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# **Externalities of Non-Cooperative Tax Policy in the Globally Integrated Market\***

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## **Abstract**

This paper investigates efficiency losses caused by independent tax systems, and proposes ways of remedying this coordination failure. Whereas the harmful effects of tariff competition have been thoroughly explored in the trade policy literature, little is known about the externalities that result from jurisdictional corporate tax policies on the trade of multinational companies. I show that cooperative tax policy with self-interested governments has the potential for increasing not only the levels of tax revenues and corporate profits but also the volume of trade through a more efficient allocation of tax burden.

*Keywords:* Intra-firm Trade; Tax Competition; Tax Coordination

*JEL classification:* F1; F2; H2; H7

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## **1. Introduction**

With the globalization of the economy, domestic corporate tax policies are increasingly a source of friction within international trade. Growing multinational business challenges independent tax legislation in many countries because cross-border transactions among related parties increase the scope for tax avoidance. Governments have recognized the necessity to regulate tax evasion, while fearing the consequent impediment that such tax regulations may cause to global trading. This rather new issue of trade and public finance in globalization has been recently brought to light by growing market integration movements such as the EU, and one of the major policy debates in the OECD and WTO.

This paper investigates efficiency losses caused by independent tax systems under national sovereignty, and proposes ways of remedying this coordination failure. Whereas the harmful effects of tariff competition have been thoroughly explored in the trade policy literature, little is known about the externalities that result from jurisdictional corporate tax policies on the trade of multinational companies. Utilizing a game theoretic approach, I examine the degree to which non-cooperative tax policies implemented by independent tax jurisdictions create an efficiency loss. Furthermore, I explore whether a Pareto improvement may emerge once the governance of interconnected markets is coordinated across multiple taxation authorities.

The situation is modeled as a dynamic game of complete information using a two-stage tax game with three players: a multinational company, a tax authority in a foreign host country, and a tax authority in a home country. In the first stage, each tax authority chooses a tax rate to maximize its tax revenues given a tax rate chosen by the other country. In the second stage, a multinational company chooses output (which impacts the

volume of trade) to maximize after-tax profits of the group. Tax-induced trade distortion is observed as the tax system varies across jurisdiction because the company reduces its tax burden by adjusting output so as to generate more profit in the country with the lower tax rate.

To engage in policy analysis, cooperative tax policy is modeled as joint revenue maximization constrained by the company's profits obtained under non-cooperative tax policies. After comparing the two policy regimes, I show that policy coordination with self-interested governments has the potential for enhancing not only tax revenues but also trade through a more efficient allocation of tax burden. The larger tax revenue results from enhancement of the profits once the companies internalize the cost of the intra-firm transaction in an integrated tax system. It is concluded that jurisdictional tax policies cause negative fiscal externalities via distorted trade of multinational companies.

The policy implications are explored using numerical examples. A simulation reveals that policy coordination may involve transfer payments between governments upon an increase of tax revenues. This is because an increase in total tax revenues upon policy coordination can be due to increased revenue in one country, which surpasses decreased revenue in the other country. Given such transfer payments are not general practice under current tax system, the result suggests that the system should be reconstructed to integrate tax administration across different countries.

This paper contributes to provide an analytical framework for studying a rather new issue of the harmful effects of non-cooperative jurisdictional tax policies. Inter-governmental fiscal relations related to corporate taxes have been discussed in the trade and public finance literature with the expansion of multinational business in the 1970s.

The earlier literature tries to explain decision-making of multinational companies under different tax systems across jurisdictions, and shows that the mechanism of transfer pricing can be a device to arbitrage profits so as to reduce the tax burden of companies (Horst, 1971; Copithorne, 1971; Eden, 1985; Kant, 1990).<sup>1</sup> I introduce interactive decision-making between governments and multinational companies into the discussion, and construct a model by referring to the recent tax administration in this area. As a result, welfare consequences of different tax policies are characterized by the technology structure of a firm (i.e., the cost and production functions) and consumers' preference (i.e., the demand function). Considering that specific policy implications can be derived after estimating the parameters in these functions, this analysis provides governments with potentially useful information for tax planning.

The plan of this paper is as follows. Section 2 describes a model for studying the externalities that result from jurisdictional tax policies on the trade of multinational companies. Comparing welfare consequences of such policies with cooperative policies, the mechanism of an efficiency loss caused by jurisdictional tax policies is clarified in Section 3. Section 4 concludes the paper with directions for future research.

## **2. Model**

The markets across two countries are interrelated through an intra-firm transaction of a vertically integrated multinational company. Trade within a firm is modeled as a manufacturing process from a mother factory in an upstream location to assembly (or

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<sup>1</sup> More recent literatures treat transfer pricing as private information and propose an analysis of mechanism design: how to implement tax policies so as to induce an appropriate transfer price from multinational companies (Prusa, 1990; Gresik and Nelson, 1994; Stoughton and Talmor, 1994; Bond and Gresik, 1996). Their policy concern (which is different from the one in this paper) is whether a less-informed government

distribution) factories at the destination market as in the trade literature.<sup>2</sup> A typical process observed is that a parent company in the home country produces and exports intermediate goods that are further assembled or manufactured by a subsidiary in the host country. Final goods are sold at the local markets in the host country.

The intra-firm transaction is characterized to be the fixed-coefficient production function following the traditional vertical integration literature (Greenhut and Ohta, 1979). Let  $q > 0$  be the quantity of the intermediate goods produced by a multinational parent in the home country, and  $Q > 0$  be the quantity of the final goods processed by a subsidiary in the host country. The production function is denoted as  $Q = \alpha q$ , where  $\alpha$  is the positive constant. The special case of  $\alpha = 1$ , as is commonly observed in aforementioned trade and public finance literature, is justified with the proper choice of units such that one unit of the intermediate goods is required to produce one unit of the final goods.

The company is assumed to have a monopoly on its differentiated goods in the markets in the host country. Let the inverse demand function for final goods in the host market be  $p = p(q)$ , where  $p$  is the price of the final goods. The price is assumed to be twice continuously differentiable, strictly monotone decreasing, and concave in the quantity of output. The demand for intermediate goods is derived indirectly from the demand for the final goods in a vertically integrated structure.

