International Tax Competition with Endogenous Sequencing

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Abstract

This paper examines an international tax rate competition with endogenous sequencing. Unlike existing studies, we assume that each country can decide not only its corporate tax rate on international traded capital but also the timing of whether they decide it firstly or secondly. A consideration of Nash equilibrium derives two conclusions with respect to alternative international double tax allowance. First, the deduction method derives a simultaneous move game whereas the credit method causes a sequential one. Second, a capital-exporting country would be better than under the deduction, while a capital-importing country could have a highest economic welfare under the credit method.

Keywords: International Tax Competition; Endogenous Sequencing; Double Taxation Allowance; Foreign Direct Investment

JEL classification Numbers: H87; C72; H23; F21

1. Introduction

Each government often uses tax policy so as to attract business, to create jobs, and to increase domestic economic welfare in an interdependent world economy. Therefore, the topic of tax competition for international traded capital has arisen on the political and research agenda. Generally, it is very important for policy maker to choose not only what actions to take but also when to take them on a real political process. However, very few serious attempts have been made to consider this point in the studies of an international tax competition. The aim of this paper is to examine theoretically the timing of strategic tax policy in an economic environment with international capital movements.

Initially, we have to consider whether corporate income taxes on mobile capital can be sustained. According to Gordon (1992), foreign earnings cannot be monitored and hence cannot be taxed effectively. Monitoring issues are relevant particularly when foreign investment takes the form of portfolio investment. However, the taxation of income originating from foreign direct investment is different from that case. The firms are well monitored and are usually interested in

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documenting such investment. Therefore, it is possible that countries effectively levy corporate tax on the income generated from foreign direct investment.

This derives the new issue of international double taxation, i.e., overlapping taxation on income generated from foreign direct investment by capital-importing and capital-exporting countries. This issue causes a heavier tax burden on foreign than on domestic direct investment, even if both types of investment yield the same profit. Such bias against international capital flows disturbs the efficient allocation of the world capital stock. OECD committee thus suggests that this problem can be allowed by international tax treaties.

International double taxation treaties may then involve main two possible provisions, or tax rules. First, countries can the credit the tax paid in the foreign country, up to the amount that would have been incurred under purely domestic taxation. The credit method leads to taxation at the higher of the two rates. Second, countries can allow the foreign tax to be deducted from income before the domestic corporate tax is applied. This is titled the deduction method.

According to classical approach (see, for instance, Musgrave and Musgrave, 1989), the credit method can achieve horizontal equity in the tax burden by full allowance for international double taxation, which the deduction method cannot. Additionally, the tax rules clearly differ with respect to incentives to invest abroad, the incentive varying inversely with the generosity of the allowance for the foreign country taxes. Thus, the two tax rules differently affect the efficient allocation of capital and, thereby, alter economic welfare. Musgrave (1969), for example, argued that the credit method yields a capital allocation that results in the highest level of world economic welfare, whereas the deduction method provides a capital allocation that maximizes a capital-exporting country's economic welfare.

If the various national tax rates are set independent of one another, this conclusion might be significantly correct. However, in an environment with tax competition, one country's choice of tax rate will depend on that adopted by another, as well as on other features of the tax rule, including the generosity of the allowance for the foreign country taxes paid. There is no agreement on the non-cooperative game equilibrium with alternative rules. Hamada (1966) concluded that the credit method can allow both countries to be better off than the deduction method. By contrast, Bond and Samuelson (1989) showed that capital flows and economic welfare in both countries would be greater under a regime of the deduction method than under the credit method. Moreover, Janeba (1995) demonstrates that capital flows, and the economic welfare of both countries, are independent of the chosen tax rules. On the other hand, Feldstein and Hartman (1979) derive their results within a framework where a capital importing country is passive with respect to the policies of an exporting country, or, if a capital importing country does react, such behavior is fully anticipated by an exporting country. This appears to be similar to the results obtained by Bond and Samuelson, which favored some the deduction of foreign country taxes when computing tax liability.

One important feature distinguishing different models is whether countries set its tax simultaneously or whether they do it sequentially with earlier movers acting as leaders and later movers acting as followers. Most studies implicitly assumed that simultaneous tax competition occurs among similar size-countries, or that a large country acts as leaders and a small country acts as followers among different size-countries.

However, numerous recent literatures on game theory pointed out that whether duopolists play a simultaneous or a sequential tax rate game should not be exogenous but should result from the player' decisions. There is substantial interest in the theoretical literature on endogenous timing in games. This literature started with Saloner (1987), Hamilton and Slutsky (1990), Robson (1990) and Amir (1995) and developed into a rich and active research area in game theory with recent contributions by Henkel (2002), Matsumura (2002), Normann (2002), van Damme and Hurkens (2004), and Supasri and Tawada (2007). The basic question these models try to answer is simple but significant.

Considering various real political situations, it is often important that governments choose not only what actions to take but also when to take them. Whether one country becomes the leader or the follower in the game could be significant because an alternative order of moves often gives rise to different results. However, no attempt has been made to consider endogenous timing of move decision in the studies of international tax competition. The current paper addresses this deficiency.

The following two conclusions are drawn from the Nash equilibrium with endogenous sequencing. First, the deduction method derives the simultaneous move game, whereas the credit method yields the sequential one. Second, an exporting country would be better off under the deduction method, while an importing country could have a highest economic welfare under the credit method.

The paper is organized as follows: section 2 presents the models and section 3 derives capital market equilibriums. Sections 4 and 5 respectively analyze an international tax rate competition with endogenous sequencing under two alternative tax rules. Section 6 draws some conclusions.

2. Model

The model used in this paper is identical to that in Janeba (1995). Consider a two-country model in which each country, both home and foreign, chooses a tax policy on investment income to maximize individual national income (all foreign variables are indexed with an asterisk). To isolate the strategic issues that arise in tax competition between countries and the role played by tax rules, this model keeps the production side of the model as simple as possible.[1]

[1] According to Ruffin (1984), the MacDougall and Kemp model is the simplest model to analyze international capital movements. Beside the studies cited in this paper, many others have used this model to analyze international tax competition.

