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International Outsourcing, Tax and Patent Protection

by

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Abstract

We show that, in the case of a vertical technology transfer, if there is imperfect knowledge spillover under a weak patent protection, the strong patent protection in the developing country increases the profit of the developed-country firm if there is a uniform tax rate in the developing country. If there is either perfect knowledge spillover under weak patent protection or the developing country charges discriminatory tax rates, the profits of the developed-country firms are the same under weak and strong patent protections in the developing countries.

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Non-Technical Summary

An important suggestion of the WTO is to strengthen patent protection in the developing countries in order to give the developed-country firms proper returns from their innovations. However, the existing literature shows that a strong patent protection in the developing countries may reduce the profits of the developed-country firms under a vertical technology transfer. We show that this result does not hold in the presence of government intervention.

We show that, under a vertical technology transfer, if there is imperfect knowledge spillover under a weak patent protection, the strong patent protection in the developing country increases the profit of the developed-country firm if there is a uniform tax rate in the developing country. If there is either perfect knowledge spillover under weak patent protection or the developing country charges discriminatory tax rates, the profits of the developed-country firms are the same under weak and strong patent protections in the developing countries.

1. Introduction

Under the current WTO (World Trade Organization) regime, an important issue is the standardization (and strengthening) of patent systems across countries, and it has gathered momentum due to the Dunkel proposal in connection with Trade Related Intellectual Property Rights (TRIPS). An important aspect of this standardization process is to strengthen patent protection in the developing countries. It is often the case that a weak patent protection in the developing country allows the developing-country firms to compete with the developed-country firms after imitating the technologies of the latter firms. Thus, a weak patent protection in the developing country may reduce innovation in the developed country by reducing the return of the innovator in the developed-country.

It follows from Pack and Saggi (2001) that the above view may not be correct if there is a vertical technology transfer.¹ Their analysis suggests that knowledge spillover in the developing countries² may actually increase the profits of the developed-country firms, which outsource production to the developing countries. Hence, as an important implication of their work, a strong patent protection in the developing countries may actually reduce the profits and innovation in the developed

¹ A large body of empirical evidence shows that vertical knowledge transfer occurs as firms from industrialized countries have bought outputs of firms from Asian newly industrialized countries (Hobday, 1995). As mentioned in Pack and Saggi (2001), Radio Shack and Texas Instruments have commissioned firms from newly industrialized countries to produce components or entire products, which have been sold under the name of the retailers. The results of extensive interviews in Korea in the late 1970s show that almost half of the firms in the sample benefitted from the technical information provided by the foreign buyers (Rhee et al., 1984). Keesing (1982) found that, in Korea and Taiwan in the late 1970s, importers maintained a very large staffs based in the countries which spent considerable time with their local manufacturers. Hou and Gee (1993) also confirm significant technology transfer by developed country importers to the producers from newly industrialized countries.

² The presence of weak property rights in several Asian countries along with the type of knowledge transferred made it difficult to prevent knowledge spillover in the producing countries. As documented in Becker (1964), the training provided by the developed country firms are highly transferable to other firms.

countries in the presence of vertical technology transfer, thus contradicting the view of WTO.

We develop a simple model of international outsourcing with an active developing-country government, which imposes per-unit tax on the developing-country firms, to revisit this issue. We consider two situations: (i) where the outputs are not sold in the developing country (which is the producing country), and (ii) where the outputs are sold entirely in the developing country. In each of these situations, we consider uniform and discriminatory taxes imposed by the developing country. Though discriminatory tax rates provide the government distributional flexibility, the uniform tax rates are simpler and easier to implement. As mentioned in Coşgel (2006, pp. 333) “The cost of administering a system with discriminatory rates can be very high when the characteristics of tax payers do not differ systematically or when these differences cannot be easily observed. It is generally easier to identify differences between the sectors of the economy than within each sector, making it harder to implement discriminatory rates within a sector.”³

In this framework, we show that if the knowledge spillover under weak patent protection is imperfect, the strong patent protection, which eliminates knowledge spillover in the developing country, makes the developed-country firm (which is outsourcing its production to the developing country) better off under a uniform tax policy. If there is either perfect knowledge spillover under weak patent protection or the developing country imposes discriminatory tax rates, the profit of the developed-country firm is the same under weak and strong patent protections. Thus, our result suggests that, in the presence of an active developing-country government, a strong

³ Davidson et al. (2005) show that even if an economy sets a uniform tax rate, the effective taxation may be closer to an optimal discriminatory tax system if the firms self-select into a black market.

patent policy in the developing country may be required to encourage vertical technology transfer.