The factor markets are characterized to be competitive (either in the home or host country) because many local companies provide non-differentiated parts necessary for

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regulating tax avoidance of multinational companies could be compatible with the business incentives of the private sector. This paper is related to Karni and Chakrabarti (1997).

<sup>2</sup> For example, Helpman and Krugman (1985).

production. I use a simple linear cost function  $C_i = c_i q$ , where  $c_i$  is a positive constant marginal cost in location  $i$ . The location is denoted as  $i = h$  for the home country and  $i = f$  for the host country. The assumptions of linear cost and fixed coefficient production functions avoid analytical complexity from vertical integration and provide insight into the externality caused by non-cooperative jurisdictional tax policies without lose of generality.

A transfer price of the intra-firm trade is regulated as in the current tax system, and denoted as  $\bar{\theta} = (1 + k)c_h$  with a positive, constant mark-up rate  $k$ .<sup>3</sup> The mark-up is an advanced agreement among a multinational company and two governments, and carefully chosen so that sizable profit of the company is allocated into each country.<sup>4</sup> Each affiliate pays corporate income taxes calculated at a corporate tax rate  $t_i$  in its resident country together with a tariff charged by customs in the host country at a rate  $\tau$  on the import of intermediate goods.

The situation is modeled as a dynamic game of complete information using a two-stage tax game with three players: a multinational company, a tax authority in a foreign host country, and a tax authority in a home country. In the first stage, each tax authority chooses a tax rate to maximize its tax revenues given a tax rate chosen by the other

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<sup>3</sup> This is the so-called cost plus method, and is one of the several suggested methods to calculate the arm's length price in the tax regulations. This method is chosen because it is ordinarily used in cases involving manufacturing, assembly or other production goods that are sold to related parties (Intercompany Transfer Pricing Regulations under Section 482, §1.482-3(d)(1)). Additionally, the cost-plus method is the most frequently used method according to surveys on intra-firm transfer pricing (Al-Eryani, Alam, and Akhter, 1990; Hamaekers, 1992; Ernst & Young LLP, 1997).

<sup>4</sup> This paper focuses on the Bilateral Advanced Pricing Agreement (BAPA) case, which is when tax authorities in the two countries agree to use the same arm's length price so as to eliminate the risk of double taxation. The model in Elitzur and Mintz (1996), in which tax authorities in each jurisdiction apply a different arm's length method, may cause international double taxation. Discussion of the BAPA framework is a relevant topic since we have observed an increasing number of the applicants to the system (Transfer Pricing Report 7(19), 1999, p.722).

country. Revenue maximization captures current tax competition, which is often described as a “tax war” between different tax jurisdictions.<sup>5</sup> This approach allows me to examine the interesting question of whether policy coordination with self-interested governments has the potential for improving social welfare. In the second stage, a multinational company chooses output (which impacts the volume of trade) to maximize after-tax profits of the group. Global profit maximization is assumed as is typical in the literature, though companies may have multiple objectives and could possibly benefit from decentralization. Given market demand and industry cost, a subgame perfect Nash equilibrium in pure strategies of this game is characterized.

## 2.1 Decision of Company

This section clarifies the mechanism through which tax strategies in different countries influence the trade of multinational companies. It is shown that domestic tax policies entail externalities to the trade because the company tries to increase the after-tax global profits by adjusting its output, which is accomplished by generating more profits in the country where the tax rate is relatively low.

Let us begin the discussion by constructing the after-tax global profits of the multinational company as the sum of profits earned in the two countries:

$$\Pi = ((1 - t_h)(\bar{\theta} - c_h) + (1 - t_f)(p(q) - (1 + \tau)\bar{\theta} - c_f))q. \quad (1)$$

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<sup>5</sup> The cases of Nissan and Toyota are notable for the large amount of tax correction and prolonged negotiations that required a political settlement between the Japanese and U.S. governments. After twelve years of strife, the IRS succeeded in receiving an additional tax of about 640 million dollars (464 million from Nissan and 176 million from Toyota) in 1987 and 1988, while the corporate tax revenues in Japan were reduced by the same amount correspondingly. Nissan had to pay another 160 million dollars to the IRS in 1993. A counter-action by the Japanese government toward American companies operating in Japan followed. Subsidiaries of the American International Underwriters (AIU) and Coca-Cola were two of those hit, early on, with tax penalties in Japan.



The first-order condition (which is also a sufficient condition) for the analysis of a Cournot equilibrium provides the familiar, but slightly modified relationship in a way that the after-tax marginal revenue is equated to the after-tax marginal cost at the group level.

$$(1-t_h)(\bar{\theta}-c_h)+(1-t_f)\left(\frac{dp}{dq}q+p-(1+\tau)\bar{\theta}-c_f\right)=0 \quad (2)$$

Examining the above condition reveals the cause and mechanism of externalities, which tax policies in different countries entail to the trade of the multinational company, because the optimal output  $q^*$  is a function of the parameters in the cost and demand functions, including the tax rates in the two countries.

*Proposition 1*

1. The optimal volume of trade  $q^*$  is decreasing in the home tax rate  $t_h$ , and increasing in the foreign host tax rate  $t_f$ .
2. The optimal volume of trade  $q^*$  is decreasing in both the tariff rate  $\tau$  and the marginal cost in the host country  $c_f$ .

*Proof*

The result is obtained immediately by applying the implicit function theorem to the first-order condition (2).

$$1.1 \quad \frac{\partial q}{\partial t_h} = \frac{(\bar{\theta}-c_h)}{(1-t_f)(2\frac{dp}{dq}+\frac{d^2p}{dq^2}q)} < 0, \text{ and } \frac{\partial q}{\partial t_f} = \frac{p(q)-(1+\tau)\bar{\theta}-c_f+\frac{dp(q)}{dq}q}{(1-t_f)(2\frac{dp(q)}{dq}+\frac{d^2p}{dq^2}q)} > 0. ///$$

$$1.2 \quad \frac{\partial q}{\partial \tau} = \frac{\bar{\theta}}{2 \frac{dp}{dq} + \frac{d^2 p}{dq^2} q} < 0, \quad \text{and} \quad \frac{\partial q}{\partial c_f} = \frac{1}{2 \frac{dp}{dq} + \frac{d^2 p}{dq^2} q} < 0. ///$$