Firms in each country employ capital K (K^*) and labor L (L^*) to produce one good under conditions of perfect competition in all markets. The production function F (F^*) is homogeneous of degree one, strictly quasi-concave, and satisfies the standard Inada conditions. Each country is endowed with an inelastic supply of capital and labor ($\bar{K}$, $\bar{K}^*$, $\bar{L}$, $\bar{L}^*$). Capital is also assumed to be internationally mobile, unlike labor. As labor is inelastically supplied and internationally immobile, it is omitted from the production function for notational convenience. Moreover, we assume that all capital movements take the form of equity-financed foreign direct investment and that all earnings are repatriated to capital owners in the home country, such that the corporate income tax applies to all income from capital services.[2]

Additionally, it is assumed that the return on investment in the home country is below that in the foreign country when no capital is traded, i.e., $r = F_K[\bar{K}] < F_K^*[\bar{K}^*] = r^*$, where r and r^* denote the rental rates of capital. In other words, domestic investment-oriented capital owners in both countries invest abroad only when the return on investment in the foreign country exceeds that in the home country. We use the parameter c to write the difference in the marginal product of capital in autarky:

$$F_K[\bar{K}] \equiv c \cdot F_K^*[\bar{K}^*], \text{ where } 0 < c < 1. \tag{1}$$

This equation shows that in free-trade equilibrium, capital flows Z will be positive. Let $Z > 0$ ($Z < 0$) denote home capital outflows (inflows) as well as foreign capital inflows (outflows). In free-trade equilibrium, firms hire capital and labor until factor markets clear in both countries. Accordingly, the following international capital market equilibrium condition must hold:

$$F_K[\bar{K} - Z^0] = F_K^*[\bar{K}^* + Z^0],$$

where $Z^0 > 0$. The properties of the production functions ensure the existence of a unique equilibrium.[3]

Let us next describe the game structure. The players of this game are the home and foreign governments. The home government chooses not only the sequencing $M \in$ [*First Move*, *Second Move*] but also its tax rate $t \in [0, t_{\max}]$ where $t_{\max} < 1$ on exported capital. On the other hand, the foreign government chooses not only the sequencing $M^* \in$ [*First Move*, *Second Move*] but also its tax rate $t^* \in [0, t^*_{\max}]$ where $t^*_{\max} < 1$ on imported capital. Notice that we assume that the countries can discriminate in setting tax rates on traded and non-traded capital. Since the

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[2] These assumptions coincide with those made in Bond and Samuelson (1989). According to some empirical evidence, foreign direct investment is financed at least partially by capital-importing country sources. But as argued by Sinn (1993), new foreign subsidiaries cannot be financed by retained profits, and their parent firms usually provide transfer funds. In later phases of development, the retained earnings of capital-importing country sources are used for tax reasons.

[3] We assume no short selling of assets and accordingly derive a unique equilibrium. Otherwise, no equilibrium most likely exists since capital owners could borrow at the lower rate of return and invest in the other country.

objective in each government is taken to be the maximization of national income, there is no loss of generality in assuming that only exported (imported) capital is taxed by the home (foreign) government. Any tax that applies to all home owned or foreign-owned capital will not affect the location decision of capital owners, and is therefore a transfer from capital owners to the country which does not affect national income. The optimal such tax is then arbitrary and can be chosen to be zero.[4]

The national incomes are then determined as the payoffs of both countries. For each rule, the national incomes of the home and the foreign country are respectively:

$$Y(t,t^*) = F[\bar{K} - Z(t,t^*)] + (1-t^*) \cdot F_K^*[\bar{K}^* + Z(t,t^*)] \cdot Z(t,t^*), \tag{2}$$

$$Y^*(t,t^*) = F^*[\bar{K}^* + Z(t,t^*)] - (1-t^*) \cdot F_K^*[\bar{K}^* + Z(t,t^*)] \cdot Z(t,t^*). \tag{3}$$

The home national income (2) is the sum of home production and net income from abroad, and the foreign (3) is foreign production minus interest-dividend payments at home.

Tax rules trend to be unchangeable, because countries generally decide them from a long-term viewpoint. In this model, tax rule is exogenously determined. Therefore, we assume the two-stage game as for each tax rule:

First stage: Governments simultaneously choose whether they move first or second.

Second stage: Governments choose their own tax rate at their move.

At each move in the game, players with a move know the full history of the game actions thus far. We indicate that a collection of decision nodes constitutes an information set by connecting the nodes by a dotted line, as in the extensive form representation of the first stage game $G_1 = \{M, M^*; Y, Y^*\}$ given in Fig.1.

The interpretation of the foreign government' information set is that when the foreign government gets the move, all she knows is that the information set has been reached (i.e. that the home government has moved), not which nods has been reached (i.e. what she did). At each of the nodes, 2a-2d, a subgame which is the basic game with a particular order of play begins. We

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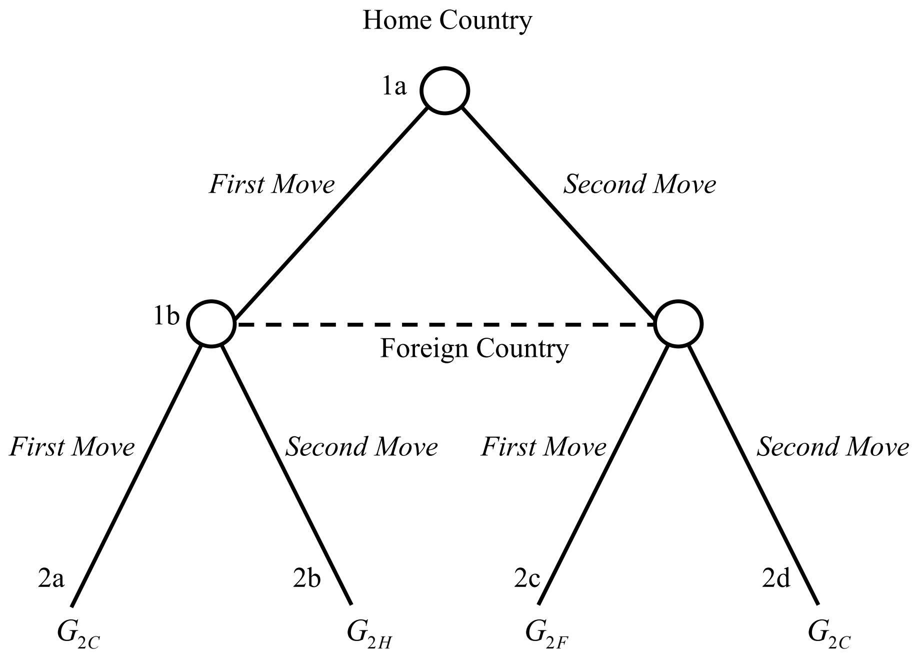
[4] Since countries are national income maximizers and capital is in perfectly inelastic supply, taxes on non-traded capital are pure transfers that do not affect national income. If capital was supplied elastically, the optimal tax on non-traded capital would be zero so as to not distort supply decisions. Hamada (1966) considers the capital market equilibrium condition

$$(1-\beta) \cdot F_K[\bar{K} - Z] = (1-t)(1-t^*) \cdot F_K[\bar{K}^* + Z],$$

where β denotes the tax rate imposed by the home country on capital located at home and t and t^* are as defined in this paper. He then defines $(1-\tau) = (1-\beta) / (1-t)$ and lets τ be the choice variable for the home country for fixed β. Since $\tau = (\beta - t) / (1 - t)$, it follows that $\tau > 0$ if the tax rate on exported capital is less than the tax rate on capital that remains at home. These two approaches are clearly equivalent, since the optimum rate for t can be derived from the optimal value of τ and the assumed value of β. Note that since the home country will want to tax exported capital at a higher rate than domestic capital, $\tau < 0$ at the optimum.

investigate only subgame perfect Nash equilibria, so there is only one possible outcome in each subgame.

