation (19) to equation (20) and partial differentiate of π_h with respect to y_h, domestic producer's first-order conditions for profit maximization shown below.

$$\frac{\partial \pi_h}{\partial y_h} = (\alpha - 2y_h) - t = 0 \qquad (21)$$

$\alpha - 2y_h$ represents marginal revenue and t represents marginal cost. Domestic producer's profit will maximize when $\alpha - 2y_h$ equals t. In given tariff, y_h can be derived from equation (21).

$$y_h = \frac{\alpha - t}{2} \qquad (22)$$

By putting equation (22) to equation (19), we can get p_f. In given tariff, p_f, π_h, foreign consumer surplus CS_f, foreign government's tariff income T_f, and foreign social welfare W_f shown below.[10]

$$p_f = \frac{\alpha + (1-\phi)\tau}{2} \qquad (23)$$

$$\pi_h = \frac{[\alpha - (1-\phi)\tau]^2}{4} \qquad (24)$$

$$CS_f = \frac{[\alpha - (1-\phi)\tau]^2}{8} \qquad (25)$$

$$T_f = \frac{[\alpha - (1-\phi)\tau](1-\phi)\tau}{2} \qquad (26)$$

$$W_f = \frac{[\alpha - (1-\phi)\tau]^2}{8} + \frac{[\alpha - (1-\phi)\tau](1-\phi)\tau}{2} + \pi_f(\tau) \qquad (27)$$

Go back to domestic social welfare. By putting consumer surplus which consumers consume the original is $\theta - p_h$ and consumer consume the pirate edition $q\theta - p_f$ from equation (2) to equation (18), we can get domestic social welfare function shown below.[11]

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[10] We represent π_f as the function of τ, because we haven't solved π_f yet.

[11] We represent π_h as the function of ϕ, because we haven't solved π_h yet.

$$W_h(\phi) = \int_{\theta_c}^{\bar{\theta}} (\theta - p_h) d\theta + \int_{\theta_x}^{\theta_c} (q\theta - \frac{b}{1-\phi}) d\theta + \pi_h(\phi)$$

$$= \frac{1}{8} [\bar{\theta} + \frac{1}{1-q} (\frac{b}{1-\phi} - c_f)] \{(1+2q)\bar{\theta} - \frac{1}{1-q} [\frac{(3-2q)b}{1-\phi} + (1-2q)c_f]\}$$

$$+ \frac{q}{8} [\bar{\theta} + \frac{c_f}{1-q} - \frac{b(2-q)}{q(1-\phi)(1-q)}]^2 + \frac{1}{4} [\alpha - \tau(1-\phi)]^2 \tag{28}$$

Besides, we can rewrite equation (28) to $W_h(\phi) = W_h^0(\phi) + \pi_h(\phi)$.

$W_h^0(\phi) = \int_{\theta_c}^{\bar{\theta}} (\theta - p_h) d\theta + \int_{\theta_x}^{\theta_c} (q\theta - \frac{b}{1-\phi}) d\theta$ and from Wang and Yang (2008) we know $W_h^0(\phi)$ is a convex

function, shown as figure 1. When the minimum of the function is $\phi = \tilde{\phi}_N^0$, $\tilde{\phi}_N^0$ shown as (29). The maximum of $W_h^0(\phi)$ exists when $\phi = 0$.

$$\tilde{\phi}_N^0 = 1 - \frac{b(4-3q)}{q[c_f + 3(1-q)\bar{\theta}]} \tag{29}$$

$\pi_h(\phi)$ of equation (24) shown as Figure 2 and it's an increasing function.

From Figure 1 and Figure 2, if relative maximum of $W_h(\phi)$ exists, ϕ must between 0 and $\tilde{\phi}_N^0$. We explain as below. Between $\tilde{\phi}_N^0$ and $\bar{\phi}$, $W_h^0(\phi)$ and $\pi_h(\phi)$ are both increasing functions, so there are no relative maximum. Besides, between 0 and $\tilde{\phi}_N^0$, if relative maximum ϕ^* exists it must satisfied $\phi > \phi^*$ and $W_h^0(\phi)$ decreasing faster than $\pi_h(\phi)$ increasing. However, $W_h^0(\phi)$ is decline decreasing when $\phi < \tilde{\phi}_N^0$, so $W_h(\phi)$ won't have maximum. Government's optimal enforcement rate must be 0 or $\bar{\phi}$.