The latter result of Proposition 1.1 seems to be unexpected at a first glance; however, it can happen when a similar argument for tax arbitrage via transfer pricing works in the current model with a change in a tax rate. The standard rule for transfer pricing is to evade the tax burden by manipulating a transfer price so that income is allocated to a country with lower tax rates. Instead of using transfer pricing, a company tries to increase the after-tax global profits by adjusting its output, which is accomplished by generating more profits in the country, where the tax rate is relatively low. This idea is easily understood once the optimal output is solved in a closed form. Let us introduce a linear demand function on final products sold at the host market:  $p = a - bq$ , where  $a > 0$  and  $b > 0$ , then the optimal output is simplified as

$$q^* = \frac{1}{2b} \left\{ a - (1 + \tau)\bar{\theta} - c_f + \frac{1 - t_h}{1 - t_f} (\bar{\theta} - c_h) \right\} \quad (3)$$

(and is a finite quantity from  $t_f \neq 1$ ). Equation (3) shows that the relative tax rates in the two countries play a key role in deciding the optimal volume of trade. Such tax-induced trade distortion is observed because the level of the corporate profits varies depending on how the company allocates the tax burden in these countries via output adjustments. It is interesting to notice that manipulating corporate tax rates enables governments to control the market as well as tariffs or subsidies for the purpose of either protecting a domestic industry or promoting trade.

Proposition 1.2 shows that the volume of trade increases if a company faces more favorable cost conditions such as less of a tariff burden, cheaper factor inputs, and more advanced production technology. These results are consistent with the policy implication from traditional trade theory, which claims that eliminating both tariff and non-tariff barriers enhances social welfare through the promotion of trade, though the model in this paper employs a different approach. It is uncertain about the effect of the marginal cost in the home country and the mark-up ratio on the volume of trade because these parameters operate as not only costs but also gains in profits due to a transfer price calculation in the cost-plus method (i.e.,  $\bar{\theta} = (1 + k)c_h$ ).

## 2.2 Tax Competition

A non-cooperative taxation game is developed in a two-jurisdictional model, where tax authorities in two different countries compete for tax revenues from a multinational company under independent tax systems. Each government chooses a pure strategy tax rate to maximize its tax revenue, while taking the tax rate set by the other country as given. Since governments cannot impose a tax rate greater than 100%, the strategy sets  $(t_f, t_h)$  are assumed to be in  $[0,1]^2$ , in the model of tax competition. Such a strategic tax competition game is formally defined as follows.

### *Definition*

The strategic tax competition game of complete information consists of

- The set of players is  $N = \{f, h\}$  where  $f$  represents the tax authority in the foreign host country and  $h$  represents the one in the home country.

- The set of pure strategies (i.e., tax rates) available to each player  $i \in N$  is  $A_i = [0,1]$ .

I refer to a pure strategy profile  $t = (t_f, t_h)$  as an outcome, and denote the set  $A_f \times A_h$  of outcomes by  $A$ .

- A payoff function is  $T_i : A \rightarrow \mathfrak{R}_+$ .

I denote the game  $\langle N, (A_i), (T_i) \rangle$ .

A “tax war” between different countries is analyzed using a Nash equilibrium. A Nash equilibrium captures the decision-making of self-interested governments under national sovereignty so that analysis of the equilibrium will help to understand the nature of non-cooperative tax strategies under independent tax systems. The analysis focuses on a pure strategy equilibrium but not a mixed strategy equilibrium. Particularly, it is natural to assume that governments do not decide their tax rates by flipping coins. It will be shown that such a pure strategy equilibrium exists.

### *Definition*

A Nash equilibrium in pure strategies of the game  $\langle N, (A_i), (T_i) \rangle$  is a profile of tax rates  $t^* \in A$  with the property that for every tax authority  $i \in N$ ,

$$T_i(t_i^*, t_{-i}^*) \geq T_i(t_i, t_{-i}^*) \quad \forall t_i,$$

where  $t_{-i}$  is the tax rate in country  $j = N - \{i\}$ .

I use the linear demand function hereafter, otherwise the analytical complexity of the two-stage game makes the discussion less intuitive as one can see the tedious expression

of equilibrium tax rates obtained in the following section. This formulation allows tax revenues in each country to be solved in a closed form of the parameters in the cost and demand functions as

$$T_h = \frac{Bt_h}{2b} \left( A + \frac{1-t_h}{1-t_f} B \right) \quad \text{and} \quad (4)$$

$$T_f = \frac{t_f}{4b} \left( A^2 - \left( \frac{1-t_h}{1-t_f} B \right)^2 \right), \quad (5)$$

where  $A = a - (1 + \tau)\bar{\theta} - c_f$  and  $B = \bar{\theta} - c_h$ .

Note that the optimal output of the company (solved in the previous section) is embodied in these payoffs. The parameter B is before-tax per unit profit of the multinational affiliate in the home country and the parameter A is a value positively correlated with before-tax per unit profit of the affiliate in the host country because the per unit profit in the host country is  $A - bq$  but not  $A$ .

It is interesting to observe the tax revenue in the home country includes the parameter A (in addition to B) as a positive element, while a positive influence on revenue in the host country is solely from the parameter A. The former is explained because the tax base (i.e., profits) in the home country is derived from the demand for the final products at the host market. Larger final sales at the host country (which will happen at larger A) mean higher demand for intermediate goods, therefore, induce more profits in the home country when the profit in the home country is monotonically increasing in sales. The latter is related with the observation that maximizing global profits requires a larger amount of output than maximizing the profit in the host country. At larger B, the affiliate in the home country is motivated to sell more products to

increase the profit, however, the price of final goods at the host market need to decrease to make such larger sales possible. Since such a decrease in price always dominate the effect on the profit in the host country than the one of an increase in output, the tax base in the host country includes the parameter  $B$  as a negative element.

Having understood the nature of the payoff functions, an analytical solution for an equilibrium of this game can be obtained by taking the first-order conditions of the two payoff functions, confirming them to be sufficient, and solving them simultaneously. In the process, we abandon complex solutions and restrict the discussion in the domain  $0.067 \leq E \leq 3$ , where  $E = B/A$ . Truncating the domain of  $E$  eliminates two unpleasant situations, which conflict with the assumption that tax rates are real numbers in the interior of  $[0,1]$ . The first case is when the equilibrium tax rate in the host country is so prohibitively high (nearly 100%) that the company exits from the market ( $E < 0.067$ ). The second case is when the host government suffers from a budget deficit because it provides a subsidy to support the company using a negative tax rate ( $E > 3$ ). Though those cases may happen in reality, I have to consider them incompatible with self-interested governments maximizing tax revenues.