The remainder of the paper is organized as follows. Section 2 describes the model and shows the results. Section 3 concludes.

2. The model and the results

We adopt the model from Pack and Saggi (2001). Assume that there are three firms: firm 1 from a developed country (called country 1), firm 2, which is an incumbent producer in a developing country (called country 2) and firm 3, which is a potential producer in the developing country. The profit firm 1 can earn by producing in country 1 is normalized to zero. We assume that firm 1 transfers its technology to firm 2, which produces the output at the marginal cost c_1 , which is assumed to be zero for simplicity. However, if there is a weak patent protection in country 2, technology transfer to firm 2 may create knowledge spillover, which allows firm 3 to compete with firm 2 at the constant marginal cost $c \geq 0$. If $c > 0$, knowledge spillover in the developing country is imperfect. Technical complexity may affect the benefit from knowledge spillover, thus affecting the value of c . Though firm 1 loses control over its technology due to knowledge spillover in country 2 under a weak patent protection, we assume that firms 2 and 3 do not have enough marketing skills to sell the product. Hence, firm 1 does not face any threat of competition in the product market from firms 2 and 3. We assume that there is no knowledge spillover under a strong patent protection in country 2. Hence, there is no production of firm 3 under a strong patent protection in country 2.

We consider the following game. At stage 1, firm 1 transfers its technology to firm 2. However, if there is a weak patent protection in country 2, knowledge about

firm 1's technology diffuses to firm 3, while firm 2 remains the sole producer of the product under a strong patent protection in country 2. At stage 2, the government of country 2 imposes per-unit output tax on the producers in country 2. At stage 3, firm 2 chooses its output if there is no knowledge spillover in country 2, and the output is sold to firm 1 at the per-unit price w , which is determined from the demand faced by firm 2. However, in the presence of knowledge spillover, at stage 3, both firms 2 and 3 produce the outputs like Cournot duopolists, and the outputs are sold to firm 1 at the per-unit price w , which is determined from the total demand faced by firms 2 and 3. At stage 4, firm 1 determines its output and the profits are realized. We solve the game through backward induction.

Assume that the market demand function is

$$P = a - q, \quad (1)$$

where P is the price and q is the output, and $a > c$.

2.1. Uniform tax policy

Let us first consider the situation where the government of country 2 imposes a uniform tax rate, t . Given w , firm 1 maximizes the following expression to determine its output:

$$\text{Max}_q (a - q - w)q. \quad (2)$$

The equilibrium output is

$$q_1^* = \frac{a - w}{2}, \quad (3)$$

The second order condition for maximization is satisfied. Equation (3) creates the inverse derived demand curve $w = a - 2q_1$ for the firms in country 2.

2.1.1. Strong patent protection in country 2

Let us first consider the situation of a strong patent protection, i.e., of no knowledge spillover, in country 2. In this situation, only firm 2 produces in country 2. Firm 2 produces its output to maximize the following expression:

$$\text{Max}_{q_{12}} (a - 2q_{12} - t)q_{12}. \quad (4)$$

The equilibrium output of firm 2 is

$$q_{12}^* = \frac{a - t}{4}. \quad (5)$$

The second order condition for maximization is satisfied.

If the products of firm 1 are not sold in country 2, welfare of country 2 is $W_2 = (w - t)q_{12} + tq_{12} = wq_{12}$. Government of country 2 determines t to maximize the following expression:

$$\text{Max}_t \frac{(a^2 - t^2)}{8}. \quad (6)$$

The equilibrium tax rate is

$$t^* = 0. \quad (7)$$

The second order condition for maximization is satisfied.

The equilibrium outputs of firms 1 and 2 are $q_1^* = q_{12}^* = \frac{a}{4}$. The price paid by firm 1 is $w^* = \frac{a}{2}$ and the equilibrium profit of firm 1 is

$$\pi_1^* = \frac{a^2}{16}. \quad (8)$$

Welfare of country 2 is given by $W_2 = \frac{a^2}{8}$.