Figure 1: The Extensive Form of the Subgame $\mathbf{G_1}$



If both countries decide to set tax rates in the same timing, a simultaneous tax rate game occurs, whereas if both countries decide to set tax rates in the different timing, a sequential tax rate game arises. In other words, at the second stage, we have to examine three different games that are distinguished only by their timing structure: A simultaneous tax rate game G_{2C} $=\{ t , t^* ; Y , Y^* \}$and two games with sequential moves and perfect information, G_{2H} $=\{ t , t^*(t) ; Y , Y^* \}$ and $G_{2F} =\{ t(t^*) , t^* ; Y , Y^* \}$. In the game G_{2H}, the home government moves first, choosing a pure strategy t , and the foreign government moves after observing t, choosing its pure strategy $t^*(t)$, where $t^*(t)$ is a mapping from t to t^*. In the game G_{2F}, the foreign government moves first, choosing a pure strategy t^* , and the home government moves after observing t^*, choosing its pure strategy $t(t^*)$, where $t(t^*)$ is a mapping from t^* to t.

Before we start with the analysis of each game, let discuss capital market equilibriums.

3. Capital Market Equilibriums

Given a tax rule, each country's capital owners invest abroad until the marginal product of domestic capital corresponds to the rental rates of capital in the other country. Regarding Z, there exist two types of equilibriums. Most natural is the case where Z > 0, i.e. the home country exports capital. The capital market equilibrium conditions are as follows:[5]

$$F_K[\bar{K}-Z]=(1-t)(1-t^*)\cdot F_K^*[\bar{K}^*+Z] \quad \text{under the deduction method,} \tag{4}$$

$$F_K[\bar{K}-Z]=(1-\max[t,t^*])\cdot F_K^*[\bar{K}^*+Z] \quad \text{under the credit method.} \tag{5}$$

The tax factor for a home capital owner investing in the foreign country is the sum of the foreign taxation and the home taxation that foreign taxation allowed under each tax rule: under the deduction method, the home government allows the foreign tax to be deducted from income before the domestic corporate tax is applied; under the credit method, the home country the credits the foreign tax that was paid up to the amount that would have been incurred under purely domestic taxation.

Totally differentiating the capital market equilibrium conditions (4) and (5) yields:

$$\frac{\mathrm{d}Z}{Z}=-\frac{\varepsilon\varepsilon^*}{\varepsilon+\varepsilon^*}\left[\frac{\mathrm{d}t}{1-t}+\frac{\mathrm{d}t^*}{1-t^*}\right] \quad \text{under the deduction method,} \tag{6}$$

$$\frac{\mathrm{d}Z}{Z}=\begin{cases}-\dfrac{\varepsilon\varepsilon^*}{\varepsilon+\varepsilon^*}\dfrac{\mathrm{d}t}{1-t} & \text{as } t>t^* \\ -\dfrac{\varepsilon\varepsilon^*}{\varepsilon+\varepsilon^*}\dfrac{\mathrm{d}t^*}{1-t^*} & \text{as } t\le t^*\end{cases} \quad \text{under the cedit method,} \tag{7}$$

where the elasticity of supply of exported capital for the home country is $\varepsilon \equiv -F_K / F_{KK}Z$, and the elasticity of demand for imported capital for the foreign country is $\varepsilon^* \equiv -F_K^* / F_{KK}^*Z$.

The case where $Z < 0$ can not exist as the lemma shows.

Lemma 1: *Capital flows are non-negative in an equilibrium* ($Z \geq 0$).

Proof: Before proceeding to a more detailed discussion, we must derive some preliminary outcomes. Assuming that Z is negative, the representative capital market equilibrium must hold

[5] As discussed by, for instance, Davies (2003) and Chisik and Davies (2004) and, this model does not explicitly represent two-way capital flows. However, not all capital mobility arises only by the investment decisions of one country's agents. Let us define capital flows as $Z=S-S^*$, where $S\geq 0$ ($S^*\geq 0$) denotes the level of foreign direct investment undertaken by the home capital owner (the foreign capital owner) into the foreign country (the home country). Regarding Z, we may have to consider six types of equilibrium: (a) $Z>0$ with $S>S^*=0$, (b) $Z=0$ with $S=S^*=0$, (c) $Z<0$ with $S^*>S=0$, (d) $Z>0$ with $S>S^*>0$, (e) $Z=0$ with $S=S^*>0$, (f) $Z<0$ with $S<S^*<0$. In this model, however, capital owners invest abroad only when the return on investment in the other country exceeds that in the own country, because they are assumed to have no country-specific capital. Therefore, S and/or S^* would be zero, since capital owner in either country (on occasion, in both countries) has no incentive to invest abroad. Accordingly, the cases (d)-(f) would be impossible. Hence this paper focuses on the case (a)-(c). Furthermore, the above argument suggests that capital owners in a capital-importing country have no income generated from investment abroad and therefore are indifferent to any tax rules.

$$F_K^*[\bar{K}^* + Z] = (1-\Phi)\cdot F_K[\bar{K} - Z], \tag{8}$$

where the tax factors for a foreign capital owner investing in the home country is

$$\Phi = \begin{cases} t + t^*(1-t) & \text{under the deduction method,} \\ t + (t^* - \min[t, t^*]) = \max[t, t^*] & \text{under the credit method.} \end{cases}$$

Since $F_{KK}[\bullet] < 0$, $F_{KK}^*[\bullet] < 0$ and Eq.(8), we have two relations:

$$F_K^*[\bar{K}^* + Z] > F_K^*[\bar{K}^*], \tag{9}$$

$$(1-\Phi)\cdot F_K[\bar{K} - Z] < (1-\Phi)\cdot F_K[\bar{K}] = (1-\Phi)\cdot cF_K^*[\bar{K}^*]. \tag{10}$$