### *Equilibrium*

For all  $E$  such that  $0.067 \leq E \leq 3$ , a profile of tax rates  $(t_f^*, t_h^*)$  such that

$$t_f^* = \frac{1}{15} \left( 13 - 2E - \left( J + 30E\sqrt{K} \right)^{\frac{1}{3}} - \left( J - 30E\sqrt{K} \right)^{\frac{1}{3}} \right) \quad \text{and} \quad (6)$$

$$t_h^* = \frac{1}{2} \left[ 1 + \frac{1}{15E} \left\{ 2 + 2E + \left( J + 30E\sqrt{K} \right)^{\frac{1}{3}} + \left( J - 30E\sqrt{K} \right)^{\frac{1}{3}} \right\} \right], \quad (7)$$

where  $J = 8 - 156E + 474E^2 - 37E^3$ ,  $K = 3E^4 - 18E^3 + 360E^2 - 24E$ ,

is a Nash equilibrium in pure strategies of the tax competition game  $\langle N, (A_i), (T_i) \rangle$ .

A Nash equilibrium of the tax competition game is solved as a function of  $E$ . The parameter  $E$  is a value correlated with the difference in profit per unit in the two countries and is equivalent to the difference of the tax bases because the tax base is calculated by multiplying the per unit profit by sales (which are the same in both countries). The value of  $E$  approaches to three if the profit in the home country dominates the global profits and to 0.067 if the profit in the host country dominates the global profits. The range of equilibrium tax rates explains the restrictions on  $E$ , while it can be rephrased that the current analysis eliminates an extreme case when an affiliate in one country contributes to most of global profits. The relationship between each country's tax strategy under tax competition and the difference of the tax bases in two countries is characterized as follows.

The country with the larger tax base levies a higher tax rate than the country with the smaller tax base under an equilibrium of the tax competition game  $\langle N, (A_i), (T_i) \rangle$ .<sup>6</sup>

It is an intuitive result that the government with larger tax bases levies tax aggressively on multinational companies when the profits are allocated to each country with trade. If global profits are mainly generated by the affiliate in the home country (larger  $E$ ), the host government needs to lower the tax rate (even to be negative values for  $E$  larger than

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<sup>6</sup> For a formal exposition, refer to Appendix.

three) and support the affiliate in the host country. On the other hand, the host government increases the tax rate up to 100%, when the affiliate in the host country generates more profits compared to the affiliate in the home country (smaller E). This proposition may be related to the result of the KPMG corporate tax rate survey, which states that “stronger economies are more likely to have higher corporate tax rates.”

The next proposition characterizes the equilibrium tax rates by their response to changes in the parameters in the cost and demand functions.

### *Proposition 2*

The equilibrium tax rates of the tax competition game  $\langle N, (A_i), (T_i) \rangle$  are increasing in the intercept of the inverse demand function  $a$ , and decreasing in the tariff rate  $\tau$ , the marginal cost in both countries  $c_h$  and  $c_f$ , and the mark-up ratio  $k$ .

Proof

Appendix

The equilibrium tax rates take higher value when a company faces more favorable market demand and cost conditions. The intercept of the inverse demand function takes a larger value when either the potential size of the market or the maximum willingness to pay of consumers for the good is larger. Marginal costs in either the home and host country are smaller when companies possess more advanced production technology and enjoy cheaper prices of factor inputs. Since higher profits are more likely to occur under such



conditions, it is concluded that tax authorities can levy higher tax rates to share the benefits with the company.

This implication is not so obvious in the case of a lower mark-up ratio, but is related to efficiency losses caused by independent tax systems. It will be clear when we discuss the benefits of tax coordination in the next section; therefore, I provide only a general sketch. The mark-up ratio operates as a proxy of a hazard index in a way that measures the degree under which independent tax systems hinder multinational companies to enjoy the benefits of vertical integration. The companies cannot internalize the costs of intra-firm transactions in the tax systems, which segregate profits earned by two different affiliates within the same company for the purpose of imposing the tax independently as in Equation (1). A lower mark-up ratio works to eliminate the hazard and increases the profits of the companies. One may imagine that this is a close analogy to an efficiency loss caused by double marginalization of monopolies in the industrial organization literature. I shall return to this point later.

### **3. Policy Analysis**

#### **3.1 Tax Coordination**

Market integration movements such as the EU are putting increasing pressure on policy makers to adjust national tax structures. This section examines the interesting question of whether policy coordination with self-interested governments can raise more tax revenues without harming the business incentives for global trading, and the impact of such a tax policy on the size of the market. To capture the policy concern, the situation is modeled as a two-stage taxation game with a slight modification to the previous model:

governments try to maximize joint tax revenues without lowering after-tax profits of a multinational company below these resulting from tax competition. Let us introduce the consolidated tax revenues in the two countries  $T$ , which are obtained by adding (4) and (5). Tax coordination is the governments' decision-making process expressed as the following optimization problem:

$$\underset{t_f, t_h}{\text{Max}} T = \frac{B^2}{4b} (D + \rho)(2t_h + t_f(D - \rho)) \text{ subject to } \Pi(t_f, t_h) \geq \Pi(t_f^*, t_h^*),$$

$$\text{where } D = \frac{A}{B}, \rho = \frac{1-t_h}{1-t_f}, \text{ and } \Pi(t_f, t_h) = \frac{B}{4b} \left( 2HD + \frac{H^2}{F} + FD^2 \right),$$

$$\text{where } H = 1 - t_h, \text{ and } F = 1 - t_f.$$

For notational convenience, I use  $D = A/B$  instead of  $E = B/A$  in this section. The model of tax coordination is developed as joint revenue maximization constrained by the company's profits obtained under non-cooperative tax policies.

### *Definition*

An equilibrium of tax coordination is a profile of tax rates  $(t_f^{**}, t_h^{**})$  with the property such that  $T(t_f^{**}, t_h^{**}) \geq T(t_f, t_h) \quad \forall t_f, t_h$ , and  $\Pi(t_f^{**}, t_h^{**}) \geq \Pi(t_f^*, t_h^*)$ .