Let us now consider the situation where all the outputs of firm 1 are sold in country 2. In this situation, welfare of country 2 is

$W_2 = (w - t)q_{12} + tq_{12} + \frac{q_{12}^2}{2} = wq_{12} + \frac{q_{12}^2}{2}$. Government of country 2 determines t to

maximize the following expression:

$$\text{Max}_t \frac{(a^2 - t^2)}{8} + \frac{(a - t)^2}{32}. \quad (9)$$

The equilibrium tax rate is

$$t^* = -\frac{a}{3}. \quad (10)$$

The equilibrium outputs of firms 1 and 2 are $q_1^* = q_{12}^* = \frac{a}{3}$. The price paid by firm 1

is $w^* = \frac{a}{3}$ and the equilibrium profit of firm 1 is

$$\pi_1^* = \frac{a^2}{9}. \quad (11)$$

Welfare of country 2 is $W_2 = \frac{a^2}{6}$.

2.1.2. Weak patent protection in country 2

Now consider the case of a weak patent protection, which creates knowledge spillover, in country 2. In this situation, both firms 2 and 3 produce in country 2. Total demand faced by firms 2 and 3 is $w = a - 2q_1$.

Firms 2 and 3 produce their outputs to maximize the following expressions respectively:

$$\text{Max}_{q_{12}} (a - 2q_{12} - 2q_{13} - t)q_{12} \quad (12a)$$

$$\text{Max}_{q_{13}} (a - 2q_{12} - 2q_{13} - t - c)q_{13}. \quad (12b)$$

The equilibrium outputs of firms 2 and 3 are respectively

$$q_{12}^* = \frac{a-t+c}{6} \quad (13a)$$

$$q_{13}^* = \frac{a-t-2c}{6}. \quad (13b)$$

The second order conditions for maximization are satisfied.

If the products of firm 1 are not sold in country 2, welfare of country 2 is $W_2 = (w-t)q_{12} + (w-t-c)q_{13} + tq_1 = wq_1 - cq_{13}$, where $q_1 = q_{12} + q_{13}$, and the government of country 2 determines t to maximize the following expression:

$$\text{Max}_t \frac{(a+2t+c)(2a-2t-c)}{18} - \frac{c(a-t-2c)}{6}. \quad (14)$$

The equilibrium tax rate is

$$t^* = \frac{2a-c}{8}. \quad (15)$$

The second order condition for maximization is satisfied.

The equilibrium outputs of firms 2 and 3 are respectively $q_{12}^* = \frac{2a+3c}{16}$ and

$q_{13}^* = \frac{2a-5c}{16}$. We assume that $c < \frac{2a}{5}$, which ensures positive output of firm 2.

The price paid by firm 1 is $w^* = \frac{2a+c}{4}$. The equilibrium output of firm 1 is

$q_1^* = \frac{2a-c}{8}$, and the equilibrium profit of firm 1 is

$$\pi_1^* = \frac{(2a-c)^2}{64}. \quad (16)$$

Let us now consider the situation where all the outputs of firm 1 are sold in country 2. In this situation, welfare of country 2 is

$W_2 = (w-t)q_{12} + (w-t-c)q_{13} + tq_1 + \frac{q_1^2}{2} = wq_1 - cq_{13} + \frac{q_1^2}{2}$. The government of

country 2 determines t to maximize the following expression:

$$Max_t \frac{(a+2t+c)(2a-2t-c)}{18} - \frac{c(a-t-2c)}{6} + \frac{(2a-2t-c)^2}{72}. \quad (17)$$

The equilibrium tax rate is

$$t^* = 0. \quad (18)$$

The second order condition for maximization is satisfied.

The equilibrium outputs of firms 2 and 3 are respectively $q_{12}^* = \frac{a+c}{6}$ and

$q_{13}^* = \frac{a-2c}{6}$. We assume that $c < \frac{a}{2}$, which ensures positive output of firm 2.

The price paid by firm 1 is $w^* = \frac{a+c}{3}$. The equilibrium output of firm 1 is

$q_1^* = \frac{2a-c}{6}$, and the equilibrium profit of firm 1 is

$$\pi_1^* = \frac{(2a-c)^2}{36}. \quad (19)$$

Proposition 1: Consider a uniform tax policy in the developing country (i.e., country 2).