Consequently, Eq.(1), (9) and (10) implies that $Z < 0$ requires

$$1 < (1-\Phi)\cdot c. \tag{11}$$

Assuming that the foreign tax rule is the deduction method, Eq.(11) indicates $1 < (1-t)c$, which is impossible. Assume that the foreign tax rule is the credit method. As $t \le t^*$, Eq. (11) would be $1 < c$, which is a contradiction. Similarly, for $t > t^*$, we need $(1-t^*) < (1-t)c$, or at least $(1-t^*) < (1-t)$, which contradicts $t > t^*$. The above lemma thus can be derived. ■

The following explanation of Ida (2006) may then help to provide an intuitive interpretation of this lemma. If the home country imports capital, the return on investment in the home country must exceed that in the foreign country. However, without capital movements, the former is below the latter. Accordingly, the home capital inflows require that this difference in the marginal product of capital is compensated by foreign taxation. However, under the deduction method, t^* does not matter; and under the credit method, if the foreign tax rate t^* matters, only when it is below that in the home country. From this reason, the home country exports capital independently of parameter, tax rate and tax rules.

Before proceeding to a more detailed discussion, we can state the following lemma:

Lemma 2: *A positive capital flow yields a higher level of each country's national income relative to non-traded one, unless the credit method is employed and* $t \le t^*$

Proof: Totally differentiating Eq. (2) and (3) gives respectively the following:

$$\mathrm{d}Y = [(1-t^*)F_K^* - F_K - (1-t^*)F_K^*/\varepsilon^*]\mathrm{d}Z - F_K^* Z\mathrm{d}t^*, \tag{12}$$

$$\mathrm{d}Y^* = [t^* F_K^* + (1-t^*)F_K^*/\varepsilon^*]\mathrm{d}Z + F_K^* Z\mathrm{d}t^*. \tag{13}$$

Eq. (12) and (13) indicates that home national income is decreasing in the foreign tax rate, while the foreign one is increasing in its tax rate. Each equations can be transformed as follows:

$$\frac{\mathrm{d}Y}{\mathrm{d}Z}=\begin{cases}(1-t^*)\cdot F_K^*\cdot\left[t-1/\varepsilon^*\right] & \text{under the deduction method,}\\ (1-t^*)\cdot F_K^*\cdot\left[1-\dfrac{1-\max(t,t^*)}{1-t^*}-\dfrac{1}{\varepsilon^*}\right] & \text{under the credit method,}\end{cases} \tag{14}$$

$$\frac{\mathrm{d}Y^*}{\mathrm{d}Z}=(1-t^*)F_K^*\left[t^*/(1-t^*)+/\varepsilon^*\right]. \tag{15}$$

Evaluation of Eq.(14) and (15) at $Z=0$ yields respectively:

$$\left.\frac{\mathrm{d}Y}{\mathrm{d}Z}\right|_{Z=0}=\begin{cases}(1-t^*)\cdot F_K^*\cdot t & \text{under the deduction method,}\\ (1-t^*)\cdot F_K^*\cdot\left[1-\dfrac{1-\max(t,t^*)}{1-t^*}\right] & \text{under the credit method,}\end{cases} \tag{16}$$

$$\left.\frac{\mathrm{d}Y^*}{\mathrm{d}Z}\right|_{Z=0}=(1-t^*)\cdot F_K^*\cdot\left[t^*/(1-t^*)\right]. \tag{17}$$

Eq.(16) and (17) indicates that the increase of capital flow Z from zero raises the foreign national incomes, unless the credit method is employed and $t\le t^*$. According to Lemma 1, capital flow is non-negative in the equilibriums. The above lemma can be thus derived. ■

Based on these results, the next section would analyze a Nash equilibrium sequencing after the investigation of tax rate game with the deduction method.

4. Deduction Method

From the analysis of tax rate game with the deduction method, this study can state the following lemma:

Lemma 3 : *With the deduction method, an equilibrium pair of tax rates causes a positive capital flow independent of game type.*

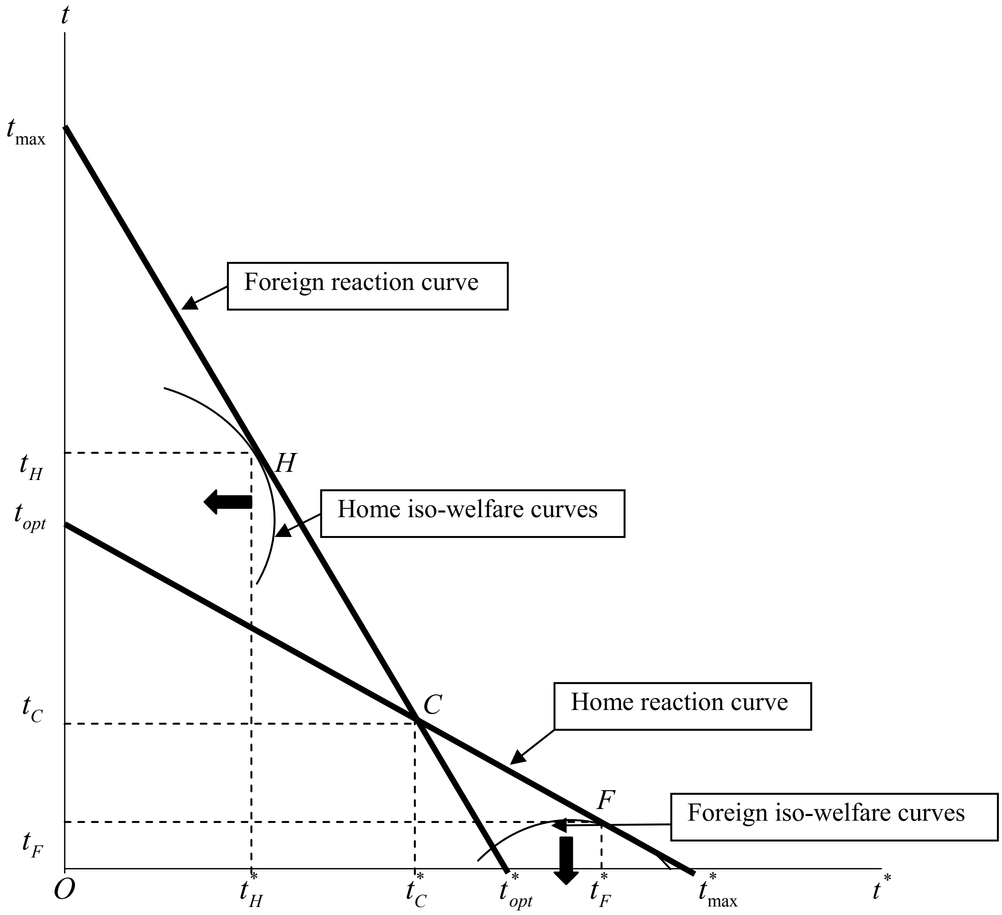
Proof: Before proceeding to a more detailed discussion, let us examine the relationship between the national income and the tax rates. Substituting Eq. (4) and (6) into (12) and (13) respectively yields:

$$\mathrm{d}Y=-A\left[\left(t-\frac{1}{\varepsilon^*}\right)\frac{\mathrm{d}t}{1-t}+\left(t+\frac{1}{\varepsilon}\right)\frac{\mathrm{d}t^*}{1-t^*}\right], \tag{18}$$

$$\mathrm{d}Y^* = -A\left[\left(\frac{t^*}{1-t^*}+\frac{1}{\varepsilon^*}\right)\frac{\mathrm{d}t}{1-t}+\left(\frac{t^*}{1-t^*}-\frac{1}{\varepsilon}\right)\frac{\mathrm{d}t^*}{1-t^*}\right], \tag{19}$$

where $A \equiv \varepsilon\varepsilon^*(1-t^*)F_K^* Z/(\varepsilon+\varepsilon^*) > 0$. According to these equations, one country's national income is decreasing in another country's tax rate. Fig. 2 thus illustrates the home iso-welfare curves obtained from Eq.(18) and the foreign ones originated from Eq.(19).

Figure 2: Reaction Curves with Deduction Method



In addition, an inspection of (18) indicate that for given t^*, Y is optimized by setting $t = 1/\varepsilon^*$, and a consideration of (19) show that for a given t, Y^* is optimized by setting $t^*/(1-t^*) = 1/\varepsilon$. The second-order condition for the home and the foreign government's maximization problem requires respectively:

$$\frac{\partial^2 Y}{\partial t^2} = -\frac{\partial}{\partial t}\left(\frac{A}{1-t}\right)\cdot\left(t-\frac{1}{\varepsilon^*}\right)-\left(\frac{A}{1-t}\right)\cdot\frac{\partial}{\partial t}\left(t-\frac{1}{\varepsilon^*}\right) < 0, \tag{20}$$

$$\frac{\partial^2 Y^*}{\partial t^{*2}} = -\frac{\partial}{\partial t^*}\left(\frac{A^*}{1-t^*}\right)\cdot\left(\frac{t^*}{1-t^*}-\frac{1}{\varepsilon}\right)-\left(\frac{A}{1-t^*}\right)\cdot\frac{\partial}{\partial t^*}\left(\frac{t^*}{1-t^*}-\frac{1}{\varepsilon}\right)<0. \tag{21}$$

The minimum requirement of Eq.(20) is $(\partial/\partial t)(t-1/\varepsilon^*)>0$, i.e., $(\partial\varepsilon^*/\partial Z)<0$, while that of Eq.(21) is $(\partial/\partial t^*)[t^*/(1-t^*)-1/\varepsilon]>0$, i.e., $(\partial\varepsilon/\partial Z)<0$ from Eq.(6). Totally differentiating the home reaction function $t=1/\varepsilon^*$ yields the slop of it:

$$\frac{\mathrm{d}t(t^*)}{\mathrm{d}t^*} = -\left(t\frac{\partial\varepsilon^*}{\partial t^*}\right)\Bigg/\left(\varepsilon^*+t\frac{\partial\varepsilon^*}{\partial t^*}\right)<0 \qquad \text{for the home reaction curve.}$$

Totally differentiating the foreign reaction function $t^*/(1-t^*)=1/\varepsilon$ gives the slop of it:

$$\frac{\mathrm{d}t^*(t)}{\mathrm{d}t} = -\left(t^*\frac{\partial\varepsilon}{\partial t}\right)\Bigg/\left(1+\varepsilon+t^*\frac{\partial\varepsilon}{\partial t^*}\right)<0 \qquad \text{for the foreign reaction curve.}$$

As a result, the home and the foreign reaction curve can be illustrated in Fig. 2.

Now let us illustrate the equilibriums of tax rate game with Fig.2. This argument follows Bond and Samuelson (1989). Firstly, we will begin with the Cournot equilibrium of G_{2C} Notice that the vertical intercept of the home reaction curve, t_{opt}, is the tax rate imposed by the home government when the foreign government sets a zero tax rate. In addition, the vertical intercept of the foreign reaction curve must be the home tax rate that eliminates international capital movements (denoted $t_{\max}$), since an optimal choice $t^*=0$ (with ε finite) by the foreign government requires $Z=0$ from Eq.(13). Clearly, if $t^*=0$, there exists a tax rate $t<t_{\max}$, which induces $Z>0$. Any such tax rate gives a higher value of Y than does $t_{\max}$ (or any $t>t_{\max}$) and satisfies $t<t_{\max}$.This guarantees $t_{opt}<t_{\max}$. A similar argument establishes that the horizontal intercept of the home reaction curve must exceed that of the foreign reaction curve, ensuring the existence of at least one intersection, for example, the point *C*. A pair of (t_C, t_C^*) denotes the Cournot equilibrium tax rates which correspond to it. The equilibrium payoffs must exceed the no-trade payoffs, since each government has available a strictly inferior choice of tax rate of unity which forces $Z=0$. The capital flows must be thus positive in the Cournot equilibrium.

Secondly, let us turn to the Stackelberg equilibrium of the sequential tax rate games. As for the game G_{2H}, the home government chooses the tax rate t_H such that the home iso-welfare curves thorough the point *H* is tangent to the foreign reaction curve. On the other hand, the foreign governments set t_H^* satisfying its reaction function for a given t_H. Analogous discussion on G_{2F} demonstrates that in the equilibrium, both governments choose a pair of tax rates (t_F, t_F^*) which correspond to the point *F*. By the way, the leader governments would have a highest level of its national income on the follower government's reaction curve in the sequential games. According to Lemma 2, a positive capital flow would yield a higher level of each country's national income than non- traded capital does under the deduction method. Hence, the Stackelberg equilibrium would cause $Z > 0$. The above lemma can be thus derived. ■

Based on the outcomes of tax rate game, we can state the following proposition with respect to the sequencing.