An analytical solution for equilibrium tax rates in tax coordination is derived by applying the Kuhn-Tucker Theorem to the optimization problem. With two variables and one constraint, eight possible solution patterns need to be considered but some of them are easily eliminated from a candidate of equilibrium tax rates such as the cases where both tax rates are zero and the after-tax profit constraint is slack (i.e.,  $\Pi(t_f, t_h) > \Pi(t_f^*, t_h^*)$ ).

The latter is intuitive. The governments try to extract as much profits as possible so that the constraint is binding at the profit level of tax competition. After eliminating those possibilities, equilibrium tax rates are obtained by substituting the possible candidate tax rates into the objective function and comparing the levels of them for each case.

### *Equilibrium*

A profile of tax rates  $(t_f^{**}, t_h^{**})$  such that

$$(t_f^{**}, t_h^{**}) = \left(1 - \frac{G}{(1+D)^2}, 1 - \frac{G}{(1+D)^2}\right), \quad (8)$$

$$\text{where } D = \frac{A}{B}, \quad G = 2H^*D + \frac{H^{*2}}{F^*} + F^*D^2,$$

$$\text{where } H^* = 1 - t_h^* \text{ and } F^* = 1 - t_f^*,$$

is an equilibrium of tax coordination.

Charging a uniform tax rate in two countries is an equilibrium of tax coordination. A uniform tax rate removes the influence of tax policies on a company's decision so that tax revenues simplify to be a monotonically increasing function of a uniform tax rate. It is interesting to observe that policy coordination creates a tax monopoly in which the governments try to absorb the profits (more precisely, the monopoly rents in this model) as the tax revenues by escalating the tax rates. However, the equilibrium shows that the governments can impose higher tax rates only if their decision is constrained by the lower profit level of the multinational company. This can be seen by the fact that the second term of the equilibrium tax rates is rewritten as the ratio of the after-tax profit under tax

competition  $\Pi(t_f^*, t_h^*) > 0$  and the profit without any taxes  $\Pi(0,0) > 0$  :

$$0 < \frac{G}{(1+D)^2} = \frac{\Pi(t_f^*, t_h^*)}{\Pi(0,0)} < 1.$$

These inequalities also help to prove that the profile of tax rates defined in (8) is always in  $[0,1]^2$ . This completes the discussion of an equilibrium, including the existence.

To engage in policy analysis, welfare consequences of two different tax regimes are compared.

### *Theorem*

1. Tax coordination increases joint tax revenues without lowering corporate profits obtained under tax competition when compared to tax competition.
2. Tax coordination enhances consumer surplus by promoting trade when compared to tax competition, if the home country overcharges the tax rate under tax competition.

### *Proof*

### Appendix

The results imply that policy coordination with self-interested governments has the potential of increasing not only the levels of tax revenues and corporate profits, but also the volume of trade through a more efficient allocation of tax burden. The larger tax revenue results from the enhancement of the profits after eliminating tax distortion on the trade. This can be easily confirmed by observing that slightly lower uniform tax rate than the equilibrium tax rate of tax coordination gives still larger revenues and profits than tax

competition. Larger profits are possible because tax coordination allows multinational companies to enjoy the benefits of vertical integration, which cannot be appreciated under independent tax systems. Remember that the systems segregate profits earned by different affiliates within the same company for the purpose of imposing the tax independently. With the profit function, a company has an incentive to save on taxes by adjusting its production if tax rates are different across jurisdictions. The output adjustments play an intermedium role in creating an efficiency loss under tax competition in a way that the company earns less profit by producing either too much or too little. A uniform tax rate can eliminate the segmentation between the two affiliates and allows the company to earn more profits by internalizing the cost of the intra-firm transaction. On the other hand, tax coordination promotes trade only if the home country in an upstream location overcharges the tax rate than the host country in a downstream location. This is because the company is reluctant to produce a greater amount of output when the home country's tax rate is higher than the host country's rate (as was shown in *Proposition 1*) due to tax saving motivation.

The core of the analysis is that a multinational company can earn greater profits once the company enjoys the benefits of vertical integration by eliminating the segmentation of profits earned within the same company. This implies that a uniform tax rate is not a unique solution but is one method for eliminating the distortion. Another approach is to allocate a portion of ex post before-tax profits between jurisdictions based on a contribution rate attributed to each affiliate (so called the profit split method). Each government levies taxes on the allocated tax bases at its own tax rate. Using the previous notation, the after-tax global profits are expressed as

$\Pi = (1 - gt_f - (1 - g)t_h)\pi$ , where  $\pi$  is before-tax profits of a company, and

$g$  is a contribution rate attributed to an affiliate in the country  $f$ .

Contrary to the tax bases calculated using a regulated transfer price (so called the arm's length methods), the profit split method can avoid a tax distortion despite different tax rates across jurisdictions.

Tax coordination may involve transfer payments between two governments upon an increase of tax revenues because the increase in total tax revenues can be due to increased revenue in one country, which surpasses decreased revenue in the other country. A simulation confirms the possibility as is seen in Figure 1. After calculating an equilibrium of a tax competition game for a given parameter, a numerical approach is employed. I plot the profiles of tax rates, which provide the same levels of indices obtained under the tax competition game. For example, the curve  $T^*$  is an iso-revenue curve for the joint tax revenue under tax competition, and larger joint revenues are obtained above the line. Other indices are plotted similarly: an iso-revenue curve for the host government  $T_f^*$ , an iso-revenue curve for the home government  $T_h^*$ , an iso-profit curve for after-tax profits of the multinational company  $\Pi^*$ , and an iso-quant curve for the volume of trade  $q^*$ . These indices take larger values in the area towards which the arrows point. An equilibrium of tax coordination occurs in the shaded area (2), where any profiles of tax rates increase not only the levels of both the joint tax revenues and the profits but also the volume of trade, at the sacrifice of the tax revenue in the host country. In this case, it is natural to consider that the host government is entitled to claim a portion of the increased revenues as its contribution to the coordinating tax policy. Given such

transfer payments are not general practice under the current tax system (where the source of taxation rights relies on national sovereignty), the result suggests that the system should be integrated to accommodate a flexible revenue allocation across different countries. One may wonder about the feasibility of such policy coordination, but it is not as an antithetical proposal as it sounds, considering that the EU is reallocating the member countries' tax revenues through its agricultural subsidy policy.