$W_h(\bar{\phi}) - W_h(0) = [W_h^0(\bar{\phi}) - W_h^0(0)] + [\pi_h(\bar{\phi}) - \pi_h(0)]$, from Wang and Yang (2008) we know $[W_h(\bar{\phi}) - W_h(0)] < 0$ and from equation (24) we get the second part is larger than zero. When foreign market size α close to zero then $[W_h(\bar{\phi}) - W_h(0)] < 0$, but $\partial[\pi_h(\bar{\phi}) - \pi_h(0)]/\partial\alpha = \tau\bar{\phi}/2 > 0$. Therefore, when α is infinite then $[W_h(\bar{\phi}) - W_h(0)] > 0$. Given τ, we can get a critical value $\underline{\alpha}(\tau)$ which satisfies $[W_h(\bar{\phi}) - W_h(0)] = 0$.[12]

$$\underline{\alpha}(\tau) = \frac{2bq[c_f + 3(1-q)\bar{\theta}](1-\bar{\phi}) - b^2(4-3q)(2-\bar{\phi}) + 2(1-q)q\tau^2(2-\bar{\phi})(1-\bar{\phi})^2}{4(1-q)q\tau(1-\bar{\phi})^2}$$

$$= \frac{b^2(4-3q)\bar{\phi} + 2(1-q)q\tau^2(2-\bar{\phi})(1-\bar{\phi})^2}{4(1-q)q\tau(1-\bar{\phi})^2} \tag{30}$$

To sum up, when $\alpha > \underline{\alpha}(\tau)$ the optimal enforcement rate is $\bar{\phi}$, on the contrary, the optimal enforcement rate is 0.

Proposition 1. When $\alpha > \underline{\alpha}(\tau)$ the optimal enforcement rate is $\bar{\phi}$, on the contrary , the optimal enforcement rate is 0.

Domestic social welfare equals consumer surplus plus export profit, so domestic government should consider both side to decide optimal enforcement rate. When foreign market α is small, domestic government will take domestic consumer's welfare seriously.

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[12] Putting $\bar{\phi}$ into $2bq[c_f + 3(1-q)\bar{\theta}](1-\bar{\phi}) - b^2(4-3q)(2-\bar{\phi})$, part of equation (30), and after simplify, we can get $b^2(4-3q)\bar{\phi} > 0$. That is $\underline{\alpha}(\tau) > 0$.

However, when foreign market α is large enough, domestic government will take domestic producer's profit seriously. That is, when α is small, the optimal enforcement rate of domestic government is zero, on the contrary, the optimal enforcement rate is $\bar{\phi}$. In the latter case, foreign government can use tariff ($t = (1-\phi)\tau$) to influence the setting of enforcement rate.

4. Foreign Government's Optimal Tariff

In this chapter, we will use foreign social welfare to get foreign government's optimal tariff by given domestic government enforcement rate and foreign import tariff ($t = (1-\phi)\tau$). Foreign social welfare $W_f(\tau)$ equals foreign consumer surplus CS_f, tariff income T_f, and producer surplus PS. Foreign consumer surplus CS_f equals foreign owner of intellectual property's profit π_f. Combine equations (1), (17), and (27), foreign social welfare shown as equation (31).

$$W_f(\tau) = \frac{[\alpha-(1-\phi)\tau]^2}{8} + \frac{[\alpha-(1-\phi)\tau](1-\phi)\tau}{2} + \frac{[(1-q)\bar{\theta}+(\frac{b}{1-\phi}-c_f)]^2}{4(1-q)} \qquad (31)$$

Domestic government's optimal enforcement rate ϕ will influence by foreign market size α. As proposition 1 describing, when $\alpha > \underline{\alpha}(\tau)$ then $\phi = \bar{\phi}$ and $\alpha < \underline{\alpha}(\tau)$ then $\phi = 0$. Although ϕ influences by τ, there are only two actual values of ϕ.

Therefore, given different ϕ, foreign government's optimal tariff link $\tau = \alpha/[3(1-\phi)]$ will be $\tau = \alpha/[3(1-\bar{\phi})] (\equiv \tau_1)$ and $\tau = \alpha/3 (\equiv \tau_2)$ when $\phi = \bar{\phi}$ and $\phi = 0$ ($\tau_1 > \tau_2$).[13] $\underline{\alpha}(\tau)$ partial differentiate of τ, we can get the solution.

$$\frac{\partial \underline{\alpha}(\tau)}{\partial \tau} = (1-\frac{\bar{\phi}}{2}) - \frac{b^2(4-3q)\bar{\phi}}{4(1-q)q\tau^2(1-\bar{\phi})^2} \qquad (32)$$

To simplify, we assume counterfeiters' marginal cost b is small enough then equation (32) will be positive. The economics meaning of positive equation (32) is that when tariff link τ is larger and under the same enforcement rate, domestic producer will face higher tariff to export. In order to larger domestic producer's profit, foreign market size α must be larger and then enforcement rate will stay at $\bar{\phi}$. This is Corollary 1.[14]

Corollary 1. When domestic counterfeiters' marginal cost b is smaller, foreign government's tariff link τ and $\underline{\alpha}(\tau)$ will larger.