Proposition 1: *If the deduction method is employed, a simultaneous move game would occur in a Nash equilibrium.*

Proof: We will use a brute-force approach to prove this proposition. Before the detailed discussion, let us show the preliminary outcomes. Hereafter, a pair of (Y_i, Y_i^*) denotes the home and the foreign national incomes that correspond to the equilibrium point i ($i = C, F, H$).

According to Lemma 3, equilibrium capital flows would be positive under the deduction method. In addition, the relationship between a leader-country's national income and its tax rate are as follows:

$$\frac{\mathrm{d}Y}{\mathrm{d}t} = -A\left[\left(t - \frac{1}{\varepsilon^*}\right)\frac{1}{1-t} + \left(t + \frac{1}{\varepsilon}\right)\frac{1}{1-t^*}\frac{\mathrm{d}t^*(t)}{\mathrm{d}t}\right] \quad \text{for the game } G_H, \tag{22}$$

$$\frac{\mathrm{d}Y^*}{\mathrm{d}t^*} = -A\left[\left(\frac{t^*}{1-t^*} + \frac{1}{\varepsilon^*}\right)\frac{1}{1-t}\frac{\mathrm{d}t(t^*)}{\mathrm{d}t^*} + \left(\frac{t^*}{1-t^*} - \frac{1}{\varepsilon}\right)\frac{1}{1-t^*}\right] \quad \text{for the game } G_F. \tag{23}$$

Note that Cournot equilibrium tax rates lies on their own reaction curves. Accordingly, the value of Eq.(22) at $t = 1/\varepsilon^*$ is

$$\left.\frac{\mathrm{d}Y}{\mathrm{d}t}\right|_{t=1/\varepsilon^*} = -\left(\frac{A}{1-t^*}\right)\cdot\left(t + \frac{1}{\varepsilon}\right)\frac{\mathrm{d}t^*(t)}{\mathrm{d}t} > 0 \quad \text{for the game } G_H, \tag{24}$$

and that of Eq. (23) at $t^* = 1/(1+\varepsilon)$ is

$$\left.\frac{\mathrm{d}Y^*}{\mathrm{d}t^*}\right|_{t^*=1/(1+\varepsilon)} = -\left(\frac{A}{1-t}\right)\left(\frac{t^*}{1-t^*} + \frac{1}{\varepsilon^*}\right)\frac{\mathrm{d}t(t^*)}{\mathrm{d}t^*} > 0 \quad \text{for the game } G_F. \tag{25}$$

According to Eq.(24), the home government would have a higher national income by raising its tax rate t from t_C. Consequently, t_H is larger relative to t_C, because the home government would have the highest national income on the foreign reaction curve in the game G_{2H}. The analogous argument on G_{2F} demonstrate that t_F^* is larger than t_C^*. As shown before, one country's national income is decreasing in another country's tax rate. Hence, Y_F is smaller than Y_C due to $t_F^* > t_C^*$, while Y_H^* is smaller relative to Y_C^* due to $t_H > t_C$.

Tab. 1 shows the payoffs to the two countries when a particular pair of strategies is chosen are given in the appropriate cell of the bi-matrix under the deduction. By convention, the payoff to the home government is the first payoff given, followed by the payoff to the foreign government.

Table 1: Payoff Matrix with Deduction Method

		Foreign Country: *First-Move*	Foreign Country: *Second-Move*
Home Country	*First Move*	$\underline{Y_C}$ $\underline{\hat{Y}_C^*}$	$\underline{Y_H}$ Y_H^*
Home Country	*Second Move*	Y_F $\underline{Y_F^*}$	Y_C Y_C^*

In a two players-game, a brute-force approach begins as follows: for each player and for each feasible strategy for that player, determine the other player's best response to that strategy. That is to say, this approach to finding a game's Nash equilibrium is simply to check whether each possible combination of strategies satisfies the Nash equilibrium condition:

$$Y(\hat{M},\hat{M}^*) \geq Y(M,\hat{M}^*) \text{ as well as } Y^*(\hat{M},\hat{M}^*) \geq Y(\hat{M},M^*). \tag{26}$$

Tab. 1 does this for this game by underlining the payoff to one government's best response to another one's feasible strategies. A pair of strategies satisfies the Nash equilibrium condition (26) if both payoffs are underlined in the corresponding cell of the matrix. Consequently, a pair of the home and the foreign Nash equilibrium move with the deduction method are (*First Move*, *First Move*), i.e. simultaneous moves. The above can be stated. ■

Based on the backward-induction, the next section will now examine a Nash equilibrium timing after the consideration of tax rate game under the credit method.

5. Credit Method

The argument on tax rate game with the credit method yields the following lemma:

Lemma 4: *With the credit method, the Stackelberg equilibrium tax rates give a positive capital flow, whereas the Cournot equilibrium tax rates eliminate capital movement.*

Proof: Before the detailed arguments on equilibriums, let us show some results. Substituting Eq.(5) and (7) into Eq. (12) gives:

$$
\mathrm{d}Y = \begin{cases} -A\left[\left(\dfrac{t-t^*}{1-t^*}-\dfrac{1}{\varepsilon^*}\right)\dfrac{\mathrm{d}t}{1-t}+\dfrac{\varepsilon+\varepsilon^*}{\varepsilon\varepsilon^*}\dfrac{\mathrm{d}t^*}{1-t^*}\right] & \text{as } t > t^*, \\ \\ -\dfrac{A}{\varepsilon}\dfrac{\mathrm{d}t^*}{1-t^*} & \text{as } t \le t^*. \end{cases} \tag{27}
$$

Substituting Eq.(5) and (7) into Eq. (13) derives

$$
\mathrm{d}Y^* = \begin{cases} -A\left[\left(\dfrac{t^*}{1-t^*}+\dfrac{1}{\varepsilon^*}\right)\dfrac{\mathrm{d}t}{1-t}-\dfrac{\varepsilon+\varepsilon^*}{\varepsilon\varepsilon^*}\dfrac{\mathrm{d}t^*}{1-t^*}\right] & \text{as } t > t^*, \\ \\ -A\left(\dfrac{t^*}{1-t^*}-\dfrac{1}{\varepsilon}\right)\dfrac{\mathrm{d}t^*}{1-t^*} & \text{as } t \le t^*. \end{cases} \tag{28}
$$