One last remark regarding tax rates is in order. Tax rates in this analysis do not necessarily mean statutory rates rather it is more appropriate to regard these as effective rates, including an adjustment for income deduction. We often observe that governments tailor the income tax to either specific industries or (foreign) companies by establishing special treatment provisions such as accelerated depreciation for certain types of investments.<sup>7</sup> For example, decelerated depreciation for plant investment will function as a tax increase for foreign companies who are relatively new entrants into the market and need large investments in fixed capital. Effective tax rates could have variation by industries and companies despite the single statutory tax rate so that the argument of effective tax rates refutes the criticism of this analysis where governments decide domestic tax rates solely from the revenues from multinational companies.

### **3.2 Alternative Regimes**

The model of tax coordination is developed as a joint revenue maximization problem to examine an efficiency loss caused by independent tax systems in the global economy.

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<sup>7</sup> Institute on Taxation and Economic Policy (2000), "ITEP Corporate Study Press Release 2000" shows "Widely varying tax rates by company and industry" and points out that "...the tax code is being used to favor some industries and some kinds of investments over others...."

One possible alternative is to consider a Nash bargaining solution as an equilibrium of the tax coordination game,

$$(t_f^{**}, t_h^{**}) = \arg \max (T_f(t_f, t_h) - T_f^*)(T_h(t_f, t_h) - T_h^*),$$

$$\text{where } T_f^* = T_f(t_f^*, t_h^*) \text{ and } T_h^* = T_h(t_f^*, t_h^*),$$

in which each government is constrained by the level of tax revenue under the tax competition game. This approach enables me to specify the amount of tax revenues after the policy coordination, while revenue allocation between two countries is another story under the joint revenue maximization and depends on other factors such as the tax authorities' bargaining ability, time preference, and attitudes toward risk.

The main purpose of studying an efficiency loss caused by independent tax policies is, however, fully understood only in the joint revenue maximization. This is because there is a case such that the Nash bargaining solution does not achieve a Pareto improvement but the joint revenue maximization does. An example is shown in Figure 1. The Nash bargaining solution, which guarantees an increase in tax revenues for both countries, occurs in the shaded area (1). As the figure shows, the Nash bargaining approach helps to remedy coordination failure between two different governments but does not eliminate an efficiency loss caused by its consequent externalities on the trade of a multinational company. Policy co-operation under independent tax systems (such as the Nash bargaining solution) is not enough but further coordination is necessary to attain larger tax revenue through enlarged profits as was shown in the joint revenue maximization approach. The result suggests that the tax systems should be reconstructed to integrate tax administration across different countries.



Another remark is regarding an equilibrium of tax competition. A “tax war” between different countries is analyzed using a Nash equilibrium: both tax authorities decide their strategies at the same time. Instead, it is possible to employ sequential games using a Stackelberg-type equilibrium, where one tax authority decides the tax policy before the other does. This change of formulation does not alter the conclusions of this research, while it alters the level of transfer payments upon tax coordination. The same efficiency losses of the preceding discussion are present as far as the governance of interconnected markets is distributed across different tax authorities.

#### **4. Concluding remarks**

The analysis shows that policy coordination motivated by self-interested governments has the potential of not only raising more tax revenues without harming the business incentives of multinational companies but also improving the welfare of consumers through trade promotion. This is a very attractive policy implication. Both the amount of tax revenue and the volume of trade are often the main concerns of governments. Governments take a keen interest in the activities of multinational companies in order to collect more tax revenues as well as improve social welfare by promoting global trading. Sizable tax revenues from multinational companies are often needed to finance social policies in developing countries, where multinational companies play a dominant role in the economy. Trade-promoting tax policies are catalysts for enhancing the size of a market, creating job opportunities, and inducing technology transfer through an increase in foreign direct investment, and therefore are effective engines of economic growth.

Multinational companies will surely welcome such a tax policy unless it deteriorates the level of their profits.

It is noteworthy that Pareto improvement may emerge once the governance of the interrelated markets is coordinated among different tax authorities across jurisdictions. Such tax coordination may include not only collaborative policy planning but also the implementation, including redistribution of tax revenues between governments in two countries. This is because an increase in total tax revenues after policy coordination can be due to increased revenue in one country, which surpasses decreased revenue in the other country. Given such transfer payments are not general practice under the current tax system, the result suggests establishing a new inter-governmental fiscal relationship through the integration of tax administration across different countries.

The analytical framework will be applicable to other interesting but more complicated situations with appropriate modifications to the model. One possible extension is to include foreign direct investment (FDI). The result of the analysis (i.e., Pareto improvement may emerge under tax coordination) does not necessary conflicts with the theoretical literature on tax incentives for FDI, which often supports tax competition between countries. The current analysis examines the effect of tax policy on the trade of multinational companies when two countries (a home country and a host country) are already interrelated through their intra-firm transactions, while the FDI literature considers the situation where two host countries compete for FDI from a company in a home country. Since the secondary FDI (such as an extra investment for expanding facilities) follows by a change in the volume of trade, tax incentives for FDI can be reanalyzed in relation to the impact of tax policy on the trade. Another extension

is to consider regimes of multi-agents such as regions, nations, or government agencies within the same nationality.<sup>8</sup> In reality, policy effectiveness is often limited without cooperative planning and implementation among multiple agents because some agents could free ride the benefits obtained by selected agents' policy coordination. This paper did not cover the argument of multi-agents due to analytical difficulty; however, a numerical simulation will allow further analysis. One last extension is to include the uncertainty of policy commitment. This is a serious problem in developing countries, where the governments frequently change their tax policies. Introducing the commitment issue requires altering the nature of the game defined in the paper and switching the order of decision-making between a company and governments. Though those extensions may change some results obtained in this paper, the main conclusion that independent tax systems cause an efficiency loss in the globally interrelated market is likely to still be valid. All of these topics represent future lines of research.

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<sup>8</sup> Possible examples include not only corporate tax policies in the EU (as is discussed currently) but also state tax policies in the U.S.

## **Acknowledgements**

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## Appendix

### 1. Best response functions

Rearranging the first order conditions obtained from (4) and (5) yields the best response functions of the home and host countries:

$$t_h^* = \frac{1}{2} \left( 1 + \frac{1-t_f}{E} \right) \quad \text{and} \quad (9)$$

$$t_h = 1 - \left( \frac{1}{E} \right) \left( \frac{(1-t_f^*)^3}{1+t_f^*} \right)^{\frac{1}{2}}, \quad (10)$$

where  $t_i^*$  for all  $i \in N$  is the best response for each country.