(i) If all the outputs of firm 1 are sold outside country 2, a weak patent protection in country 2 reduces the profit of firm 1 for $c > 0$.

(ii) If all the outputs of firm 1 are sold in country 2, a weak patent protection in country 2 reduces the profit of firm 1 for $c > 0$.

Proof: (i) The comparison of (8) and (16) shows that (8) > (16) for any $c > 0$.

(ii) The comparison of (11) and (19) shows that (11) > (19) for any $c > 0$. Q.E.D.

Proposition 1 shows that if the government of country 2 plays an active role and imposes output-tax on the producers in country 2, knowledge spillover under

vertical technology transfer reduces the profit of the developed-country firm, thus contrasting Pack and Saggi (2001). It follows from the above analysis that knowledge spillover does not affect the profit of the developed-country firm if $c = 0$, i.e., if knowledge spillover is perfect.

The reason for the above result is as follows. Weak patent protection (compared to strong patent protection) increases the tax rate in country 2. If the outputs of firm 1 are not sold in country 2, the government of country 2 sets the tax rate to maximize the total profits of the firms in country 2. Since competition under weak patent protection tends to increase output and reduce the total profits of the firms in country 2, it increases the incentive to increase the tax rate compared to a strong patent protection, where firm 2 becomes the monopoly producer in country 2. If the outputs of firm 1 are sold entirely in country 2, the government of country 2 cares about both the profits of the firms in country 2 and consumer surplus. Since weak patent protection increases competition in country 2, which helps to reduce the total profits of the firms in country 2 but to increase consumer surplus, it increases the incentive for higher tax (or lower subsidy as evident from (10) and (18)) compared to a strong patent protection in country 2. Hence, on one hand, given the tax rate, weak patent protection tends to reduce the price paid by firm 1. On the other hand, weak patent protection increases the tax rate compared to a strong patent protection, which, in turn, tends to increase the price paid by firm 1. On the balance, the price paid by firm 1 is higher under weak patent protection, thus reducing its profit under weak patent protection compared to a strong patent protection.

It is worth mentioning that, due to the asymmetry between firms 2 and 3, one may think that the welfare maximizing government of country 2 may prefer to set the tax rate in a way so that only firm 2 (i.e., the cost efficient producer) produces.

However, it is easy to check that this is not the case, and the government of country 2 prefers to set the uniform tax rate in a way so that both firms 2 and 3 produce.

2.2. Discriminatory tax policy

Let us now consider the case where the government of country 2 imposes discriminatory taxes t_2 and t_3 to firms 2 and 3 respectively. Given w , firm 1 maximizes (2) and the equilibrium output is given by (3), which gives the inverse derived demand curve $w = a - 2q_1$ for the firms in country 2.

2.2.1. Strong patent protection in country 2

If there is no knowledge spillover, the analysis is similar to subsection 2.1.1. If the outputs of firm 1 are not sold in country 2, the profit of firm 1 is $\pi_1^* = \frac{a^2}{16}$, which is shown in (8). If the outputs of firm 1 are sold entirely in country 2, the profit of firm 1 is $\pi_1^* = \frac{a^2}{9}$, which is shown in (11).

2.2.2. Weak patent protection in country 2

Now consider the case of a weak patent protection in country 2. In this situation, both firms 2 and 3 produce in country 2. It follows from (3) that the demand function faced by the firms in country 2 is $w = a - 2q_1$. Therefore, firms 2 and 3 produce their outputs to maximize the following expressions respectively:

$$\underset{q_{12}}{\text{Max}}(a - 2q_{12} - 2q_{13} - t_2)q_{12} \quad (20a)$$

$$\underset{q_{13}}{\text{Max}}(a - 2q_{12} - 2q_{13} - t_3 - c)q_{13}. \quad (20b)$$

The equilibrium outputs of firms 2 and 3 are respectively

$$q_{I2}^* = \frac{a - 2t_2 + t_3 + c}{6} \quad (21a)$$

$$q_{I3}^* = \frac{a - 2t_3 + t_2 - 2c}{6}. \quad (21b)$$

The second order conditions for maximization are satisfied.