Under Corollary 1 establishing, we will discuss three situations because of $\tau_1 > \tau_2$ then $\underline{\alpha}(\tau_1) > \underline{\alpha}(\tau_2)$.

[Situation 1] When foreign market size is too small, that is $\alpha < \underline{\alpha}(\tau_2)$.

At this time, domestic enforcement rate will be $\phi = 0$. Therefore, the foreign government's optimal tariff t will be $\alpha/3$ when $\tau = \tau_2$.

[Situation 2] When foreign market size is big enough, that is $\alpha > \underline{\alpha}(\tau_1)$.

At this time, domestic enforcement rate will be $\phi = \bar{\phi}$. Therefore, the foreign government's optimal tariff t will be $\alpha/3$ when $\tau = \tau_1$.

[Situation 3] When foreign market size is moderate, that is $\alpha \in (\underline{\alpha}(\tau_2), \underline{\alpha}(\tau_1))$.

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[13] Getting from the first two part of equation (31).

[14] Equation (32) partial differentiate of q and simplify, we can get $b^2\bar{\phi}(2-3q)(2-q)/4(1/q)^2q^2\tau^2(1-\bar{\phi})^2$, which means when $q<(>)2/3$, the larger the q the equation (32) is more likely to be positive (negative). That is, we use b instead of q to talk about the influence of equation (32).

First, the domestic optimal enforcement rate will differ from foreign government's optimal tariff link. For example, when tariff link $\tau = \tau_2$, domestic optimal enforcement rate will be $\phi = \bar{\phi}$, however, when $\tau = \tau_1$, domestic optimal enforcement rate will be $\phi = 0$. Given the same tariff link, foreign social welfare function under different enforcement rate will be shown below.

$$W_f(\phi = 0) = \frac{(\alpha - \tau)^2}{8} + \frac{(\alpha - \tau)\tau}{2} + \frac{[(1-q)\bar{\theta} + (b - c_f)]^2}{4(1-q)} \qquad (33)$$

$$W_f(\phi = \bar{\phi}) = \frac{[\alpha - (1-\bar{\phi})\tau]^2}{8} + \frac{[\alpha - (1-\bar{\phi})\tau](1-\bar{\phi})\tau}{2} + \frac{[(1-q)\bar{\theta} + (\frac{b}{1-\bar{\phi}} - c_f)]^2}{4(1-q)} \qquad (34)$$

Second, when $\tau \in (\tau_2, \tau_1)$, we can find a $\alpha \in (\underline{\alpha}(\tau_2), \underline{\alpha}(\tau_1))$ which lets $\alpha > \underline{\alpha}(\tau)$. That is, the domestic optimal enforcement rate will be $\bar{\phi}$. When $\alpha < \underline{\alpha}(\tau)$, the domestic optimal enforcement rate will be 0. So that, we can derive that when $\alpha \in (\underline{\alpha}(\tau_2), \underline{\alpha}(\tau_1))$, we can find market size α and $\tau(\alpha) \in (\tau_2, \tau_1)$ which let domestic government will to take enforcement rate ϕ as $\bar{\phi}$ or 0.[15] Comparing the third part of equation (33) and (34), the latter is larger than the former. However, when b is small, this difference will smaller.

The sum of first two parts of equation (34) will larger $(\alpha\tau_1\bar{\phi}^2)/[8(1-\bar{\phi})]$ than the sum of first two parts of equation (33) when τ close to τ_1; the sum of first two parts of equation (34) will smaller $(\alpha\tau_2\bar{\phi}^2)/8$ than the sum of first two parts of equation (33). Therefore, when b is smaller, we can find a market size $\alpha^* \in (\underline{\alpha}(\tau_2), \underline{\alpha}(\tau_1))$ and $\tau(\alpha^*) \in (\tau_2, \tau_1)$ which can let the domestic optimal enforcement rate will be $\bar{\phi}$ when $\alpha > \alpha^*$.[16] When $\alpha < \alpha^*$, the tariff link $\tau(\alpha)$ will make the domestic optimal enforcement rate be 0. Notice that in $\alpha \in (\underline{\alpha}(\tau_2), \underline{\alpha}(\tau_1))$, foreign government has chance by not setting optimal tariff to influence domestic government's optimal enforcement rate. For example, when $\alpha > \alpha^*$, tariff t is smaller than $\alpha/3$; when $\alpha < \alpha^*$, t will larger than $\alpha/3$. Summarizing three situations above, we can get Proposition 2.

Proposition 2. When foreign market size $\alpha > \alpha^*$, foreign government can through the tariff link $\tau(\alpha)$ which makes the domestic optimal enforcement rate be $\bar{\phi}$; when $\alpha > \alpha^*$. When $\alpha < \alpha^*$, the tariff link $\tau(\alpha)$ will make the domestic optimal enforcement rate be 0.