### 2. Claim

If the tax base in the home country  $TB_h$  is larger than the tax base in the host country  $TB_f$ , then  $t_h^* > t_f^*$ .

Suppose  $t_h^* \leq t_f^*$ . This inequality can be rearranged as  $(2E+1)t_f^* - E - 1 \geq 0$  (from (9)), which is equivalent to  $E \leq 1/3$ . Remember that  $TB_h = Bq$  and  $TB_f = (A-bq)q$ , then  $TB_f - TB_h = (1 - (\rho^* + 2)E)Aq$  from (3). Since we know that  $A > 0$  and  $q > 0$ , the sign of the equation  $TB_f - TB_h$  is the same as the sign of  $1 - (\rho^* + 2)E$ . For  $0.067 \leq E \leq 1/3$ , a numerical approach shows that  $1 - (\rho^* + 2)E \geq 0$  (as in Figure 2). This is equivalent to  $TB_h \leq TB_f$ , which contradicts  $TB_h > TB_f$ . ///

Similarly, it is shown that if the tax base in the host country  $TB_f$  is larger than the tax base in the home country  $TB_h$ , then  $t_h^* < t_f^*$ .

### 3. Proof of Proposition 2

First, show that if  $0.067 \leq E \leq 3$ , then  $t_h^*$  is a monotonically decreasing function of  $E$ .

Suppose  $\frac{dt_h^*}{dE} \geq 0$  for some  $E$  such that  $0.067 \leq E \leq 3$ .

$$\frac{dt_h^*}{dE} = -\frac{Y}{90EX^{\frac{4}{3}}}(X^{\frac{2}{3}} - 4 + 52E + 11E^2) + \frac{1}{30E^2 X^{\frac{1}{3}}}(4 + 11E^2 - 2X^{\frac{1}{3}} + X^{\frac{2}{3}}),$$

where  $X = 8 - 156E + 474E^2 - 37E^3 + 30E\sqrt{3E^4 - 18E^3 + 360E^2 - 24E}$  and

$$Y = 156 + 111E^2 - 948E + 45\sqrt{3E^4 - 18E^3 + 360E^2 - 24E} + 15\sqrt{3} \frac{(\sqrt{E})^3}{\sqrt{E^3 - 6E^2 + 120E - 8}}(120 - 12E + 3E^2).$$

This is greater than and equal to zero if  $E$  takes a value such that  $E \leq Z$ ,

$$\text{where } Z = \frac{86}{7} - \frac{11}{7}\sqrt[3]{188 + 84\sqrt{5}} - \frac{44}{7\sqrt[3]{188 + 84\sqrt{5}}} - \frac{4}{7} \left( -\frac{1}{2}\sqrt[3]{188 + 84\sqrt{5}} - \frac{2}{\sqrt[3]{188 + 84\sqrt{5}}} + 4 \right)^2 \cong 6.6888 \times 10^{-2}.$$

This contradicts  $0.067 \leq E \leq 3$ . ///

Next, show that if  $0.067 \leq E \leq 3$ , then  $t_f^*$  is a monotonic decreasing function of  $E$ . I use a geometric approach. A good place to start is Figure 3a and 3b, which depict the best response functions in either the home or host country: the optimal tax rate for the host country  $t_f^*$  is an increasing function of the tax rate set by the home country  $t_h$  from

$$\frac{dt_h^*}{dt_f} = \frac{1}{2E} \left( \frac{(1-t_f)^3}{1+t_f} \right)^{-\frac{1}{2}} \left( \frac{3(1-t_f)^2(1+t_f) + (1-t_f)^3}{(1+t_f)^2} \right) > 0, \text{ and the optimal tax rate for}$$

the home country  $t_h^*$  is a decreasing function of the tax rate set by the host country  $t_f$

from  $\frac{dt_h^*}{dt_f} = -\frac{1}{2E} < 0$ . Suppose  $E$  decreases. This makes the influence of the negative

term in (10) larger. To hold the equality given  $t_h$ ,  $t_f^*$  needs to increase. Similarly,  $t_h^*$

needs to increase so as to make Equation (9) be held given  $t_f$ ; smaller  $E$  makes not only

the intercept of  $t_h^*$  larger but also  $t_h^*$  more responsive to changes of  $t_f$  in the equation.

These facts mean that both best response curves shift out with a decrease in  $E$  as shown

in Figure 3a and 3b. Figure 3c depicts their interactive relationship (i.e., the transition of

the equilibrium tax rates). It is obvious from the figure that  $t_f^*$  never decreases while  $E$

decreases. ///

Now the equilibrium tax rates  $(t_f^*, t_h^*)$  are monotonically decreasing functions of  $E$ , the results are obvious from

$$\frac{E}{\partial a} = -\frac{B}{A^2} < 0, \frac{E}{\partial c_h} = \frac{k(a-c_f)}{A^2} > 0, \frac{E}{\partial c_f} = \frac{B}{A^2} > 0, \frac{E}{\partial \tau} = \frac{k(1+k)c_h^2}{A^2} > 0, \text{ and}$$

$$\frac{E}{\partial k} = \frac{c_h(A + (1+\tau)kc_h)}{A^2} > 0. ///$$

#### 4. Proof of Theorem

- Show  $T(t_f^{**}, t_h^{**}) \geq T(t_f^*, t_h^*)$ .

Define  $t'$  be a reservation tax rate, which satisfies  $T(t', t') = T(t_f^*, t_h^*)$ . Since  $T(t, t)$  is a monotonically increasing function of a tax rate, once we show that, for all  $E$  such that  $0.067 \leq E \leq 3$ ,  $t^{**} \geq t'$  and the proof is done.

Given the previous notation, the reservation tax rate is calculated as

$$t' = \frac{2(1-H^*)\left(D + \frac{H^*}{F^*}\right) + (1-F^*)\left(D^2 - \frac{H^{*2}}{F^{*2}}\right)}{(1+D)^2}.$$

The inequality  $t^{**} \geq t'$  can be shown to be equivalent to  $(t_h^* - t_f^*)^2 \geq 0$ , which is true. ///

- Show  $q^{**} > q^*$  if  $\frac{1}{3} < E \leq 3$ .