If the products of firm 1 are not sold in country 2, welfare of country 2 is $W_2 = (w - t_2)q_{I2} + (w - t_3 - c)q_{I3} + t_2q_{I2} + t_3q_{I3} = wq_{I2} - cq_{I3}$, and the government of country 2 determines t to maximize the following expression:

$$\underset{t_2, t_3}{Max} \frac{(a + t_2 + t_3 + c)(2a - t_2 - t_3 - c)}{18} - \frac{c(a - 2t_3 + t_2 - 2c)}{6}. \quad (22)$$

The optimal tax rates are

$$-2(t_2^* + t_3^*) + a - 5c = 0 \quad (23a)$$

$$-2(t_2^* + t_3^*) + a + 4c = 0. \quad (23b)$$

Both (23a) and (23b) cannot hold simultaneously, which implies that either t_2 or t_3 does not have an interior equilibrium value.

If the tax rates satisfy (23a), welfare of country 2 is

$$W_2 = \frac{9a^2 - 9c^2 - 6c(3a - 9c - 3t_3^*)}{72}. \quad (24)$$

However, if the tax rates satisfy (23b), welfare of country 2 is

$$W_2 = \frac{9a^2 - 36c^2 - 6c(3a - 3t_3^*)}{72}. \quad (25)$$

Comparison of (24) and (25) shows that (24) is greater than (25). Hence, welfare of country 2 is maximized if the equilibrium tax rates satisfy (23a). If the tax rates satisfy (23a), we get from (23b) that welfare of country 2 changes positively with respect to t_3 . Hence, the tax rate t_3^* will be as high as possible. However, a higher t_3^*

may make production unprofitable for firm 3. For a given t_2^* , if $t_3^* > \frac{a-2c+t_2^*}{2}$, we get $q_{I3}^* = 0$, and only firm 2 produces in country 2.

The above discussion suggests that, under discriminatory tax rates, welfare of country 2 under a weak patent protection is maximized if firm 3 does not produce positive outputs. However, it should be noted that, if $q_{I3}^* = 0$ and the outputs are not sold in country 2, welfare of country 2 would not be $W_2 = (w-t_2)q_{I2} + (w-t_3-c)q_{I3} + t_2q_{I2} + t_3q_{I3} = wq_I - cq_{I3}$, but it would be $W_2 = wq_{I2} = (a-2q_{I2})q_{I2}$, which would be maximized at $q_{I2} = \frac{a}{4}$. Hence, under discriminatory tax rates, if the outputs are not sold in country 2, welfare of country 2 is maximized at $q_{I2} = \frac{a}{4}$ and $q_{I3}^* = 0$. Therefore, the equilibrium tax rates are $t_2^* = 0$ and $t_3^* \geq \frac{a-2c}{2}$.⁴ In this situation, the equilibrium output of firm 2 is $q_{I2}^* = \frac{a}{4}$, welfare of country 2 is $W_2 = \frac{a^2}{8}$ and the equilibrium profit of firm 1 is $\pi_1^* = \frac{a^2}{16}$, which is equal to the profit of firm 1 under the strong patent protection.

Let us now consider the situation where all the outputs of firm 1 are sold in country 2. In this situation, welfare of country 2 is $W_2 = (w-t_2)q_{I2} + (w-t_3-c)q_{I3} + t_2q_{I2} + t_3q_{I3} + \frac{q_I^2}{2} = wq_I - cq_{I3} + \frac{q_I^2}{2}$. Government of country 2 determines t to maximize the following expression:

$$\text{Max}_t \frac{(a+t_2+t_3+c)(2a-t_2-t_3-c)}{18} - \frac{c(a-2t_3+t_2-2c)}{6} + \frac{(2a-t_2-t_3-c)^2}{72}. \quad (26)$$

The optimal tax rates are

$$-(t_2^* + t_3^*) - 3c = 0 \quad (27a)$$

$$-(t_2^* + t_3^*) + 3c = 0. \quad (27b)$$

Both (27a) and (27b) cannot hold simultaneously, which implies that either t_2 or t_3 does not have an interior equilibrium value.