The price of pirate edition a will increase with the increasing of pirate edition's marginal cost b, because $a = b/(1-\phi)$. The increasing of pirate edition's price also lets domestic consumers consume the original and then foreign producer's profit π_f will increase. At this time, the third part of equation (34) is more important than the sum of first two parts. That is, α^* will decrease and then the situation of $\alpha > \alpha^*$ will be shown up easily. This is Corollary 2.

Corollary 2. When pirate edition's marginal cost b increasing, foreign market size's critical value α^* will decrease. Foreign government can through tariff link to let domestic government's enforcement rate be $\bar{\phi}$.

To sum up, we can get Table 1.

For direct-viewing of economics, when foreign market size is larger domestic government will take export producer's profit into account. That is, domestic government will influence by foreign government's tariff policy and then set the enforcement rate be $\bar{\phi}$. On the contrary, the enforcement rate will be zero.

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[15] $\tau(\alpha)$ is the inverse function of $\underline{\alpha}(\tau)$.

[16] Using α^* and $\tau(\alpha^*)$ can let equation (33) equals equation (34).

5. Conclusion

With technological developments and growing of international trade, protecting intellectual property is a very important issue which must to be discussed by both trading countries. In this paper, we assume intellectual property is owned by foreign owner of intellectual property and there are many counterfeiters in domestic market. Besides, we assume there is no cost of piracy investigation. The study result is that the domestic government would set the enforcement rate to zero when the foreign market size is small. On the contrary, when the foreign market size is large, the domestic government would raise the enforcement rate to the upper limit. Besides, when the foreign market size is moderate, the enforcement rate would be zero or at the upper limit.

To simplify, we don't assume that foreign producer can influence foreign government's act by political contributions. However, in reality it's impossible. If foreign owner of intellectual property influence foreign government by political contributions and then domestic government's enforcement rate will increase. Besides, there are still many ways to influence another government's trading policies, such as political pressure and economic policies. However, in this paper we only focus on the impacts of using tariff. Maybe other ways can be discussed by others in the future.

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Table1. Governments' Optimal Decisions and Foreign Market Size

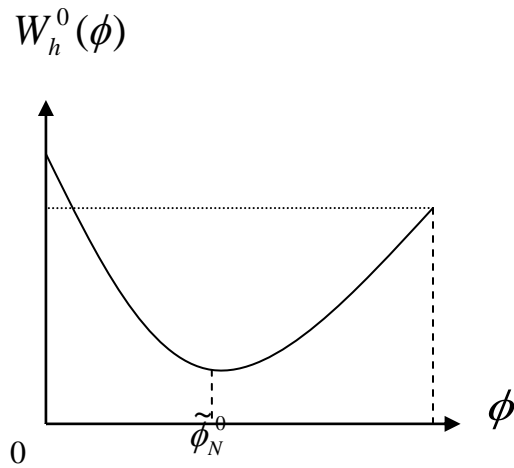| Foreign Market Size α	Enforcement Rate ϕ	Tariff Link τ	Tariff t
$\alpha < \underline{\alpha}(\tau_2)$	0	$\tau_2 = \dfrac{\alpha}{3}$	$\dfrac{\alpha}{3}$
$\alpha \in (\underline{\alpha}(\tau_2), \alpha^*)$	0	$\tau(\alpha) \in (\tau_2, \tau_1)$	$> \dfrac{\alpha}{3}$
$\alpha \in (\alpha^*, \underline{\alpha}(\tau_1))$	$\bar{\phi}$	$\tau(\alpha) \in (\tau_2, \tau_1)$	$< \dfrac{\alpha}{3}$
$\alpha > \underline{\alpha}(\tau_1)$	$\bar{\phi}$	$\tau_1 = \dfrac{\alpha}{3(1-\bar{\phi})}$	$\dfrac{\alpha}{3}$

.

$$W_h^0(\phi)$$

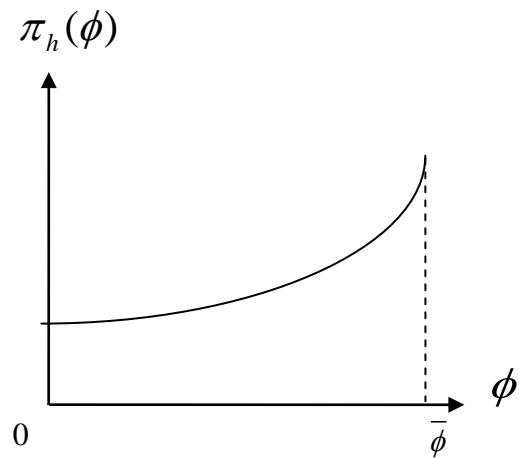Figure 1 Domestic Social Welfare Function without Domestic Producer's Profit

$$\pi_h(\phi)$$

Figure 2 Domestic Producer's Profit