Suppose  $q^{**} \leq q^*$  for some  $E$  s.t.  $\frac{1}{3} < E \leq 3$ . Remember  $q^* = \frac{1}{2b}(A + \rho^* B)$ , then the

difference in the volume of trade is  $q^{**} - q^* = \frac{B}{2b}(1 - \rho^*)$  and therefore,  $1 \leq \rho^*$ . This

inequality can be rearranged as  $-(2E+1)t_f^* + E + 1 \leq 0$  (from (9)), which is equivalent

to  $E \leq \frac{1}{3}$ . This contradicts  $\frac{1}{3} < E \leq 3$ . ///

- Show consumer welfare improves if  $\frac{1}{3} < E \leq 3$ .

Consumer surplus is the area bordered by the demand curve and the horizontal price line.

Under the ordinary assumptions on the demand function, consumer surplus increases when the price decreases due to an increase in output as it is an increasing function in the quantity of output. Thus, consumer surplus increases under the same condition as trade promotion. This completes the proof. ///



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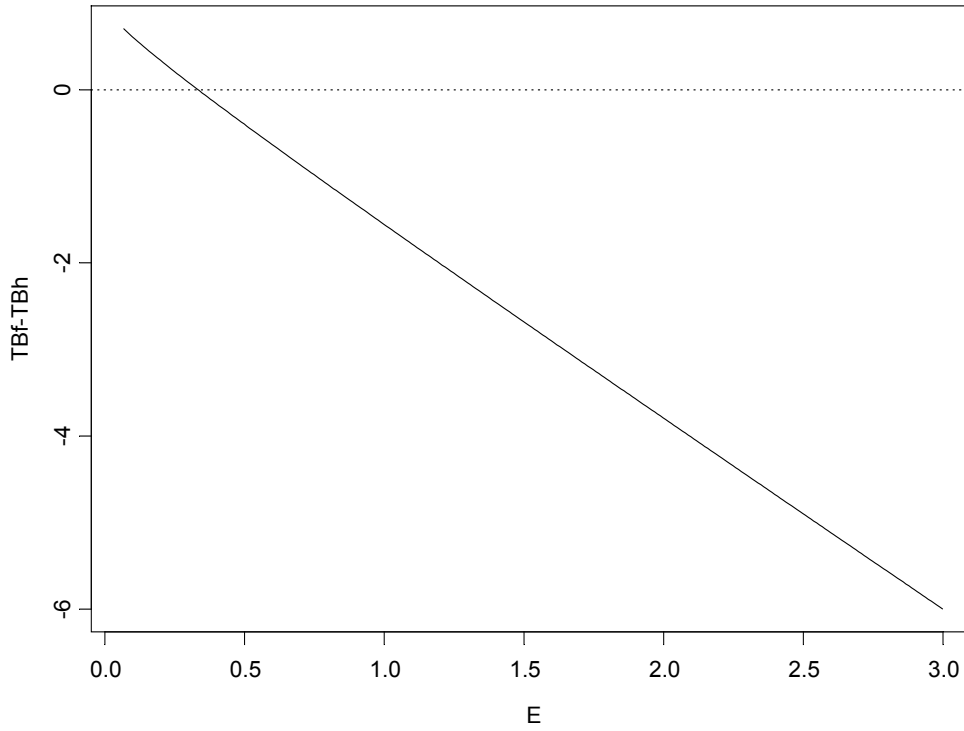
$T_f^*$ : an iso-revenue curve for the host government and larger revenues are obtained to the right of the line.

$T_h^*$ : an iso-revenue curve for the home government and larger revenues are obtained above the line.

$Pai^*$ : an iso-profit curve for after-tax profits of the multinational company under tax competition and larger profits are obtained to the left of the line.

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**Figure 2**



$TB_f - TB_h$  (in the figure) means to be  $1 - (\rho^* + 2)E$ ,

where  $TB_f$ : The tax base in the host country,

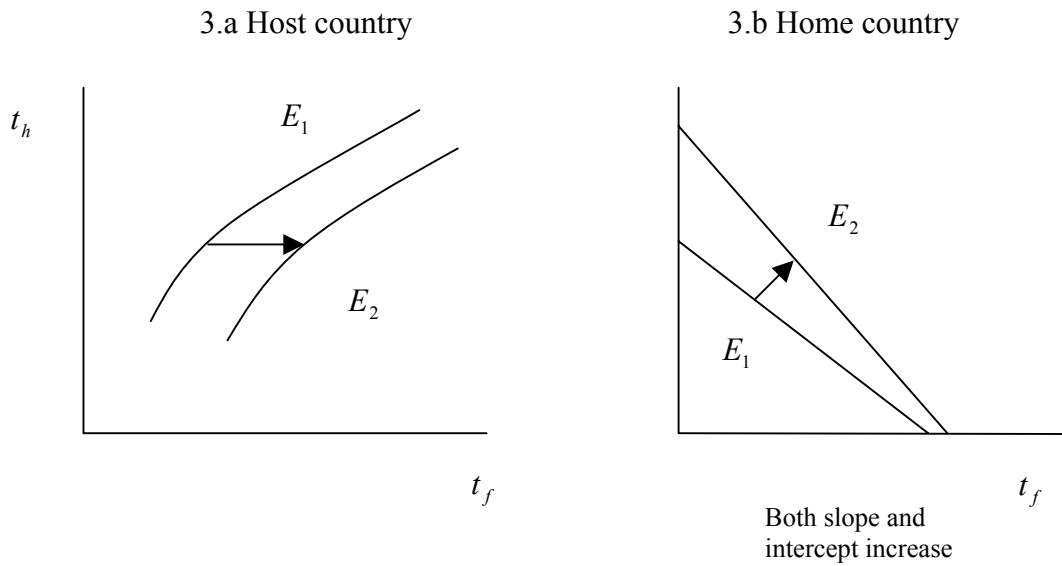
$TB_h$ : The tax base in the home country,

$$\text{and } \rho^* = \frac{1 - t_h^*}{1 - t_f^*}.$$

**Figure 3.** Transition of equilibrium tax rates

Shift of Best Response Functions

(If  $E_1 > E_2$ )



3.c Transition of equilibrium tax rates

(If  $E_1 > E_2 > \dots > E_n$ )