If the tax rates satisfy (27a), welfare of country 2 is

$$W_2 = \frac{2(a - 2c)(a + c) - 4c(a - 5c - 3t_3^*) + (a + c)^2}{18}. \quad (28)$$

However, if the tax rates satisfy (27b), welfare of country 2 is

$$W_2 = \frac{2(a + 4c)(a - 2c) - 3c(a + c - 3t_3^*) + (a - 2c)^2}{18}. \quad (29)$$

Comparison of (28) and (29) shows that (28) is greater than (29). Hence, welfare of country 2 is maximized if the equilibrium tax rates satisfy (27a). If the tax rates satisfy (27a), we get from (27b) that welfare of country 2 changes positively with respect to t_3 . Hence, the tax rate t_3^* will be as high as possible. However, given t_2^* , if

$t_3^* > \frac{a - 2c + t_2^*}{2}$, we get $q_{I3}^* = 0$, and only firm 2 produces in country 2.

The above discussion suggests that under discriminatory tax rates, welfare of country 2 under a weak patent protection is maximized if firm 3 does not produce positive outputs. However, if $q_{I3}^* = 0$ and all the outputs are sold in country 2, welfare of country 2 is not

$$W_2 = (w - t_2)q_{I2} + (w - t_3 - c)q_{I3} + t_2q_{I2} + t_3q_{I3} + \frac{q_I^2}{2} = wq_I - cq_{I3} + \frac{q_I^2}{2}, \text{ but it is}$$

$$W_2 = wq_{I2} + \frac{q_{I2}^2}{2} = (a - 2q_{I2})q_{I2} + \frac{q_{I2}^2}{2}, \text{ which is maximized at } q_{I2} = \frac{a}{3}. \text{ Hence,}$$

⁴ Note that, given $t_2^* = 0$, firm 2 does not change its output from $q_{I2}^* = \frac{a}{4}$ for $t_3^* \geq \frac{a - 2c}{2}$.

under discriminatory tax rates, if all the outputs are sold in country 2, welfare of country 2 is maximized at $q_{12} = \frac{a}{3}$ and $q_{13}^* = 0$. Therefore, the equilibrium tax rates are $t_2^* = -\frac{a}{3}$ and $t_3^* = \frac{a-3c}{3}$.⁵ The equilibrium output of firm 2 is $q_{12}^* = \frac{a}{3}$, welfare of country 2 is $W_2 = \frac{a^2}{6}$ and the profit of firm 1 is $\pi_1^* = \frac{a^2}{9}$, which is equal to firm 1's profit under the strong patent protection.

The above discussion is summarized in the following proposition.

Proposition 2: *Consider a discriminatory tax policy in country 2. Whether the outputs are not sold in country 2 or they are sold entirely in country 2, the profit of firm 1 is the same under the weak and the strong patent protections in country 2.*

Proposition 2 suggests that the patent system in country 2 does not affect the profit of firm 1, thus in contrast to Pack and Saggi (2001). Since entry of firm 3 under weak patent protection imposes a cost c per-unit of output to country 2, under discriminatory tax system, country 2 charges the tax rates in a way so that firm 3 does not produce. Hence, in contrast to the case of uniform taxation, the tax rate faced by the firm producing positive output (which is firm 1) under discriminatory tax is the same under the weak and the strong patent protections in country 2. As a result, under discriminatory tax rate, the prices paid by firm 1 and its profit are the same under both weak and strong patent protections.

⁵ Given $t_2^* = -\frac{a}{3}$, if $t_3^* > \frac{a-3c}{3}$, the output of firm 3 remains zero but the output of firm 2 reduces

3. Conclusion

An important suggestion of the WTO is to strengthen patent protection in the developing countries in order to provide proper returns to the developed-country firms from their innovations. We show that, in the case of a vertical technology transfer, if there is imperfect knowledge spillover, a strong patent protection in the developing country increases the profit of the developed-country firm if there is a uniform tax rate in the developing country. However, if there is either perfect knowledge spillover in the developing country or the developing country charges discriminatory tax rates, the profit of the developed-country firm is the same under the weak and the strong patent protections in the developing country. Thus, in contrast to the existing literature (Pack and Saggi, 2001), our result confirms the suggestion of WTO for extending patent protection in the developing countries in the presence of a vertical technology transfer.

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from $q_{12}^* = \frac{a}{3}$. As a result, country 2 charges $t_2^* = -\frac{a}{3}$ and $t_3^* = \frac{a-3c}{3}$.

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