Let begin with the discussion on the home reaction function. For $t \le t^*$, changes in the home tax rate have no effect on the home real national income, since the location of home capital is not affected and the home government receives no tax revenue. For $t > t^*$, the increases in the home tax rate raise additional revenue, but also reduce the volume of capital exports. The optimal choice of t occurs where these two effects are just balanced, which will be when $(t-t^*)/(1-t^*) = 1/\varepsilon^*$. In this case, the second-order condition for the home government's maximization problem requires:

$$
\frac{\partial^2 Y}{\partial t^2} = -\frac{\partial}{\partial t}\left(\frac{A}{1-t}\right)\cdot\left(\frac{t-t^*}{1-t^*}-\frac{1}{\varepsilon^*}\right)-\left(\frac{A}{1-t}\right)\cdot\frac{\partial}{\partial t}\left(\frac{t-t^*}{1-t^*}-\frac{1}{\varepsilon^*}\right) < 0 .
$$

This equation must satisfy at least $(\partial/\partial t)[(t-t^*)/(1-t^*)-1/\varepsilon^*] > 0$, i.e., $(\partial\varepsilon^*/\partial Z) < 0$ from Eq.(7). Totally differentiating the home reaction function $(t-t^*)/(1-t^*) = 1/\varepsilon^*$ gives the slop of it:

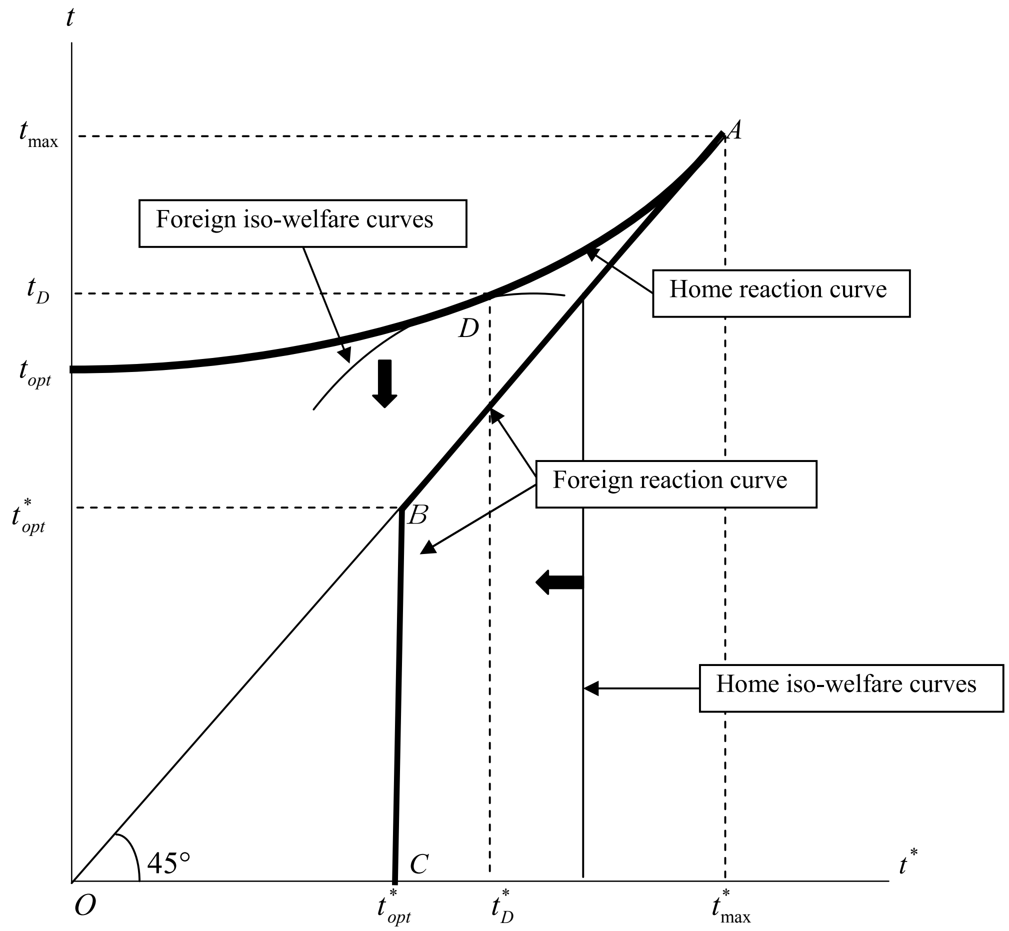
$$
\frac{\mathrm{d}t(t^*)}{\mathrm{d}t^*} = \left(\frac{\varepsilon^*}{1-t^*}\right)\Bigg/\left(\varepsilon^* + (t-t^*)\frac{\partial\varepsilon^*}{\partial t}\right) > 0 \qquad \text{for the home reaction curve.}
$$

Also, the home government's best reply to the foreign tax rate satisfies $t > t^*$ if $Z > 0$. Therefore, the home reaction curves lie above the $t = t^*$ line for all $t^* < t_{\max}$ as illustrated in Fig. 3.

We will turn to the consideration of the foreign reaction function. The increases in the foreign tax rate will reduce the home real national income in both regions of the diagram. When $t \le t^*$, the increases in the foreign tax rate reduce the amount of capital exports, reducing the home national income. When $t > t^*$, the increases in the foreign tax rate have no effect on the location of capital, but transfer tax revenue from the home government to the foreign one. When

$t > t^*$, it is always in the interest of the foreign government to raise its tax rate at least as high as the home tax rate, since these increases in tax rates raise the foreign tax revenue without altering the allocation of capital. Whenever $t < t^*_{opt} = 1/(1+\varepsilon)$, the optimal tax rate for the foreign government is t^*_{opt}, when the home government is passive. If $t > t^*_{opt}$, the optimal policy for the foreign government is to set $t = t^*$. Hence, the foreign reaction curve is illustrated in Fig. 3, and lies nowhere above the $t = t^*$ line.

Figure 3: Reaction Curves with Credit Method



Based on the above results, we will discuss the equilibrium of simultaneous game G_{2C}. Note that t_{opt}, (the home tax rate when the foreign tax rate is 0) and $t_{\max}$ (the tax rate that eliminates capital flows) have the same values as in the case of the deduction method. In addition, Fig. 3 illustrates the home iso-welfare curves obtained from Eq.(27) and the foreign ones originated from Eq.(28). According to Bond and Samuelson (1989), all Nash equilibria in the credit method gives $Z = 0$. The foreign reaction curve lies nowhere above the $t = t^*$ line, and the home reaction curve lies nowhere below it. The only possible Nash equilibria with trade will have $t = t^*$. From the discussion of the home and the foreign reaction curve above, this can occur only where a pair of the equilibrium tax rates are ($t_{\max}$,$t^*_{\max}$), which gives $Z = 0$. As a result, the above first fact can be derived.

Then, let us examine the sequential tax rate game. In the game G_{2H} , we study the case of $t \le t^*$ as for the home iso-welfare curves, because the foreign reaction curve lies below line $t = t^*$. Here, the home government sets its tax rate t such that the home iso-welfare curves thorough the interval BC is tangent to the foreign reaction curve, because the home iso-welfare curves is vertical line and is decreasing in t. As a result, the home and the foreign equilibrium tax rate are [0, t^*_{opt}] and t^*_{opt} respectively. Clearly, if the home tax rate is irrelevant, t^*_{opt} induces $Z > 0$. In the game G_{2F} , we analyze the case of $t > t^*$, because the home reaction curve is located above line $t = t^*$. The analogous discussion indicates that the foreign government chooses its tax rate such that the foreign iso-welfare curves thorough the point D is tangent to the home reaction curve. Consequently, that the home and the foreign equilibrium tax rate are a pair of t_D and t^*_D . Lemma 2 indicates that an increase of capital flows from zero increase each country's national income if the credit method is employed and $t > t^*$. Moreover, the leader governments would have a highest national income on the follower government's reaction curve in each game. Consequently, the above second result can be thus derived. ■

Based on the outcomes of tax rate game, we can state the following proposition with respect to the sequencing.

Proposition 2: *The credit method would cause a sequential move game in a Nash equilibrium.*

Proof: We will use a brute-force approach to prove this proposition as well. Tab.2 shows the payoffs to the two countries when a particular pair of strategies is chosen are given in the appropriate cell of the bi-matrix under the credit method. Here, a pair of (Y_j ,Y^*_j) denotes the home and the foreign national incomes that correspond to the equilibrium point j ($j = A, BC, D$).

Table 2: Payoff Matrix with Credit Method

		Foreign Country: *First-Move*	Foreign Country: *Second-Move*
Home Country	*First Move*	Y_A Y^*_A	$\underline{Y_{BC}}$ $\underline{Y^*_{BC}}$
Home Country	*Second Move*	$\underline{Y_D}$ $\underline{Y^*_D}$	Y_A Y^*_A

According to Lemma 2, the increase of capital flow Z from zero raises each country's national incomes. Moreover Lemma 4 indicates that with the credit method, the Stackelberg equilibrium tax give $Z > 0$ but that the Cournot ones causes $Z = 0$. Then, we can demonstrate that $Y_{BC} > Y_A$ and $Y^*_{BC} > Y^*_A$, as well as that $Y_D > Y_A$ and $Y^*_D > Y^*_A$. Consequently, a pair of the home and the foreign Nash equilibrium move with the credit method is (*First Move*, *Second Move*) or (*Second Move*, *First Move*), i.e. sequential moves. The above can be stated. ■

As shown above, the credit method has two equilibriums as for sequencing. When we take a pair of (*Fist Move, Second Move*) as one Nash equilibrium with the credit method, the following proposition can be derived:

Proposition 3: *If the credit method is applied, the foreign country could have a highest level of economic welfare whereas the home country would be worse off relative to the deduction method in a Nash equilibrium with endogenous sequencing.*

Proof: Before proceeding to a more detailed discussion, we have to discuss the preliminary facts. As shown above, with the credit method, each country would have respectively Y_{BC} and Y^*_{BC} by setting a pair of the equilibrium tax rates. According to Eq.(2) and (3), each national income depends on tax rates and capital flows. In addition, the capital market equilibrium conditions (4) and (5) are identical when one government's tax rate is zero. Accordingly, if both governments set a pair of tax rates (0, t^*_{opt}) under the deduction method, each national income would be Y_{BC} and Y^*_{BC} respectively. That is to say, since the credit method can be regarded as a special case of the deduction method, the economic welfare with alternative tax rules are comparable under the deduction method.

Based on the preliminary discussion, let us compare the equilibrium national incomes with alternative tax rules. In other words, we make a comparison between a par of (Y_{BC}, Y^*_{BC}) and (Y_C, Y^*_C). When both governments adapt a pair of (0, t^*_{opt}), the value of Eq.(18) would become

$$\left.\frac{\mathrm{d}Y}{\mathrm{d}t}\right|_{t=0} = \frac{A}{\varepsilon^*} > 0 .$$

That is to say, the home government can increase national income by setting a positive tax rate. As shown before, the equilibrium tax rates of both countries are positive under the deduction method. Consequently, we can demonstrate that Y_C is larger than Y_{BC}. In other words, the home government would have a higher national income under the deduction than the credit method. On the other hand, an inspection of Eq.(19) shows that the foreign national income is decreasing in the home tax rate. In addition, the horizontal intercept of the foreign reaction curve, t^*_{opt}, satisfies with the foreign optimal condition $t^* = 1/(1+\varepsilon)$. Accordingly, a pair of the equilibrium tax rates (0, t^*_{opt}) would yield the highest level of the foreign national income under the deduction method. As a result, the above proposition can be derived. ■

Some traditional industrious organization theory show that if both optimal reactions slope downwards, i.e. strategic substitutes, both players have a first-mover advantage, as well as that if both optimal reactions slope upwards i.e. strategic complements, at least one player has a second-mover advantage. In this model, the reaction curves of both countries slop downward under the deduction method, while those slope upward with the credit method. The above contributions can assist this proposition.

6. Concluding Remarks

This paper examines the impact on capital flows and economic welfare of alternative domestic income tax policies toward foreign income tax payments, in a setting of international tax competition. Unlike existing studies, we investigate the strategic decisions of not only the corporate tax rate but also the timing of whether governments move simultaneously or sequentially.

The analysis implies the following two main outcomes based on the Nash equilibrium with endogenous sequencing. First, the deduction method derives a simultaneous move game whereas the credit method causes a sequential one. Second, a capital-exporting country would be better off under the deduction, while a capital-importing country could have a highest economic welfare under the credit method.

The first findings can be interpreted as follows. Governments would have a strategic substitutive relationship with the deduction method but a strategic complementary one with the credit method. According to Amir and Stepanova (2006), at least one player has a second-mover advantage if both optimal reactions are a strategic complement. Therefore, a sequential timing seems to be endogenously caused in the equilibrium with the credit method.

The second outcomes are significantly opposed to the results of the previous analysis which either tax rule can allow both countries to be better off than another (for example, Hamada, 1966 and Bond and Samuelson, 1989). The discrepancy seems to arise from the different assumptions about the timing of strategy decision.

Finally, according to these results, this study draws the following policy implication: the deduction method derives the simultaneous setting of tax rates and raises the economic welfare of a capital-exporting country; the credit method yields the sequential tax rate decision and could maximize that of a capital-importing country.

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